Quality Assurance Project Plan (QAPP)

Stream and Outfall Monitoring Program

Friends of the Bay

Oyster Bay, New York

July 2007

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1.0 TITLE AND APPROVALS

Friends of the Bay
Stream and Outfall Monitoring Program

Prepared by:

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Prepared for:

U.S. Environmental Protection Agency
Region 2

Effective July 1, 2007

Approved by:

Representative, Board of Directors — Date 08/16/2007
Friends of the Bay

Kyle Rabin, Executive Director — Date 08/16/07
Friends of the Bay

Patricia Aitken, Program Coordinator — Date 8/16/07
Friends of the Bay

David Relyea, Quality Assurance Officer — Date 8/16/07
Friends of the Bay

U.S. EPA QA Officer — Date 09/05/07

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3.0 DISTRIBUTION LIST

The following individuals and organizations will receive a copy of the Friends of the Bay Stream and Outfall Monitoring Program approved Quality Assurance Project Plan (QAPP) and any subsequent revisions.

- Mark Tedesco, United States Environmental Protection Agency
- Paula Zevin, United States Environmental Protection Agency
- Deborah Long, United States Fish and Wildlife Service
- Megan Grubb, United States Army Corps of Engineers
- Susan White, National Oceanic & Atmospheric Administration
- Peter Scully, Regional Director, Region I New York State Department of Environmental Conservation
- Charlie de Quillfeldt, New York State Department of Environmental Conservation
- Rick D'Amico, New York State Department of Environmental Conservation
- Christine Olsen, Connecticut Department of Environmental Protection
- Greg Capobianco, New York State Department of State, Division of Coastal Resources
- Dennis Mildner, New York State Department of State, Division of Coastal Resources
- John Jacobs, Nassau County Department of Health
- Vito Mineo, Suffolk County Department of Health Services
- Kenneth G. Arnold, Nassau County Director of Public Works
- Thomas F. Maher, Nassau County Director of Environmental Coordination
- Carrie Meek Gallagher, Deputy Director of Planning for Suffolk County
- Sherry Forgash, Nassau County Soil and Conservation Water District
- Neil Bergin, Commissioner, Town of Oyster Bay Department of Environmental Resources
- James Byrne, Town of Oyster Bay, Department of Public Works
- Eric Swenson, Hempstead Harbor Protection Committee
- Kimberly Zimmer, New York State Sea Grant
- Ailene Rogers, Cornell Cooperative Extension of Suffolk County
- David Relyea, Co-Owner, Frank M. Flower and Sons Oyster Company
- Thomas D. Galasso, Commissioner, Oyster Bay Sewer District
- Jim Schultz, North Oyster Bay Baymen's Association

4.0 PROJECT AND TASK ORGANIZATION

4.1 Project Organization and Personnel Responsibilities

The Stream and Outfall Monitoring Program that will be implemented by Friends of the Bay will complement the existing open water body monitoring program within the Oyster Bay/Cold Spring Harbor estuary. The objectives of the stream and outfall monitoring program are to establish current baseline water quality conditions in the watershed, identify water quality impacts from potential point and non-point pollution sources, begin developing a water quality database for the watershed to guide environmental decision-making, and measure the progress toward meeting water quality goals in the watershed.

These objectives will be accomplished by collecting samples from 10 major discharges into the estuary. These discharges include streams, ponds, an untreated sewage discharge, and a "rotating "outfall that will change for each event in an effort to identify other pollutant sources (criteria for selecting the "rotating "outfall are presented in Section 10.1). Samples will be collected four times per year. Two of these monitoring events will occur following a period without precipitation ("dry" events), and the remaining two will occur during precipitation events ("wet" events). The dry events will be used to characterize background constituent inputs, and the wet events will be used to estimate additional pollutant loadings that occur as a result of precipitation runoff.

Samples will be analyzed for a variety of biological, chemical, and physical parameters including fecal coliform and escherichia coli bacteria, ammonia, nitrate/nitrite, total kjeldahl nitrogen, chemical oxygen demand, total phosphorus, turbidity, dissolved oxygen, hardness, lead, copper, zinc, pH, and temperature.

The organizational chart prepared for this project, the Friends of the Bay Stream and Outfall Monitoring Program, is presented in Figure 1. The Quality Assurance (QA) Officer and Field Sampling Leader are responsible for the implementation of the QAPP. Table 1 presents the responsibilities of the personnel that are involved with the project. For the purposes of this QAPP, the Program Manager, Field Sampling Leader, and QA Officer positions are considered to be the managers of this project (Project Managers).

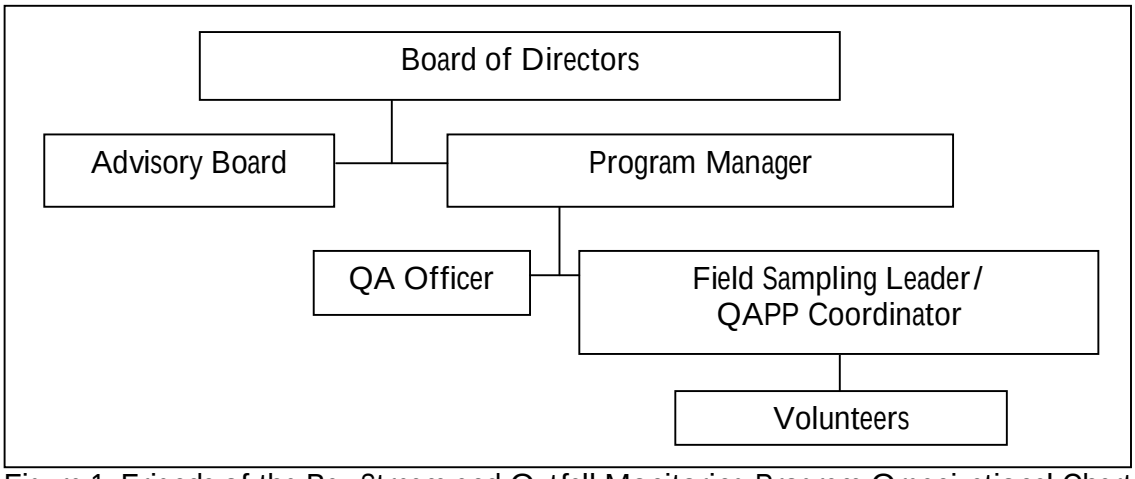

Figure 1: Friends of the Bay Stream and Outfall Monitoring Program Organizational Chart

4.2 Communication Pathways

Tasks to be accomplished during the monitoring events will be communicated between field personnel and managers following the Standard Operating Procedures presented in Appendix A. The QAPP will be reviewed by the Program Manager, Field Sampling Leader, and QA Officer at the beginning of each monitoring season. If issues arise during monitoring program implementation, these personnel will discuss and institute any necessary changes. Issues pertaining to field activities or laboratory analyses will be addressed by the Program Manager, QA Officer, or the Field Sampling Leader.

4.3 Modifications to QAPP

Modifications to this QAPP will be initiated by the Program Manager. When documenting amendments to the QAPP, the reasons for the changes will be outlined in a revision/modification log as will a description of how the changes are expected to affect the quality and usability of the data to be collected. Proposed changes to the QAPP will be submitted to EPA for review and approval.

5.0 SPECIAL TRAINING NEEDS AND CERTIFICATION

5.1 Project Management Personnel Training

Managers for Friends of the Bay Stream and Outfall Monitoring Program are required to be familiar with this QAPP and the Standard Operating Procedures (SOPs) presented in Appendix A. Additionally, the QA Officer will be trained in the use of the data verification procedures presented in Section 16. The Field Sampling Leader will be trained in the operation, calibration, and maintenance of field data collection equipment and will be familiar with appropriate field sampling procedures. Training will be provided by an individual that is experienced with similar monitoring equipment and sampling techniques (i.e. an experienced volunteer or staff member, field staff from a lab, etc.). Training provided by the sampling equipment manufacturers, if available, is preferred. The QA Officer and Field Sampling Leader should have prior water quality monitoring experience through this program, a similar program, or through work or education.

Project management performance will be evaluated during any cooperative monitoring events undertaken with similar water quality monitoring groups or environmental monitoring professionals (e.g.., representatives from EPA, Coalition to Save Hempstead Harbor/Hempstead Harbor Protection Committee, Nassau County Department of Health, South Mall Analytical Labs). Deficiencies will be corrected with the procedures presented in Section 0.

Table 1: Water Quality Monitoring Program Personnel Responsibilities

Title	Name	Affiliation	Responsibility
Board of Directors	Beth Dalton-Costello, Fritz Coudert, Matthew T. Meng, Dee Jae Diliberto, Roderick Williams, Stephen Gatfield, John M. Williams, Leland Hairr, Rosemary Bourne, Michael Held, Dr. Dorothea Cappadona, Clayton A. Prugh, Michael Chalos, David Relyea, Carolyn Core-Kenavan, Brian Walsh	Friends of the Bay	1. Recommends changes to monitoring program 2. Reviews and approves the QAPP 3. Discusses and approves changes in monitoring program 4. Reviews and approves budgets
Advisory Board	Roger L. Bahnik, Christopher Pascucci, Carter Bales, Elizabeth Roosevelt, Wendy Doremus, Lawrence Schmidlapp, Ralph Fumante, Clinton Smith, John Grace, Cynthia Stebbins, Barry Lamb, Frances R. Storrs, Frances Leone, Jean Thatcher	Friends of the Bay	1. Recommends changes to monitoring program 2. Recommends changes to the QAPP 3. Discusses and approves changes in monitoring program
Program Manager	Kyle Rabin, Executive Director	Friends of the Bay	1. Reviews and approves changes to the QAPP 2. Determines if QAPP revisions are necessary 3. Maintains correspondence with other groups 4. Coordinates grant applications
Field Sampling Leader	Patricia Aitken, WQMP Coordinator	Friends of the Bay	1. Organizes daily operation of monitoring program 2. Schedules activities related to monitoring program 3. Ensures that equipment are properly maintained and that consumables are available 4. Train volunteers and field samplers in the procedures described in this QAPP 5. Procures analytical services 6. Supervises sample handling 7. Tracks samples to verify that they reach the laboratory
Quality Assurance Officer	David Relyea, Board of Director	Friends of the Bay	1. Recommends changes to the QAPP when necessary 2. Reports data quality deficiencies to Program Manager 3. Oversees audits or data validation as mandated by this QAPP 4. Assesses whether laboratory elements outlined in the QAPP are followed 5. Monitors laboratory compliance with the QAPP and oversees data verification activities
Field Sampler	Varies	Friends of the Bay	1. Assists the Program Manager as necessary 2. Collects samples and collects and records field data 3. Assists in maintaining field equipment

5.2 Volunteer and Municipal Employee Training

Prospective volunteers and municipal employees (hereinafter "volunteers" or "volunteer") will meet with Project Managers for information regarding the monitoring program. Interested individuals will be formally trained before participating in a monitoring event. Training will include a discussion of this QAPP, the program's SOPs, and any other procedures that are necessary. Topics will typically include:

- Monitoring program background and purpose.
- The QAPP and SOPs.
- Field equipment care and maintenance, including:
    - Calibration
    - Checking the calibration
    - Checking items that wear (membrane, etc.)
- Appropriate sample collection procedures.
- Sample handling and labeling.
- Potential safety hazards.

Hands-on volunteer training will be provided during regularly scheduled sampling events. Volunteer performance will be monitored informally by Project Managers during sampling, or during cooperative sampling events with members of other groups or environmental professionals. Deficiencies will be corrected with the procedures presented in Section 5.3. A volunteer will not be permitted to sample without the Field Sampling Leader or his/her designee unless s(he) has proven to be familiar with this QAPP, the SOPs, and has demonstrated proficiency with required procedures.

5.3 Corrective Procedures

Individuals requiring additional instruction will receive instruction in the field at the time of sampling or will receive additional training prior to the next sampling event in which they participate. Systematic (group-wide) deficiencies may require revision of the monitoring protocols, QAPP, Standard Operating Procedures, Data Quality Objectives (see Section 8.0), and other program documents. Deficiencies will be noted and the training program revised to improve future groupwide performance.

5.4 Laboratory Accreditations

Accreditations for the Nassau County Department of Health Laboratory are in Appendix C.

6.0 PROBLEM DEFINITION AND BACKGROUND

6.1 Problem Definition

The project consists of water quality monitoring of selected streams and storm drainage system outfalls within the Mill Neck Creek, Oyster Bay, and Cold Spring Harbor watersheds on the north shore of Long Island. The program will complement Friends of the Bay's Open Water Body Monitoring Program, which is designed to monitor ambient water quality conditions in the Oyster Bay/Cold Spring Harbor complex. The data will be used to:

- Identify potential pollutant sources in the watershed.
- Track known or suspected pollutant sources in the watershed.
- Associate land use activities with water quality problems.
- Monitor aquatic habitats.
- Investigate long-term trends in water quality parameter levels.
- Guide municipal and county level environmental planning, policy, and compliance efforts (i.e. the Phase II Stormwater Program, inappropriate land development, TMDL development).
- Measure progress towards meeting water quality goals in the watershed.

Potential data users include Friends of the Bay, Nassau County Department of Health, Nassau County Department of Public Works, Suffolk County Department of Health Services, the Interstate Environmental Commission, the New York State Department of Environmental Conservation, the Connecticut Department of Environmental Protection (Office of Long Island Sound Programs), Long Island Sound Study, U.S. Fish and Wildlife Service, the Town of Oyster Bay, the Town of Huntington, and the other communities and municipalities surrounding the embayment complex.

6.2 Background

The Oyster Bay/Cold Spring Harbor Complex, the cleanest estuary in western Long Island Sound, is a vital ecological, economic and recreational resource. However, the estuary and the surrounding watershed have been facing increasing challenges in recent years. Among the threats are: polluted stormwater runoff; illegal dumping; untreated sewage; haphazard, uncoordinated, and unsustainable development; loss of open space and habitat; dammed streams and other barriers that inhibit fish passage; and non-native invasive species.

The Stream and Outfall Monitoring Program that will be implemented by Friends of the Bay will complement the existing open water body monitoring program within the Oyster Bay/Cold Spring Harbor estuary. The objectives of the stream and outfall monitoring program are to establish current baseline water quality conditions in the watershed, identify water quality impacts from potential point and non-point pollution sources, begin developing a water quality database for the watershed to guide environmental decision-making, and measure the progress toward meeting water quality goals in the watershed.

The collected data will support the Oyster Bay/Cold Spring Harbor Complex Harbor Management Plan, and establish background data to support the preparation of a State of the Watershed Report and a Watershed Action Plan.

7.0 PROJECT AND TASK DESCRIPTION

Friends of the Bay will monitor selected inflows to Mill Neck Creek, Oyster Bay, and Cold Spring Harbor. These inflows may include streams, pond outflows, stormwater discharges, and wastewater discharges. Table 2 presents a summary of the monitoring locations selected for this program. A map of these monitoring locations is attached as Appendix A. The selected monitoring locations include major tributary inflows into the embayment complex, known pollutant point sources, and uncharacterized point sources. Friends of the Bay may revise the

list of monitoring locations (i.e. add or remove locations) based on the monitoring results and subsequent investigations).

Table 2. Summary of Monitoring Locations

ID	Location	Coordinates	Description
OBS –1	The Birches Sewage Outfall	40º54 17 ” N 73º34 57 ” W	Adjacent to end of pipe, accessible from Meleny Road
OBS –2	Beaver Lake Outflow	40º53 15 ”N 73º33 48 ” W	South side of Robert De Graff Causeway upstream of and adjacent to waterfall
OBS –3	Beekman Creek	40º52 34 ” N 73º32 34 ” W	West Side of West Shore Road
OBS –4	Upper Mill River	40º52 01 ” N 73º32 29 ” W	South Side of Glen Cove Road adjacent to apartments
OBS –5	Mill River Outflow	40º52 27 ” N 73º32 25 ” W	Mill River upstream of Beekman Creek culvert and tidal influence
OBS –6	White ’s Creek	40º52 27 ” N 73º31 41 ” W	Adjacent to South Street upstream of tidal influence, near Commander Oil Terminal
OBS –7	Tiffany Creek	40º52 19 ” N 73º30 11 ” W	North side of Cove Neck Road
OBS –8	DeForest Pond Outflow	40º52 14 ” N 73º27 41 ” W	North of intersection of Shore Road and Spring Street in Cold Spring Harbor
OBS –9	St. John ’s Pond Outflow	40º51 25 ” N 73º27 48 ” W	South of road on top of dam adjacent to fish hatchery, south of Route 25A and west of Lawrence Hill Road
OBS –10	Rotating Outfall	Varies	Select 1 outfall during each wet weather event, and 1 outfall where discharge is occurring during a dry weather event. See Section 10.1 for detailed outfall selection criteria

A number of these monitoring locations are near the Friends of the Bay Open Water Body Water Quality Monitoring Program monitoring locations. Collected data from the stream and outfall monitoring program may be used to identify the input location of elevated pollutant levels that are observed as part of the open water body program (see Section 10.0 for a detailed discussion).

Collected data will include field measurements taken at the time of sampling, as well as laboratory analysis of collected samples. Parameters will include general physical and water quality constituents (e.g., specific conductivity, temperature, dissolved oxygen) as well as nutrients (e.g., species of nitrogen) and common stormwater pollutants (e.g., metals, bacteria). Table 3 presents a summary of parameters that will be monitored as part of this program, including applicable water quality standards.

Table 3: Parameters and Methods

Constituent	Use of Data	Standard (Class C Waters) 6 NYCRR 703	Method	Laboratory
Fecal Coliform	Indicate possible pollution by animal or human feces	Monthly geomean for minimum of 5 samples $\leq$ 200 #/mL	SM 9221E	NCDH Laboratory
Escherichia Coli	Indicate pollution by mammalian feces	N/A	EPA 1600	NCDH Laboratory

Constituent	Use of Data	Standard (Class C Waters) 6 NYCRR 703	Method	Laboratory
Ammonia	Calculate nutrient loadings, indicate possible fertilizer or sewage pollution, indicate aquatic toxicity	2 mg/L for water source. Temperature and pH dependent for aquatic toxicity	LACHAT 10-107-06-1-B	South Mall Analytical Labs
NO2/NO3	Calculate nutrient loadings, indicate fertilizer pollution	10 mg/L	EPA 354.1/353.3	South Mall Analytical Labs
Total Kjeldahl Nitrogen	Calculate nutrient loadings, calculate total nitrogen	Sum of TKN and NO2/NO3 ≤ 10 mg/L	LACHAT 10-107-06-2	South Mall Analytical Labs
Chemical Oxygen Demand	Assess loadings of oxygen-depleting compounds, oils, greases, and biodegradable pollutants	N/A	EPA 410.1	South Mall Analytical Labs
Total phosphorus	Assess nutrient enrichment in watershed	None in amounts that will result in growth of algae, weeds, and slimes.	EPA 365.3	South Mall Analytical Labs
Specific Conductance	Identify road salt runoff and industrial loadings, calculate DO saturation	Dissolved solids <500 mg/L*	Table 3 of ISO 7888-1985	Field
Total Suspended Solids	Identify watershed sources of particulate material for solids loadings	None that will cause deposition or impair water from best usages	SM 18-20 2540D	South Mall Analytical Labs
Turbidity	Secondary measure of solids, for future substitution for TSS (See Section 10.4)	Reference condition for EPA Ecoregion 84 = 1.78 FTU	EPA 180.1/SM 2130B	South Mall Analytical Labs
Dissolved Oxygen	Identify oxygen-depleted inputs	For non-trout waters, daily average of samples ≥ 5 mg/L, each sample ≥ 4 mg/L	EPA 360.1	Field
Hardness	Used to calculate toxicity of other parameters	N/A	EPA 130.2	South Mall Analytical Labs
Lead	Indicate industrial runoff, identify toxicity	Hardness-dependent. Typical values are ≤0.026 and ≤0.0010 mg/L acute and chronic toxicity, respectively**	EPA 200.7	South Mall Analytical Labs
Copper	Indicate industrial runoff, identify toxicity	Hardness-dependent. Typical values are ≤0.0043 and ≤0.0032 mg/L acute and chronic toxicity, respectively**	EPA 200.7	South Mall Analytical Labs
Zinc	Indicate industrial runoff, identify toxicity	Hardness-dependent. Typical values are ≤0.0297 and ≤0.0422 mg/L acute and chronic toxicity, respectively**	EPA 200.7	South Mall Analytical Labs
pH	Ammonia toxicity is pH dependent	between 6.5 and 8.5 S.U.	Electrometric	Field
Temperature	Identify thermal pollution, calculate DO saturation	90ºF for non-trout waters 70ºF for trout waters Other Criteria†	Electrometric	Field

**Total dissolved solids = 0.64 x Specific Conductance, per the Quanta manual (Appendix E).*

***For hardness = 30 mg/L*

†See 6 NYCRR 704

Four sampling events will occur each year as part of this monitoring program. Two of these annual monitoring events will be dry weather events, where samples will be collected following

at least 72 hours of dry weather (no previous storms of 0.1 inch or greater). These results will be used to evaluate dry weather stream and outfall characteristics, and identify possible illicit discharges. The other two annual monitoring events will be wet weather events, where samples will be collected no more than 6 hours following the start of a precipitation event of 0.5 inches or more, and that occurred at least 72 hours after a previous storm event of 0.1 inch or greater (i.e., following a minimum 72-hour antecedent dry period).

The sampling events will also be timed throughout the year to capture a variety of runoff conditions. Timing will include:

- One dry weather event in spring will be characteristic of spring runoff when high groundwater levels result in increased runoff flow.
- One dry weather event in late summer when stream flows are likely to be low, to characterize the quality of stream base flow.
- One wet weather event in late winter/early spring, after snowmelt, assess stream and outfall water quality shortly after the winter deicing season.
- One wet weather event in summer or fall to quantify typical stormwater quality characteristics.

The collected data will be summarized each year in the Friends of the Bay water quality monitoring Annual Report, along with data from the open water body monitoring program. The data may be used in other reports as well, including a planned State of the Watershed report and Watershed Action Plan.

The Field Sampling Leader will be present during monitoring events and will be assisted by volunteers. In instances where the field sampling leader will not be present, experienced volunteers that are familiar with this QAPP, the SOPs, and have demonstrated proficiency with the required procedures may sample with no supervision, provided that the Field Sampling Leader reviews and approves documentation resulting from the monitoring event (i.e., field data sheets, laboratory results).

8.0 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

8.1 Data Quality Objectives

Data quality objectives (DQOs) specify the quality of environmental data required to support decision making processes. The generation and use of quality data is important to the assessment of water quality within the harbor. Table 4 presents general DQOs for the stream and outfall monitoring program. A discussion of measurement performance criteria is presented in Section 8.2.

Table 4: General Data Quality Objectives for the Stream and Outfall Monitoring Program

Constituent	Precision	Accuracy	Range or Reporting Limit
Coliform and Enterococci	Variable, dependent on dilution	N/A, use ± 30% for duplicates	<2 to 160,000 MPN/100mL
Ammonia (concentration)	0.001 mg/L	± 30%	0.040 mg/L
Nitrate/Nitrite	0.001 mg/L	± 30%	0.010 mg/L
Total Kjeldahl Nitrogen	0.001 mg/L	± 30%	0.020 mg/L
Chemical Oxygen Demand	1 mg/L	± 30%	10 mg/L
Total phosphorus	0.001 mg/L	± 30%	0.010 mg/L
Specific Conductance	4 digits	± 5%	0 to 100 mS/cm
Total Suspended Solids	1 mg/L	± 20%	5 mg/L
Turbidity	0.1 NTU	± 20%	0.1 NTU
Dissolved Oxygen	0.2 mg/L < 20 mg/L	± 10%	0 - 50 mg/L
Hardness	0.1 mg/L	± 30%	0.1 mg/L
Lead	0.001 mg/L	± 30%	0.001 mg/L
Copper	0.001 mg/L	± 30%	0.001 mg/L
Zinc	0.001 mg/L	± 30%	0.001 mg/L
pH	0.1 su	± 0.3 SU	0 - 14 su
Temperature	0.01ºC	±5ºC	-5 to 50ºC

8.2 Measurement Performance Criteria

Data quality can be described in terms of precision, accuracy, completeness, representativeness, and comparability. Each of these terms is discussed in the following subsections.

8.2.1 Precision

Precision is defined as a measure of mutual agreement among individual measurements of the same type. In the case of laboratory analytical data, precision will be used to describe the reproducibility of the analytical data.

8.2.1.1 Sampling Measurement Systems

To assess precision in the field, a duplicate sample for all parameters to be analyzed by a laboratory will be collected nominally for every 20 samples per matrix for all parameters. The collection of field duplicates measures a combination of field and laboratory precision, thereby exhibiting more variability than a laboratory duplicate. Duplicates will not be obtained from split samples.

Additionally, a duplicate sample for parameters to be field-analyzed will be collected and analyzed for every 20 samples. Dissolved oxygen results from the Quanta meter will be validated with a sample from one location per monitoring event that will be analyzed by the modified Winkler titration method.

A calculation to determine Relative Percent Difference (RPD) between two corresponding sample results is performed. Relative Percent Difference (RPD) is used as a measure of precision. RPD limits are matrix and compound dependent. RPD is defined as follows:

$$RPD = \frac{|Conc(p) - Conc(d)|}{(1/2)(Conc(p) + Conc(d))} * 100$$

Where:
Conc(p) = Primary Sample Concentration, the first sample collected at that location
Conc(d) = Duplicate Sample Concentration, the second sample collected at that location

Precision performance criteria are included in Table 5 and Table 6. If a calculated RPD falls outside the criteria range, the discrepancy will be addressed on a case-by-case basis since the results are method, parameter and matrix dependent.

8.2.1.2 Laboratory Measurement Systems

The objective concerning precision is to equal or exceed the precision demonstrated in the analytical methods on samples of a similar matrix. Relative Percent Difference (RPD) is used as a measure of precision. The laboratory will analyze matrix spikes/matrix spike duplicates for relative percent difference. RPD is defined as follows:

$$RPD = \frac{|MSR - MSDR|}{(1/2)(MSR + MSDR)} * 100$$

Where:
MSR = matrix spike recovery
MSDR = matrix spike duplicate recovery

The absolute value of the recovery difference is used in the above equation.

Recovery limits are matrix and compound dependent. If necessary, corrective action by the laboratories will be performed according to the provisions of their Quality Assurance Plans. The Nassau County Health Department Lab implements Quality Assurance Standard Operating Procedures (SOPs) presented in Standard Methods (See Appendix D). South Mall Analytical Labs implements its own Quality Assurance Systems Manual, which is presented in Appendix D as well.

8.2.2 Accuracy

Accuracy can be defined as the degree of agreement of a measurement with an accepted reference or true value. Accuracy is generally expressed as the ratio of the measured value to the true value, which gives a measure of bias inherent in the system. Accuracy can be assessed both in the field and in the laboratory.

8.2.2.1 Field Measurement Systems

Accuracy will be measured for field activities to assess the performance of the project measurement systems. On the day of each monitoring event, the Quanta sonde and datalogger will be calibrated for dissolved oxygen (DO), salinity, and pH. The instrument will be calibrated using the procedure outlined in the user manual, presented in Appendix E. The calibration will then be checked by:

- Comparing DO results from the Quanta for one location to a result obtained via Winkler Titration for the same location.
- Comparing pH and specific conductance results from the Quanta to standard pH and specific conductance solutions (calibration solution) during the monitoring event (see Appendix E for details).
- Comparing the Quanta temperature results to results from a thermometer during the monitoring event.

These checks will be performed in the field during sampling. Calibration acceptance criteria, where applicable, are defined as DQOs in Table 6.

8.2.2.2 Laboratory Measurement Systems

Laboratory accuracy will be determined from laboratory control and surrogate samples, published historical data, method validation studies and experience with similar samples. The goal for spiked sample recoveries will be +/- 30%, since concentrations vary by compound. These concentrations vary from one compound to another. Quality Assurance SOPs implemented by the laboratories are presented in Appendix D.

8.2.3 Bias

Bias is the systematic or persistent distortion of a measurement process causing errors in one direction. Bias will be evaluated by considering factors associated with the sampling program design (i.e., time of sampling, weather conditions, choice of sampling sites), and through validation measurements using a modified Winkler titration method as described elsewhere in this plan.

8.2.4 Representativeness

The monitoring locations selected for the stream and outfall monitoring program are intended to monitor major freshwater inflows into Oyster Bay, Cold Spring Harbor, and Mill Neck Creek (e.g. stream and pond discharges),as well as point discharges, such as wastewater, and non-point source discharges, such as runoff from construction sites and development in the watershed.

The monitoring program includes a "rotating" monitoring location that can change from event to event in an effort to identify pollutant sources. Details regarding the selection of this outfall are presented in Section 10.1. Additionally, one monitoring location is upstream of the Mill River discharge to the estuary. This location was selected to examine changes in pollutant contributions within the Mill River watershed. The reach between the upstream and

downstream monitoring locations includes an apartment complex, numerous residences, Mill Pond, and freshwater wetlands.
If other locations of interest are identified (e.g., if the rotating outfall identifies significant pollutant sources), they will be considered for inclusion in this monitoring program.

Since these monitoring locations represent the major identified water and nutrient inputs to the estuary, a complete sampling event is intended to characterize the discharges to the estuary. Since the current intended use of the data is to characterize constituent levels in some of the major anthropogenic and tributary inputs to the estuary that have currently been identified, there is no specific representativeness requirement; e.g. if a sample is not collected during an event, the validity of the dataset will not be compromised.

However, if the data is to be used for other purposes, care will be taken to ensure that the collected data is representative for the intended use. In such an instance, the project managers will assess the data and the intended use and will determine if the intended use is appropriate, or recommend changes to the program that will result in collection of appropriate data.

The intended use will be assessed based on the required location (e.g. does the intended user require data for one tributary, comprehensive inputs to the estuary, or will the data be for comparison to another location?), the required parameters, analytical methods, reporting limits, etc. (e.g. does the intended use require total phosphorus to assess loadings, or orthophosphate to assess immediate availability to microorganisms?), the frequency of the data (e.g. are two wet and two dry events per year adequate?), and other factors that cannot currently be anticipated. The existing dataset will then be compared to the proposed use to determine if the needs are met. If the dataset existing at that time does not meet the intended use, the program managers will assess changes that need to be made to meet the use (e.g. require a lower reporting limit) and modify the QAPP accordingly. The modified QAPP will be submitted to EPA for approval. It is important to note that results from OBS-4 will not be directly representative of discharges to the estuary since it is located upstream.

8.2.5 Data Comparability

Comparability is an expression of the confidence with which one data set can be compared to another. The comparability objective is to collect and analyze samples using methods which will demonstrate that current data are comparable to data collected in previous and future investigations for this study area. The comparability of data is addressed by using standard protocols for the collection of field samples and by using standard methodologies for analytical procedures which were used in past investigations. If, for instance, it is determined that the laboratory used a different method than one specified, an evaluation will occur and document whether this has compromised the comparability of the data.

8.2.6 Data Completeness

Data completeness is the fraction of the planned data that is collected during a sampling program. Since a goal of the program is to monitor pollutant contributions to the embayment during varying meteorological conditions, it is important to attempt to monitor each location during each monitoring event. Program managers should evaluate the dataset if a sample cannot be collected, and attach appropriate qualifiers to the event results if necessary.

The completeness goal for each monitoring event is 80% (i.e. at least 8 of the 10 outfalls are sampled each time). The overall completeness goal for the program shall be 90% (i.e. only four samples of the 40 samples per year that are proposed to be collected can be missed). This arrangement will allow for some flexibility if difficulties arise during a particular event while ensuring that an adequate number of samples are collected overall.

However, uncollected or unanalyzed samples may not affect the goal of identifying potential pollutant sources (e.g. a high metals value at a particular outfall could still be useful as identifying a pollutant source or event even if the overall dataset does not meet the completeness criterion). As such, single sample data may be used to identify potential pollutant sources without the dataset meeting the completeness requirement.

8.2.7 Data Sensitivity

Sensitivity is the lowest detection limit of the method or instrument for each of the measurement parameters of interest. Laboratory analyses have preset limits of detection for the nitrogen analyses as well as the coliform bacteria and enterococci. Field sampling equipment have published specifications that include detection limits. Table 4 presents detection limits for the monitoring program water quality parameters.

9.0 NON-DIRECT MEASUREMENTS

9.1 Data from Other Sources

No additional data sources have been selected to be used in the monitoring program reports and data analysis. If other data is identified (e.g., Nassau County outfall monitoring data), its usability and comparability will be assessed. Such assessments will be included in this section of future revisions of the QAPP.

9.2 Surrogate Data

The proposed monitoring program includes turbidity and total suspended solids analysis such that turbidity measurements may be used by Friends of the Bay to estimate suspended solids levels in the future if a strong correlation is shown to exist between the two parameters. The method that will be used for this analysis is presented in Section 10.4.

10.0 FIELD MONITORING REQUIREMENTS

The monitoring program follows a judgment-based design intended to compare collected data with historical data and to provide a baseline for comparison with future monitoring results. A description of the monitoring locations, and the rationale for the selection of those locations, is presented in Section 8.2.4. The monitoring locations are presented in Appendix B.

10.1 Monitoring Process Design

The Friends of the Bay stream and outfall monitoring program is intended to identify potential upland sources of pollutants and causes of water quality impacts in the Oyster Bay, Cold Spring Harbor, and Mill Neck Creek estuary complex.

The monitoring program includes a "rotating" stormwater or wastewater outfall monitoring location that can change from event to event in an effort to identify pollutant sources given limited resources. Additionally, one monitoring location is upstream of the Mill River discharge to the estuary. This location was selected to examine changes in pollutant contributions within the Mill River watershed. The reach between the upstream and downstream monitoring locations includes an apartment complex, numerous residences, Mill Pond, and freshwater wetlands.

Stream and pond discharge monitoring locations include:

- OBS-2, Beaver Lake Outflow
- OBS-3, Beekman Creek
- OBS-5, Mill River Outflow
- OBS-6, White's Creek
- OBS-7, Tiffany Creek
- OBS-8, DeForest Pond Outflow
- OBS-9, St. John's Pond Outflow

Paired upstream and downstream locations include:

- OBS-4, Upper Mill River
- OBS-5, Mill River Outflow

Wastewater and stormwater discharge monitoring locations include:

- OBS-1, The Birches sewage outfall
- OBS-10, Rotating Outfall

10.1.1 "Rotating" Outfall Selection

Given the numerous stormwater outfalls to Oyster Bay and Cold Spring Harbor that have been identified by Nassau County, and the limited staff and financial resources of the Friends of the Bay Stream and Outfall Monitoring Program, a "rotating" outfall monitoring location is proposed for collection of regular monitoring data during the beginning of the program. The rotating outfall approach will allow flexibility for Friends of the Bay to select and monitor outfalls based on observations and data collected during monitoring.

The rotating outfall will be selected prior to each monitoring event, during regular open water body monitoring, or previous stream and outfall monitoring events. A quantitative rating system will be used to rank the outfalls based on the potential for water quality impacts, such as the presence of dry weather flows and poor discharge quality. When an outfall is identified for monitoring, it will be recorded in the Stream and Outfall Program Outfall Inventory Form (presented in Appendix I). The following information will be recorded:

- A unique outfall identifier
- GPS coordinates of the outfall
- The type of outfall (e.g. pipe or swale, construction material, etc.)

- The dimensions of the outfall
- Item A, whether flow was observed from the outfall (a '0' will be recorded if no flow is present, and a '1' will be recorded if flow was occurring)
- Item B, whether precipitation has occurred in the previous 24 hours (1 = yes, 2 = no)
- Items C through G, qualitative assessments of flow rate, color, suspended material, odor, and floatables, respectively (each on a scale of 0 - 5)

Program managers will add the results of Items C through G, and multiply by the product of Items A and B. The result will be a numerical value that can be used to rank the outfalls by sampling priority based on qualitative visual assessments, where outfalls with the highest values will be sampled first. The formula will result in the ranking of outfalls with discharges during dry weather (e.g. illicit discharges) as twice the value of wet-weather discharges. If no flow is observed, the outfall is ranked '0' and will be reassessed during a precipitation event. A clear, colorless, odorless discharge that is trickling during dry weather (such as the discharge of a spring in Cold Spring Harbor) will be ranked twice as high as a similar discharge during wet weather, but will be ranked lower than a slightly turbid, colored discharge with a strong odor but no floatables during wet weather.

The outfall for the first monitoring event will be identified from the outfall map prepared for the estuary by Nassau County outfall map, as amended. A copy of this map is presented as Appendix J.

10.1.2 Addition of Monitoring Locations

If other locations of interest are identified (e.g., if the rotating outfall identifies the potential for significant pollutant sources), they will be considered for inclusion as regular monitoring locations in this monitoring program. To make this determination, program managers will use the following criterion as a guide:

- "Significant" will mean that the results for at least one parameter are above the 85th percentile of results from that parameter from other monitoring locations

Based on the assessment of the data, program managers may consider adding a location even if it does not meet this criterion (e.g. two parameter levels are near but do not exceed the 85th percentile values).

10.1.3 Removal of Monitoring Locations

Program managers may consider removing monitoring locations following the first year of sampling if the monitoring results for that location are consistent and relatively low in level. To make this determination, program managers will use the following criteria as a guide:

- "Consistency" will mean that the results for each parameter vary by no more than +/- 50% from the running mean from the beginning of the program
- "Low in level" will mean below the 25th percentile of results for that parameter from all the locations

Program managers may consider removing locations that are close to meeting one or more of these criteria.

10.1.4 Sampling Parameters

Sampling parameters have been selected to characterize inputs to the estuary that could be toxic to aquatic life and indicate potential impacts from commercial and industrial land use (lead, copper, zinc, ammonia), to identify sources of nutrients that could result in algae blooms and subsequent low DO levels within the estuary and watershed waterbodies (Ammonia, NO2/NO3, Total Kjeldahl Nitrogen, Total phosphorus), to track low dissolved oxygen inputs, to quantify inputs of pollutants that consume oxygen upon discharge to the estuary (Chemical Oxygen Demand), and to quantify inputs of particulate matter to the estuary (Total Suspended Solids, turbidity).

Other parameters that are proposed for measurement are used to compare levels of other pollutants to significant thresholds (specific conductance, pH, hardness, temperature), to identify sources of bacteria pollution (E. Coli and Fecal Coliform), and to screen for potential illicit discharges, including potable water, domestic wastewater, and industrial discharges. Table 3 presents the intended use of each parameter.

Samples will be collected from the ten monitoring locations during two wet weather and two dry weather sampling events each year. Table 5 summarizes the sampling design logistics

Table 5: Sampling Design Logistics

Type of sample	Constituent	Number of Locations	Sample Type	Sampling Frequency
Bacteriological	Fecal Coliform	10	Grab sample	2 wet and 2 dry events/yr
Bacteriological	Escherichia Coli	10	Grab sample	2 wet and 2 dry events/yr
Chemical	Ammonia	10	Grab sample	2 wet and 2 dry events/yr
Chemical	NO_2/NO_3	10	Grab sample	2 wet and 2 dry events/yr
Chemical	Total Kjeldahl Nitrogen	10	Grab sample	2 wet and 2 dry events/yr
Demand	Chemical Oxygen Demand	10	Grab sample	2 wet and 2 dry events/yr
Chemical	Total phosphorus	10	Grab sample	2 wet and 2 dry events/yr
Physical	Specific Conductance	10	In-situ with Quanta	2 wet and 2 dry events/yr
Physical	Total Suspended Solids	10	Grab sample	2 wet and 2 dry events/yr
Physical	Turbidity	10	Grab sample	2 wet and 2 dry events/yr
Chemical	Dissolved Oxygen	10	In-situ with Quanta	2 wet and 2 dry events/yr
Chemical	Hardness	10	Grab sample	2 wet and 2 dry events/yr
Chemical	Lead	10	Grab sample	2 wet and 2 dry events/yr

Type of sample	Constituent	Number of Locations	Sample Type	Sampling Frequency
Chemical	Copper	10	Grab sample	2 wet and 2 dry events/yr
Chemical	Zinc	10	Grab sample	2 wet and 2 dry events/yr
Physical	pH	10	In-situ with Quanta	2 wet and 2 dry events/yr
Physical	Temperature	10	In-situ with Quanta	2 wet and 2 dry events/yr

10.2 Data Use between Programs

The data collected as part of the Stream and Outfall Monitoring Program may be useful to Friends of the Bay to identify potential causes of in-harbor water quality concerns. These concerns include high pollutant levels (such as high nitrogen levels or high bacteria levels) that were identified as part of the Open Water Body Water Quality Monitoring Program. Several of the stream and outfall monitoring locations are near open water monitoring locations. These stations include:

- OBS-1, which is less than 1.5 miles upstream of open water body locations FB-17, FB-16, FB-14, and FB-13.
- OBS-2, which is less than 1.5 miles upstream of FB-15, FB-14, and FB-13
- OBS-3 and OBS-5 are each within approximately ¼ mile of FB-10
- OBS-7 is near FB-7

Since OBS-1 and OBS-2 are major known pollutant sources and surface water discharges to Mill Neck Creek, samples at these locations may be useful in tracking sources of bacteria pollution that have previously been identified in the Creek.

High bacteria levels have been identified at FB-10 as well. Both Mill Pond and Beekman Creek discharge to Oyster Bay in that area. Sampling these two discharges as OBS-5 and OBS-3, respectively, will assist Friends of the Bay in determining or ruling out potential bacterial sources in that location.

Finally, OBS-7 is located near FB-7. If pollutants of concern are identified at FB-7, OBS-7 may assist in tracking the source into the watershed.

However, the data collected by the two programs may not be directly comparable since different parameters are proposed for collection (e.g. E. Coli instead of enterococci), and detailed analysis of the data collection methods have not been completed. As such, it may not be possible to analyze the data from both sources together. This limitation will not preclude the use of the data for tracking pollutant sources, since fecal pollution as measured by E. Coli in freshwater may still be traceable as enterococci in an estuarine receiving water. Additionally, differences in the timing of sample collection between the two monitoring programs may limit comparison of the two datasets.

10.3 Monitoring Methods

The Friends of the Bay stream and outfall monitoring program Standard Operating Procedures, presented as Appendix A, contain field data collection methods, operating instructions field analytical equipment, an equipment list, and field decontamination procedures. Table 6 presents methods used by field equipment and the limitations of those methods.

Table 6: Field Parameters and Limitations

Constituent	Method	Sampling Equipment/Bottle	Achievable Detection Limit	Range
Specific Conductance	Table 3 of ISO 7888-1985	Quanta, in field	N/A	0-100 mS/cm
Dissolved Oxygen	EPA 360.2 (Winkler)	Lamotte kit	0.2 mg/L	1-25 mg/L
Dissolved Oxygen	EPA 360.1 (Electrometric)	Quanta, in field	N/A	0-50 mg/L
pH	Electrometric	Quanta, in field	N/A	0-14 su
Temperature	Electrometric	Quanta, in field	N/A	-5-50 ºC

10.4 Field Quality Control

Parameters monitored in the field are recorded on a copy of the field data sheet presented in Appendix F. Field equipment is maintained as discussed in the SOPs presented in Appendix A. Table 7 presents a summary of field quality control requirements. Field quality control requirements are performed as necessary to assess field monitoring equipment and techniques, and to assess field sampling procedures for parameters that are analyzed by a laboratory.

Table 7: Field Quality Control Requirements

Constituent	Quality Indicator	Field QC Check	QC Action Frequency	DQO	Corrective Action
Coliform and Enterococci	Precision	Duplicate sample	Once per 20 samples	± 30%	Assess sampling technique
Coliform, Enterococci	Accuracy, Represent-ativeness	Temperature Control Sample	Each monitoring event	2 to 8ºC	Assess sample handling technique
Ammonia (concentration)	Precision	Duplicate sample	Once per 20 samples	± 30%	Assess sampling and analysis technique
Nitrate/Nitrite	Precision	Duplicate sample	Once per 20 samples	± 30%	Assess sampling and analysis technique
Total Kjeldahl Nitrogen	Precision	Duplicate sample	Once per 20 samples	± 30%	Assess sampling and analysis technique
Chemical Oxygen Demand	Precision	Duplicate sample	Once per 20 samples	± 30%	Assess sampling and analysis technique
Total phosphorus	Precision	Duplicate sample	Once per 20 samples	± 30%	Assess sampling and analysis technique
Specific Conductance	Accuracy	Check known reagent	Once per event	± 5%	Assess instrument calibration
Total Suspended Solids	Precision	Duplicate sample	Once per 20 samples	± 20%	Assess sampling and analysis technique
Turbidity	Precision	Duplicate sample	Once per 20 samples	± 20%	Assess sampling and analysis technique

Constituent	Quality Indicator	Field QC Check	QC Action Frequency	DQO	Corrective Action
Dissolved Oxygen	Accuracy	Winkler titration	Once per event	± 0.5 mg/L	Assess instrument calibration
Hardness	Precision	Duplicate sample	Once per 20 samples	± 30%	Assess sampling and analysis technique
Lead	Precision	Duplicate sample	Once per 20 samples	± 30%	Assess sampling and analysis technique
Copper	Precision	Duplicate sample	Once per 20 samples	± 30%	Assess sampling and analysis technique
Zinc	Precision	Duplicate sample	Once per 20 samples	± 30%	Assess sampling and analysis technique
pH	Accuracy	Check known reagent	Once per event	± 0.3 SU	Assess instrument calibration
Temperature	Accuracy	Thermometer	Once per event	+/- 1 ºC	Assess instrument calibration

10.5 Surrogate Analysis Methods

Turbidity data may be used to estimate suspended solids levels using a correlation between datasets[1]. Friends of the Bay will collect both turbidity and TSS data and will correlate TSS to turbidity, following every four monitoring events, by linear regression. If the coefficient of determination resulting from this (R^2 value) is greater than or equal to 0.9 and the correlation is statistically significant (p value of less than or equal to 0.05), Friends of the Bay will define the relationship as valid, and may estimate suspended solids levels from turbidity in future reporting and discontinue total suspended solids analysis. If R^2 is less than 0.9 or the p value is greater than 0.05, Friends of the Bay will continue to analyze samples for TSS and turbidity.

11.0 ANALYTICAL REQUIREMENTS

Friends of the Bay will submit samples to laboratories for the majority of the parameters included in the program. Bacteria analysis will be performed by the Nassau County Department of Health laboratory, and analysis of other parameters will be performed by South Mall Analytical Labs, Inc.

11.1 Analytical Methods

Each laboratory is accredited for the parameters that it will analyze, and will use the method listed in Table 3. Each lab will follow applicable internal QA/QA procedures and procedures described in the appropriate test method.

11.2 Analytical Quality Control

11.2.1 Equipment Blanks

Dedicated sampling equipment will be used; therefore no equipment blanks are required.

[1] Christensen, V.G., Jian, Xiaodong, Ziegler, A.C., 2000, *Regression Analysis and Real-Time Water-Quality Monitoring to Estimate Constituent Concentrations, Loads, and Yields in the Little Arkansas River, South-Central Kansas, 1995-99*. U. S. Geological Survey Water-Resources Investigations Report 00-4126.

11.2.2 Trip Blanks

Volatile organic compounds will not be analyzed; thus, trip blanks are not required.

11.2.3 Temperature Control Blank

A temperature control blank will be obtained from the NCDH laboratory prior to each sampling event. The blank will be packed with the samples to be analyzed for bacterial parameters, and the temperature checked upon delivery to the laboratory.

11.2.4 Field (Blind) Duplicate Samples

Duplicate samples (i.e. true duplicates, not split samples) will be collected to check the precision of the laboratory analysis and field sampling procedures. Duplicate samples will be analyzed for the same parameters as the corresponding primary samples collected at the same time. The duplicate sample set will be assigned a different sample number than the original set so that the sample identity is blind to the laboratory. One duplicate sample will be collected nominally per twenty samples per matrix and submitted to the laboratory.

11.2.5 Fixed Laboratory QC

Quality control samples that will be initiated by the laboratory (i.e., method blanks, instrument blanks, MS/MSDs, etc.) will be analyzed in accordance with their quality assurance procedures and Laboratory Methods Manual.

12.0 SAMPLE HANLDING AND CUSTODY PROCEDURES

The majority of the measurements taken as part of the monitoring program are recorded in the field. Bacterial and nitrate/nitrite samples are labeled with a specific site identifier, the date, and the name of the sampler on a supplied data sheet. The samples are stored upright in a cooler with ice (for temperature control) during the monitoring event and are immediately transported to the laboratory once sampling is completed. A temperature control vial is checked to assure the samples were maintained within the required temperature range (2°-8°C). If the temperature control sample is out of range, the results are flagged and qualified. Table 8 presents preservation and holding time requirements for the analyses performed by laboratories. All other parameters are field measured and dedicated samples collected for these purposes are not held or preserved.

A Chain of Custody (COC) document is completed to record the sample location/Site ID, data and time of sampling. This document remains with the field samples to document sample transfers. A field data sheet is completed on-site at the time of sampling.

Table 8: Sampling Method Requirements

Constituent	Bottle	Preserve	Sampling Method	Max Holding Time
Coliform and Enterococci	250-mL plastic	Sterile, iced	Grab	6 hours
Ammonia	300-mL plastic	H_2SO_4, iced	Grab	28 days

Constituent	Bottle	Preserve	Sampling Method	Max Holding Time
Nitrate/Nitrite	100-mL plastic	iced	Grab	48 hours
Total Kjeldahl Nitrogen	500-mL plastic	H_2SO_4, iced	Grab	28 days
Chemical Oxygen Demand	50-mL, plastic	H_2SO_4, iced	Grab	28 days
Total phosphorus	50-mL plastic	iced	Grab	28 days
Total Suspended Solids	100-mL plastic	iced	Grab	7 days
Turbidity	100-mL plastic	iced	Grab	48 hours
Hardness	100-mL plastic	H_2NO_3, iced	Grab	6 months
Lead	500-mL plastic	H_2NO_3, iced	Grab	6 months
Copper	500-mL plastic	H_2NO_3, iced	Grab	6 months
Zinc	500-mL plastic	H_2NO_3, iced	Grab	6 months

13.0 TESTING, INSPECTION, MAINTENANCE, AND CALIBRATION

13.1 Instrument/Equipment Testing, Inspection, and Maintenance

Equipment maintenance procedures are presented in the SOPs, included as Appendix A, and in the equipment-specific operation manuals, presented in Appendix E and Appendix F.

13.2 Instrument/Equipment Calibration and Frequency

Equipment calibration procedures are presented in the SOPs, included as Appendix A, and in the equipment-specific operation manuals, presented in Appendix E and Appendix F.

13.3 Inspection/Acceptance of Supplies and Consumables

Supplies needed for this monitoring program include sampling bottles, calibration solutions, and equipment replacement parts. Samples will be collected in bottles supplied by the laboratory scheduled to perform the analysis. Bottles will be inspected for signs of contamination (i.e. unexpected liquids, broken seals) and wear (i.e. cracks, indentations, scratched lid threads) before use. Calibration solutions and replacement parts will be obtained from the original manufacturer of the equipment.

14.0 DATA MANAGEMENT

Field data is collected on a field data sheet during each sampling event (see Appendix G). Field data will be compiled electronically after each event. A sample of the electronic data repository is presented in Appendix H. The electronic file will be backed-up periodically. The original field data sheets will be maintained on file for at least five years.

The Quality Assurance Officer will frequently (i.e. once per month) compare a sample of the field data sheets to the electronic file and edit any incorrectly entered data.

Records of QAPP amendments will be maintained on-file at Friends of the Bay offices. A summary of changes and revisions from the previous version of the QAPP, along with a brief justification for the changes, will be appended to the front of the superseded QAPP in the file.

A record of the EPA pertinent approvals shall be maintained with each version of the document.

15.0 ASSESSMENT AND RESPONSE ACTIONS

Volunteer training and review procedures are presented in Section 5.2. Management review procedures are presented in Section 16.0. Data review, verification, validation, and usability are discussed in Section 16.0. Data quality audits will be conducted at least once per season by the QA Officer or other project management members. Audits will consist of inspecting the Field Data Sheets, laboratory QA/QC data, and field duplicate RPD calculation, if available. Any deficiencies will be reported to the QAPP Manager, who will oversee the resolution of deficiencies. Possible courses of action include revising the QAPP, seeking assistance from the laboratories and other groups, and marking previously accepted data as invalid or provisional.

The following is a list of possible occurrences that may require corrective action and the corresponding action that would likely occur:

- If any sample bottles break during transit such that insufficient sample is available to complete the analysis re-sampling may have to occur.
- If meters or other sampling equipment break or malfunction during sampling, efforts will be made to repair, re-calibrate, or replace them with back-up equipment.
- If there are unusual changes in detection limits, re-sampling and re-analysis may have to occur.

16.0 DATA REVIEW, VERIFICATION, VALIDATION, AND USABILITY

The objectives of data verification are to:

- Assess and summarize the analytical quality and defensibility of data for the end user.
- Document factors contributing to analytical error that may affect data usability, such as: data discrepancies, poor laboratory practices that impact data quality, site locations for which samples were difficult to analyze.
- Document any "sampling error" that may be identified by the data verification process, such as contaminated trip or equipment blanks, incorrect storage or preservation techniques, improper sampling containers, and improper sampling techniques.

16.1 Data Review, Verification and Validation

During or soon after a monitoring event, monitoring and quality control results will be reviewed by the Project Manager. Any unusual values will be flagged. Unusual values may include data quality objectives that are exceeded or not met, any changes in reporting or detection limits that are noted, unexpectedly large or small values that were recorded, any noted deviation from this QAPP, or any missing values. The QA Officer will compare manually-entered electronic data with the original data sheets to ensure the data was entered correctly. Any errors found will be corrected.

The QA Officer will then examine and validate the reviewed data. Data that meets the DQOs and that is collected following the procedures presented in this QAPP are considered valid. Data that is inconsistent with these standards (data that was flagged) will be examined by the

Field Sampling Leader, QA Officer, and Project Manager (or a combination of at least two thereof) to determine the cause of the deficiency and evaluate the usability of the affected data. This data may be accepted, marked as conditional, or discarded.

Depending on the outcome of the review, other actions may be taken. If equipment failure is suspected to be the reason for the problem, calibration or maintenance techniques will be reviewed and improved. If human error is suspected, team members will receive additional training as necessary. If data consistently violates DQOs, the SOPs and QAPP will be reviewed and revisions suggested to correct identified problems (e.g., due to more variability in the sampled system or site specific issues). Additionally, the DQOs will be evaluated and adjusted if they are unreasonably stringent. Any data discrepancies, DQO violations, or other conditions that are not anticipated by the QAPP will be resolved on a case-by-case basis. Pertinent program procedures and documents will be revised as necessary. EPA will be notified of modifications to the QAPP in order to approve changes.

Friends of the Bay will attempt to track the sources of any unexpected conditions encountered during monitoring, such as unusually high monitoring results or exceedance of water quality standards. If appropriate, further investigation will be undertaken, or the situation will be referred to an appropriate state or local agency.

16.2 Data Usability

The purpose of this QAPP is to provide data that is acceptable to current users, including those identified in Section 6.1. Input from data users will be considered during any revisions and modifications that may be made to this QAPP. Possible input could include revising data quality objectives, changing calibration procedures, and adjusting data verification techniques.

User requirements and data quality problems will be considered on a case-by-case basis. For example, if the calculated relative percent different (RPD) for a nitrate field duplicate and the corresponding sample is greater than 30%, the difference may have resulted from variability in the sampled system, and the two results could be averaged. However, if the RPD for a laboratory matrix spike is larger than 30%, equipment problems may be present and the results from the sampling round for the noncompliant parameter should be discarded. The lab, other monitoring groups, EPA guidance documents, and other information will be consulted to determine the usability of a conditional sample.

Collected data will be used for the intended purpose. For example, monitoring locations selected to monitor inflow concentrations of pollutants will not be included in evaluating ambient harbor water quality conditions.

17.0 REPORTING, DOCUMENTATION, AND RECORDS

Friends of the Bay currently plans to present the data collected as part of the program in the following formats:

- Friends of the Bay s Annual Water Quality Reports.
- State of the Watershed Report and Watershed Action Plan for the Oyster Bay, Cold Spring Harbor, and Mill Neck Creek estuary that Friends of the Bay is currently planning to prepare.

- Presentations to the Public and interested organizations.
- Friends of the Bay's newsletter.
- Newspaper Letters to the Editor, interviews regarding pertinent local environmental topics, and other public press forums.

Documentation and record keeping requirements are presented in Section 14.

APPENDIX A

STANDARD OPERATING PROCEDURES

Standard Operating Procedures (SOPs)

Stream and Outfall Monitoring Program

Friends of the Bay

Oyster Bay, New York

July 2007

Fuss & O Neill
78 Interstate Drive
West Springfield, MA 01089

STANDARD OPERATING PROCEDURES
Friends of the Bay Stream and Outfall Monitoring Program

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END OF REPORT

1.0 PROGRAM OVERVIEW

The project consists of a stream and outfall water quality monitoring program in the watershed of the Oyster Bay/Cold Spring Harbor estuary complex on the north shore of Long Island. Four monitoring events will occur each year as part of this monitoring program.

Two of these annual monitoring events will be dry weather events, where samples will be collected following at least 72 hours of dry weather (no previous storms of 0.1 inch or greater). These results will be used to evaluate dry weather stream and outfall characteristics, and identify possible illicit discharges.

The other two annual monitoring events will be wet weather events, where samples will be collected no more than 6 hours following the start of a precipitation event of 0.5 inches or more, and that occurred at least 72 hours after a previous storm event of 0.1 inch or greater (i.e., following a minimum 72-hour antecedent dry period).

The program will complement Friends of the Bay's Open Water Body Monitoring Program, which is designed to monitor ambient water quality conditions in the Oyster Bay/Cold Spring Harbor complex. The data will be used to:

- Identify potential pollutant sources in the watershed.
- Track known or suspected pollutant sources in the watershed.
- Associate land use activities with water quality problems.
- Monitor aquatic habitats.
- Investigate long-term trends in water quality parameter levels.
- Guide municipal and county level environmental planning, policy, and compliance efforts (i.e. the Phase II Stormwater Program, inappropriate land development, TMDL development).
- Measure progress towards meeting water quality goals in the watershed.

Potential data users include Friends of the Bay, Nassau County Department of Health, Nassau County Department of Public Works, Suffolk County Department of Health Services, the Interstate Environmental Commission, the New York State Department of Environmental Conservation, the Connecticut Department of Environmental Protection (Office of Long Island Sound Programs), Long Island Sound Study, U.S. Fish and Wildlife Service, the Town of Oyster Bay, the Town of Huntington, and the other communities and municipalities surrounding the embayment complex.

1.1 Sampling Parameters

Table 1 presents monitoring parameters, methods, standards, and anticipated data uses for the stream and outfall monitoring program. A sample from each monitoring location will be analyzed for each parameter during each monitoring event.

Table 1: Parameters and Methods

Constituent	Use of Data	Standard (Class C Waters) 6 NYCRR 703	Method	Laboratory
Fecal Coliform	Indicate possible pollution by animal or human feces	Monthly geomean for minimum of 5 samples ≤ 200 #/mL	SM 9221E	NCDH Laboratory
Escherichia Coli	Indicate pollution by mammalian feces	N/A	EPA 1600	NCDH Laboratory
Ammonia	Calculate nutrient loadings, indicate possible fertilizer or sewage pollution, indicate aquatic toxicity	2 mg/L for water source. Temperature and pH dependent for aquatic toxicity	LACHAT 10-107-06-1-B	South Mall Analytical Labs
NO2/NO3	Calculate nutrient loadings, indicate fertilizer pollution	10 mg/L	EPA 354.1/353.3	South Mall Analytical Labs
Total Kjeldahl Nitrogen	Calculate nutrient loadings, calculate total nitrogen	Sum of TKN and NO2/NO3 ≤ 10 mg/L	LACHAT 10-107-06-2	South Mall Analytical Labs
Chemical Oxygen Demand	Assess loadings of oxygen-depleting compounds, oils, greases, and biodegradable pollutants	N/A	EPA 410.1	South Mall Analytical Labs
Orthophosphate	Assess nutrient enrichment in watershed	None in amounts that will result in growth of algae, weeds, and slimes.	EPA 365.3	South Mall Analytical Labs
Specific Conductance	Identify road salt runoff and industrial loadings, calculate DO saturation	Dissolved solids <500 mg/L*	Table 3 of ISO 7888-1985	Field
Total Suspended Solids	Identify watershed sources of particulate material for solids loadings	None that will cause deposition or impair water from best usages	SM 18-20 2540D	South Mall Analytical Labs
Turbidity	Secondary measure of solids, for future substitution for TSS (See Section 10.4 of QAPP)	Reference condition for EPA Ecoregion 84 = 1.78 FTU	EPA 180.1/SM 2130B	South Mall Analytical Labs
Dissolved Oxygen	Identify oxygen-depleted inputs	For non-trout waters, daily average of samples ≥ 5 mg/L, each sample ≥ 4 mg/L	EPA 360.1	Field
Hardness	Used to calculate toxicity of other parameters	N/A	EPA 130.2	South Mall Analytical Labs
Lead	Indicate industrial runoff, identify toxicity	Hardness-dependent. Typical values are ≤0.026 and ≤0.0010 mg/L acute and chronic toxicity, respectively**	EPA 200.7	South Mall Analytical Labs
Copper	Indicate industrial runoff, identify toxicity	Hardness-dependent. Typical values are ≤0.0043 and ≤0.0032 mg/L acute and chronic toxicity, respectively**	EPA 200.7	South Mall Analytical Labs
Zinc	Indicate industrial runoff, identify toxicity	Hardness-dependent. Typical values are ≤0.0297 and ≤0.0422 mg/L acute and chronic toxicity, respectively**	EPA 200.7	South Mall Analytical Labs

Constituent	Use of Data	Standard (Class C Waters) 6 NYCRR 703	Method	Laboratory
pH	Ammonia toxicity is pH dependent	between 6.5 and 8.5 S.U.	Electrometric	Field
Temperature	Identify thermal pollution, calculate DO saturation	90ºF for non-trout waters 70ºF for trout waters Other Criteria†	Electrometric	Field

1.2 Sampling Locations

Table 2 lists monitoring locations that are proposed for the program. These locations are presented in the monitoring locations map included as Appendix B of the QAPP that has been prepared for the program.

ID	Location	Coordinates	Description
OBS –1	The Birches Sewage Outfall	40º54 17 " N 73º34 57 " W	Adjacent to end of pipe, accessible from Meleny Road
OBS –2	Beaver Lake Outflow	40º53 15 "N 73º33 48 " W	South side of Robert De Graff Causeway upstream of and adjacent to waterfall
OBS –3	Beekman Creek	40º52 34 " N 73º32 34 " W	West Side of West Shore Road
OBS –4	Upper Mill River	40º52 01 " N 73º32 29 " W	West Side of Mill River Road adjacent to apartments
OBS –5	Mill River Outflow	40º52 27 " N 73º32 25 " W	Mill River upstream of Beekman Creek culvert and tidal influence
OBS –6	White's Creek	40º52 27 " N 73º31 41 " W	Adjacent to South Street upstream of tidal influence, near Commander Oil Terminal
OBS –7	Tiffany Creek	40º52 19 " N 73º30 11 " W	North side of Cove Neck Road
OBS –8	DeForest Pond Outflow	40º52 14 " N 73º27 41 " W	North of intersection of Shore Road and Spring Street in Cold Spring Harbor
OBS –9	St. John's Pond Outflow	40º51 25 " N 73º27 48 " W	South of road on top of dam adjacent to fish hatchery, south of Route 25A and west of Lawrence Hill Road
OBS –10	Rotating Outfall	Varies	Select 1 outfall during each wet weather event, and 1 outfall where discharge is occurring during a dry weather event. See Section 10.1 for detailed outfall selection criteria

2.0 USING FIELD EQUIPMENT

2.1 Hydrolab Quanta

The Hydrolab Quanta series datalogger and sonde is used to monitor DO, temperature, specific conductance, and pH within the water column.

2.1.1 Calibration Procedures

Detailed calibration procedures for the Quanta series meter and sonde used by Friends of the Bay is presented in Appendix E of the QAPP. The Quanta is calibrated at the start of each monitoring event. The DO calibration is then checked by comparing the meter's reading at a

random location to the results of a Winkler Titration for grab samples collected at the same location.

The meter's pH, specific conductance, and temperature calibrations will be checked in the same manner at one location. If the pH, DO, or specific conductance calibrations are found to have deviated beyond the Data Quality Objective (DQO) presented in Table 7 of the QAPP, the instrument will be recalibrated. If deviations occur in subsequent calibration checks, program managers will consider performing maintenance on the instrument, or shipping the instrument to the factory for service.

If the temperature calibration is found to have deviated beyond the DQO presented in Table 7 of the QAPP, the Quanta should be shipped to the factory for recalibration. Attachment I presents a calibration sheet for the Quanta. This sheet will be stored with the instrument and completed during each monitoring event.

2.1.2 Maintenance

Sonde maintenance is performed according to the manufacturer's specifications. Procedures and maintenance items are presented in the Quanta manual in Appendix E of the QAPP. During routine operation, the following components of the sonde will be inspected:

- Battery charge.
- O-rings.
- Dampness within the sonde, cable connector port, and probe ports.
- DO membrane (replace at least every 30 days).
- Corrosion (blackness) on DO electrodes.
- Fluid openings on conductivity/temperature probe.
- Deposits on conductivity electrodes.

If maintenance procedures are unsuccessful, the sonde and/or datalogger is/are returned to the manufacturer or an authorized service center for maintenance or reconditioning.

2.1.3 Operation

While in the field, the probe is stored in the calibration cap with water between monitoring locations. At each monitoring location, the cap is removed and the sonde mounted on a platform constructed of PVC tubing, if necessary. The platform prevents the probes from contacting the bottom surface of the water body. The sonde and platform are lowered below the water surface in the predominant flow channel of the stream or ourfall, and DO, specific conductance, pH, and temperature readings are recorded after the values on the datalogger stabilize.

If the outfall includes a hydraulic drop into a receiving water, it may be necessary to collect a sample for analysis. The sample will be discarded after Quanta readings are complete. If there is no hydraulic drop, the sonde should be inserted into the outfall as far as possible while ensuring that the probes are submerged.

The sonde must be properly stored between monitoring locations to prevent damage and drying of the probes. Proper storage of the Quanta is presented in Appendix E of the QAPP.

2.2 LaMotte Kit

The LaMotte kit is used to validate results from the DO probe. Instructions for using these kits are presented in Appendix F of the QAPP.

2.2.1 Calibration Procedures

No calibration is necessary for the LaMotte Field Kits.

2.2.2 Maintenance

The field kits use single-use chemical reagents that are replaced when expired or the supply is exhausted.

2.2.3 Operation

A surface grab sample is collected at each monitoring location. The sample is collected in a sample collection bottle that was first decontaminated. As trace compounds are not being analyzed, decontamination means that the sample collection bottles will be washed with detergent once prior departure for a monitoring event. Bottles that will be reused will be rinsed twice with water from each sampling location prior to sampling at that location. The rinse water will be dumped away from the sampling location.

Wash water containing any chemicals or detergents will be collected in a dedicated container (see Section 2.2.4 below) and discarded upon completion of the monitoring event, in accordance with applicable regulations. Rinse water consisting of only native water will be dumped away from sampling location (i.e. downstream of the sample location). Samples that contacted chemical reagents will be deposited in the Sampling Refuse Container (See Section 2.2.4).

Where a field kit is to be used to validate results from the Quanta meter, a sample will be collected as close as possible to the location where the meter recorded data immediately after the probe measurement is recorded. The sample will be field analyzed for the parameter of interest, and the results compared to the meter results via the data quality objectives (DQOs) presented in the QAPP.

2.2.4 Chemical Waste

Samples that have been mixed with reagent (after analysis), water used to rinse sample collection bottles, and other liquid wastes associated with parameter measurement are transferred to a container with a screwtop lid that is properly labeled as containing chemical waste. Some of the compounds that may be dumped are considered hazardous.

The Field Sampling Leader should be aware of any hazardous compounds that may be present and ensure that the container contents are disposed of in accordance with applicable

regulations. The Field Sampling Leader should maintain a collection of Material Safety Data Sheets for hazardous compounds that are used. It is anticipated that the wastewater is compatible with domestic sewage and can thus be disposed down a sink while running the faucet.

3.0 SAMPLING TECHNIQUES

The sample collection procedures presented in this section reduce the likelihood of potential sample contamination. Samples are collected in bottles supplied by the laboratory. Sample preservative, if necessary, should be added to the bottles prior to sampling.

Attachment II to these SOPs present surface water sampling procedures to be used for this program.

3.1 Bacteriological Parameters

Bacteriological samples, including fecal coliform and enterococci samples, are collected in 250-mL bottles supplied by the NCDH laboratory. The volunteer, wearing an unused rubber, latex, or nitrile glove, will collect the sample by partially immersing the bottle at the sample location and allowing water to slowly pour in over the rim. The bottle will be filled to the mark on the side of the bottle. The sampler will ensure that none of the sodium thiosulfate powder (a compound that neutralizes chlorine) present in the bottle will escape.

It is important that the bottle be filled directly from the outfall and that a bucket, scoop, or other means is not used; bacterial samples are easily contaminated, and decontamination procedures would require the collection vessel to be acid washed. For monitoring locations where a duplicate sample is to be collected, a second sample bottle will be filled in the same manner as the first. The samples will be placed upright in a cooler on ice and transported to the laboratory as soon as feasible to meet the required hold time (i.e., 6 hours for coliform bacteria, 8 hours for enterococci). The cooler will contain an additional container of freshwater to be used by laboratory personnel for measuring the sample temperature on arrival at the laboratory.

3.2 Chemical Parameters

Chemical parameter samples are collected in bottles supplied by the laboratory. The volunteer, wearing an unused rubber, latex, or nitrile glove, will collect the sample by immersing an appropriate sample collection bottle supplied by the laboratory at the sample location. Multiple sample bottles will need to be filled at each monitoring location. The sampling bottles required are summarized in Table 7 of the QAPP. Some sample bottles will contain an acidic preservative. Volunteers must take care to not spill the preservative, or let the preservative escape the bottle during sampling.

For monitoring locations where a duplicate sample is to be collected, a second sample bottle will be filled in the same manner as the first. The samples will be placed upright in a cooler on ice and transported to the laboratory as quickly as feasible.

3.2.1 Health and Safety

Acidic sample preservatives can be a health hazard. If preservative contacts skin, rinse immediately and observe area periodically for burns or rash. If eye contact occurs, flush with clean water for 15 minutes, if possible, lifting upper and lower eyelids periodically, and seek medical attention. If ingestion occurs, seek medical attention immediately.

3.3 Flow Measurement

An estimate of flow will be made from each outfall, if practical. Methods for estimating flow are presented in Attachment II to these SOPs.

4.0 EQUIPMENT CHECKLIST

The field sampling leader is responsible for ensuring that the sampling group is properly prepared for each sampling outing. This section includes a list of equipment that will be present during each monitoring event. This list is not intended to be comprehensive; the list should be augmented or revised as necessary.

Group Safety Equipment
- o First aid kit
- o Sunblock
- o Insect Repellant
- o Personal Identification
- o Cellular Phone
- o Rubber, latex, or nitrile Gloves

Personal Equipment – To be supplied by each volunteer
- o Appropriate footwear
- o Hat
- o Raingear
- o Cold weather gear
- o Emergency Contact Information

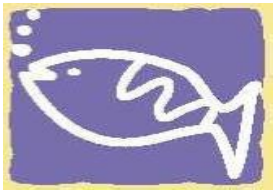
Monitoring Equipment
- o Copy of this Standard Operating Procedures Manual
- o Quanta Sonde and Datalogger
- o LaMotte DO Kit
- o PVC platform and line for sonde
- o 10 data sheets and spares
- o 10 250-mL bacterial bottles and spares
- o Sample Bottles
- o Labels for bottles
- o Bucket or bottle for field sample analysis
- o Distilled water
- o Calibration solutions
- o Cooler with ice for storage and transport of bacteria samples
- o Writing utensils
- o "Sharpie" permanent marker
- o Gauge for determining wind speed and direction
- o Dump container for storage of liquid waste materials
- o Sample Scoop, if required

ATTACHMENT I
STANDARD OPERATING PROCEDURES

QUANTA CALIBRATION SHEET

Friends of the Bay

Monitoring Programs - Hydrolab Quanta Calibration Sheet



Date	DO Calibrated? (Y/N)	Depth Calibrated? (Y/N)	Salinity or Conductance Calibrated? (Y/N)	Any Errors Noted?	DO calibrations checked by Winkler and saturated air methods?	Salinity or Conductance calibration checked?	Standard Concentration/ Instrument Reading	Did you Recalibrate the Instrument?	Membrane checked for bubbles, rips, or tears?

ATTACHMENT II
STANDARD OPERATING PROCEDURES

SURFACE WATER SAMPLING TECHNIQUES

INTRODUCTION

This Standard Operating Procedure is applicable to the collection of representative liquid samples, both aqueous and non-aqueous from streams, rivers, lakes, ponds, outfall pipes, and surface impoundments.

SURFACE WATER FLOW RATE ESTIMATION

Area-Rate Method

To estimate the flow rate of flowing surface water using the Area-Rate method, a stop watch, float and tape measure will be used. The rate will be calculated using the equation:

$$q = \frac{W \times d \times a \times l}{t}$$

Where:

q	flow (cubic feet/second)
W	the average width (feet) of the stream section
d	the average depth (feet) of the stream section
a	a constant of 0.8 for a gravely stream bed, or 0.9 for a smooth stream bed
l	length (feet) of the stream section
t	time (seconds) required for the float to travel a measured section of the stream

This test should be performed several times. The average value for q will be recorded on the Surface Water Field Data Sheet.

Volume/Time Method

To calculate the flow rate using the Volume/Time method, a bucket of known volume and a stopwatch will be used. The rate will be calculated using the equation:

$$q = \frac{V}{t * 7.481}$$

Where:

q	flow (cubic feet/second)
V	volume of bucket that is filled with the discharging water (gallons)
t	time required for the bucket to fill to mark of known volume (seconds)
7.481	conversion factor from gallons to cubic feet

This test should be performed several times. The average value for q will be recorded on the Surface Water Field Data Sheet.

SURFACE WATER SAMPLING

When the sample location is easily accessible by foot, grab samples will be collected by

submerging the sample container directly into the surface water, or filling directly from the outfall pipe discharge. Dedicated sample containers may also be used for sample collection in these circumstances. Disturbance of sediment at the sample location should be prevented.

In areas where access is limited or difficult, sampling may be conducted with a long-handled scoop. This is often the case at lakes or large stream locations where sampling away from the bank is necessary to achieve representative surface water samples. When such an intermediate container is utilized, it will be constructed of an inert material and decontaminated or replaced between samples.

The gloves worn by field personnel during surface water sample collection will be dedicated to that operation. Samples will be collected in order of decreasing volatility.

Sampling techniques for flowing and standing surface water are outlined in the following procedures.

SAMPLING FLOWING SURFACE WATER

For surface water samples collected from flowing water, the sample will be collected at mid-stream to ensure that the water is not stagnant. The sample will be collected upstream of the sampler, so as not to disturb the sample during collection. The downstream samples will be collected before upstream samples. The remainder of the samples will be collected as field personnel move upstream. Disturbance of sediment at the sample location should be prevented.

BOTTLE IMMERSION TECHNIQUE

Surface water samples can be collected from flowing water by direct bottle submersion or by using a scoop or dipper. It is important to ensure that sampling personnel do not place fingers in the sampling bottles, to avoid sample contamination and chemical burns. The protocol for collecting a surface water sample from flowing water using direct bottle submersion is as follows:

a. Uncap the sample bottle.

b. Lower the lip of the sample bottle just below the water surface.

c. Allow the bottle to fill slowly with the water running down the sidewalls to prevent splashing.

d. Cap the sample bottle.

e. Label the sample bottles and place into an iced cooler.

SCOOP SAMPLING TECHNIQUE

The protocol for collecting a surface water sample from flowing water using a scoop or dipper is outlined below.

a. Uncap the sample bottle.

b. Reach the dipper out above the water. Lower the lip of the dipper to just below the water surface.

c. Allow the dipper to fill slowly with the water running down the sidewalls to prevent splashing.

f. Cap the sample bottle.

g. Label the sample bottles and place into an iced cooler.

SUSPENDED OUTFALL PIPE TECHNIQUE

The protocol for collecting a sample from an outfall pipe that is suspended above the receiving water surface is outlined below.

a. Uncap the sample bottles.

b. Reach the bottle or dipper toward the nappe (free-falling sheet of water) of the discharge. Fill the bottle or dipper directly from the nappe.

c. Allow the dipper to fill, or fill the bottle directly. Do not allow the water to overflow the bottle if it contains preservatives.

d. Cap the bottles.

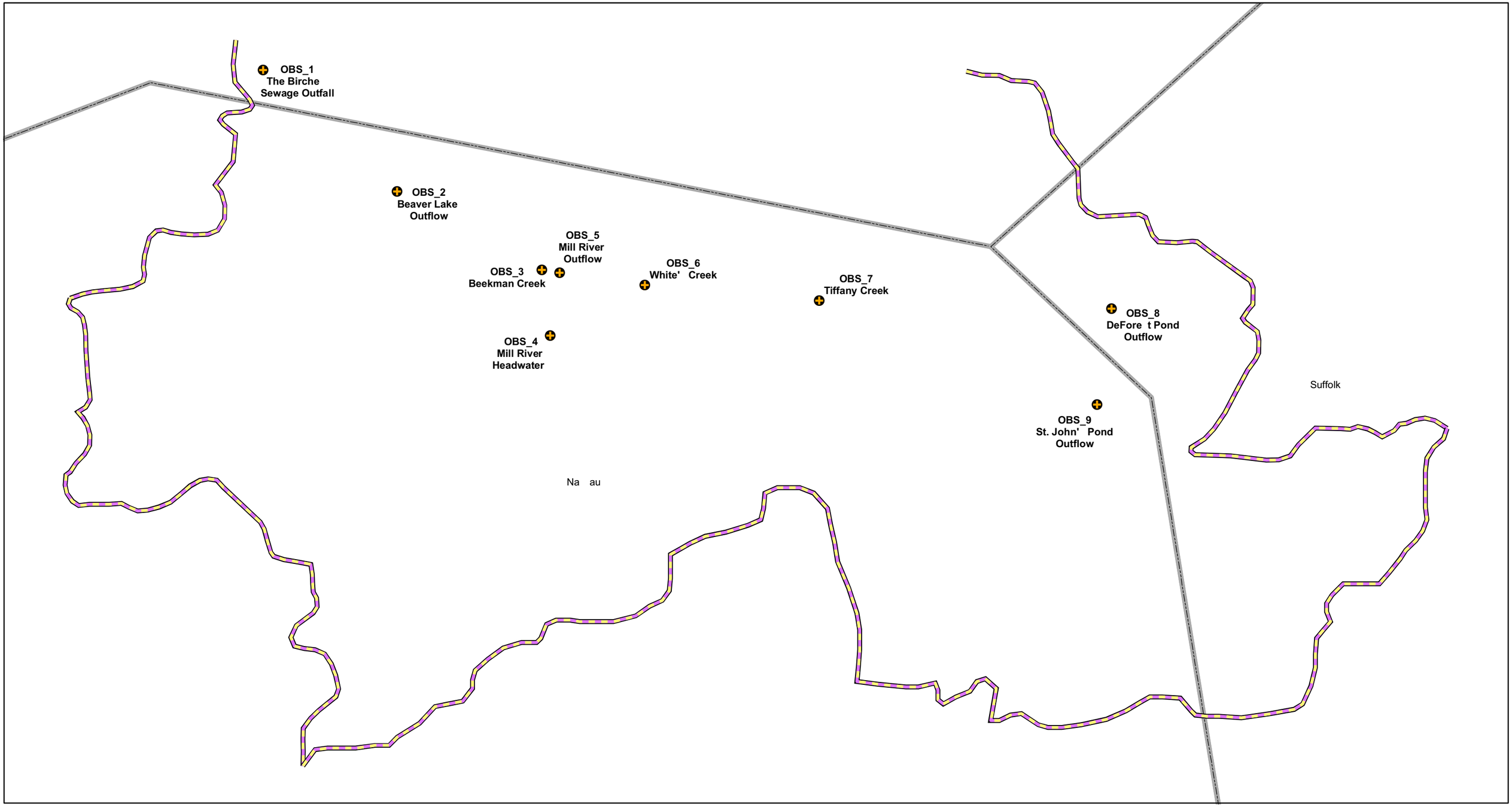
e. Label each sample bottle and place into a cooler with ice.

PARTIALLY SUBMERGED OUTFALL PIPE TECHNIQUE

For collecting a sample from an outfall pipe where the end is partially submerged, follow the bottle immersion or scoop sampling technique, above (the latter is preferred) while reaching up the outfall pipe as far as possible.

APPENDIX B

MONITORING LOCATIONS MAP



Friend of the Bay
Oy ter Bay/Cold Spring Harbor Water hed
Stream and Outfall Monitoring Location

FUSS & O'NEILL
Disciplines to Deliver

Friends OF THE Bay
Working to keep the oyster in Oyster Bay

0 0.5 1 1.5 2
Mile

Legend

Monitoring Location
Water hed_Bnd
County Line

N
W E
S

APPENDIX C

LABORATORY ACCREDITATIONS

THOMAS R. SUOZZI
County Executive

ABBY J. GREENBERG, M.D.
Acting Commissioner

PEDRO J. FRANCO, M.D.
Director of Laboratories

NASSAU COUNTY DEPARTMENT OF HEALTH
Division of Public Health Laboratories
209 Main Street
Hempstead, New York 11550
Voice: (516) 572-1200
Fax: (516) 572-1206

TELEX TRANSMITTAL COVER SHEET

DATE: 6.13.07

TO

NAME: **PAT AITKEN**

COMPANY: **FRIENDS OF THE BAY**

FAX NUMBER: **706-8750**

WE ARE TRANSMITTING 2 PAGE(S), WHICH INCLUDES THIS COVER SHEET. IF YOU DO NOT RECEIVE ALL OF THE PAGES, PLEASE CALL THE PERSON AT THE NUMBER LISTED BELOW.

FROM

NAME: **ENVIR. MICROBIOLOGY LABORATORY /** LJ

TELEPHONE NUMBER: **572-1235 or 572-1236**

FAX NUMBER: **(516) 572-1206**

CONFIDENTIAL COMMUNICATION

*ENTEROCOCCUS TO BE INCLUDED IN ELAP PROFICIENCY TESTING - HOPEFULLY THIS OCTOBER....

NEW YORK STATE DEPARTMENT OF HEALTH
WADSWORTH CENTER
RICHARD F. DAINES, M.D.

Expires 12:01 AM April 01, 2008
Issued April 01, 2007

CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

Issued in accordance with and pursuant to section 502 Public Health Law of New York State

DR. PEDRO J. FRANCO
NASSAU COUNTY DEPT OF HEALTH
209 MAIN STREET
HEMPSTEAD, NY 11550

NY Lab Id No: 10339
EPA Lab Code: NY00010

is hereby APPROVED as an Environmental Laboratory in conformance with the National Environmental Laboratory Accreditation Conference Standards for the category ENVIRONMENTAL ANALYSES NON POTABLE WATER
All approved analytes are listed below:

Bacteriology	
Coliform, fecal	SM 18-20 9221E
	SM 18-20 9222D
Coliform, Total	SM 18-20 9221B
	SM 18-20 9222B
Chlorinated Hydrocarbon Pesticides	
4,4'-DDD	EPA 625
	EPA 8270C
4,4'-DDE	EPA 625
	EPA 8270C
4,4'-DDT	EPA 625
	EPA 8270C
Aldrin	EPA 625
	EPA 8270C
alpha-BHC	EPA 625
	EPA 8270C
beta-BHC	EPA 625
	EPA 8270C
Captan	EPA 8270C
Chlordane Total	EPA 608
	EPA 8081A
delta-BHC	EPA 625
	EPA 8270C

Chlorinated Hydrocarbon Pesticides	
Dichloran	EPA 8270C
Dieldrin	EPA 625
	EPA 8270C
Endosulfan I	EPA 625
	EPA 8270C
Endosulfan II	EPA 625
Endosulfan sulfate	EPA 625
	EPA 8270C
Endrin	EPA 625
	EPA 8270C
Endrin aldehyde	EPA 625
	EPA 8270C
Heptachlor	EPA 625
	EPA 8270C
Heptachlor epoxide	EPA 625
	EPA 8270C
Isodrin	EPA 8270C
Lindane	EPA 625
	EPA 8270C
Methoxychlor	EPA 8270C
Mirex	EPA 8270C
Perthane	ASTM D3086-90
Toxaphene	EPA 608

Serial No.: 32278

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WADSWORTH CENTER
RICHARD F. DAINES, M.D.

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Issued April 01, 2007

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MR. JOSEPH P. SHAULYS
SOUTH MALL ANALYTICAL LABS
26 NORTH MALL
PLAINVIEW, NY 11803

NY Lab Id No: 10950
EPA Lab Code: NY01292

is hereby APPROVED as an Environmental Laboratory in conformance with the National Environmental Laboratory Accreditation Conference Standards for the category ENVIRONMENTAL ANALYSES SOLID AND HAZARDOUS WASTE
All approved analytes are listed below:

Acrylates	
Acrolein (Propenal)	EPA 8260B
Acrylonitrile	EPA 8260B
Amines	
2-Nitroaniline	EPA 8270C
3-Nitroaniline	EPA 8270C
4-Nitroaniline	EPA 8270C
Diphenylamine	EPA 8270C
Benzidines	
3,3'-Dichlorobenzidine	EPA 8270C
Benzidine	EPA 8270C
Characteristic Testing	
Corrosivity	EPA 1110
Ignitability	EPA 1010
Reactivity	SW-846 Ch7, Sec. 7.3
Chlorinated Hydrocarbon Pesticides	
4,4'-DDD	EPA 8081A
4,4'-DDE	EPA 8081A
4,4'-DDT	EPA 8081A
Aldrin	EPA 8081A
alpha-BHC	EPA 8081A

Chlorinated Hydrocarbon Pesticides	
beta-BHC	EPA 8081A
Chlordane Total	EPA 8081A
delta-BHC	EPA 8081A
Dieldrin	EPA 8081A
Endosulfan I	EPA 8081A
Endosulfan II	EPA 8081A
Endosulfan sulfate	EPA 8081A
Endrin	EPA 8081A
Endrin aldehyde	EPA 8081A
Endrin Ketone	EPA 8081A
Heptachlor	EPA 8081A
Heptachlor epoxide	EPA 8081A
Lindane	EPA 8081A
Methoxychlor	EPA 8081A
Toxaphene	EPA 8081A
Chlorinated Hydrocarbons	
1,2,4-Trichlorobenzene	EPA 8270C
2-Chloronaphthalene	EPA 8270C
Hexachlorobenzene	EPA 8270C
Hexachlorobutadiene	EPA 8270C
Hexachlorocyclopentadiene	EPA 8270C
Hexachloroethane	EPA 8270C

Serial No.: 32625

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All approved analytes are listed below:

Haloethers	
4-Bromophenylphenyl ether	EPA 8270C
4-Chlorophenylphenyl ether	EPA 8270C
Bis (2-chloroisopropyl) ether	EPA 8270C
Bis(2-chloroethoxy)methane	EPA 8270C
Bis(2-chloroethyl)ether	EPA 8270C
Metals I	
Barium, Total	EPA 6010B
Cadmium, Total	EPA 6010B
Calcium, Total	EPA 6010B
Chromium, Total	EPA 6010B
Copper, Total	EPA 6010B
Iron, Total	EPA 6010B
Lead, Total	EPA 6010B
Magnesium, Total	EPA 6010B
Manganese, Total	EPA 6010B
Nickel, Total	EPA 6010B
Potassium, Total	EPA 6010B
Silver, Total	EPA 6010B
Sodium, Total	EPA 6010B
Metals II	
Aluminum, Total	EPA 6010B
Antimony, Total	EPA 6010B
Metals II	
Arsenic, Total	EPA 6010B
Beryllium, Total	EPA 6010B
Chromium VI	EPA 7196A
Mercury, Total	EPA 7471A
Selenium, Total	EPA 6010B
Vanadium, Total	EPA 6010B
Zinc, Total	EPA 6010B
Metals III	
Cobalt, Total	EPA 6010B
Molybdenum, Total	EPA 6010B
Silica, Dissolved	EPA 6010B
Thallium, Total	EPA 6010B
Tin, Total	EPA 6010B
Titanium, Total	EPA 6010B
Minerals	
Sulfate (as SO4)	EPA 9036
Miscellaneous	
Cyanide, Total	EPA 9012A
Hydrogen Ion (pH)	EPA 9040B EPA 9045C
Lead in Dust Wipes	EPA 6010B

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All approved analytes are listed below:

Miscellaneous	
Lead in Paint	EPA 6010B
Oil & Grease Total Recoverable	EPA 9071
Nitroaromatics and Isophorone	
2,4-Dinitrotoluene	EPA 8270C
2,6-Dinitrotoluene	EPA 8270C
Isophorone	EPA 8270C
Nitrobenzene	EPA 8270C
Pyridine	EPA 8270C
Nitrosoamines	
N-Nitrosodimethylamine	EPA 8270C
N-Nitrosodi-n-propylamine	EPA 8270C
N-Nitrosodiphenylamine	EPA 8270C
Phthalate Esters	
Benzyl butyl phthalate	EPA 8270C
Bis(2-ethylhexyl) phthalate	EPA 8270C
Diethyl phthalate	EPA 8270C
Dimethyl phthalate	EPA 8270C
Di-n-butyl phthalate	EPA 8270C
Di-n-octyl phthalate	EPA 8270C

Polychlorinated Biphenyls	
PCB-1016	EPA 8082
PCB-1221	EPA 8082
PCB-1232	EPA 8082
PCB-1242	EPA 8082
PCB-1248	EPA 8082
PCB-1254	EPA 8082
PCB-1260	EPA 8082
Polynuclear Aromatic Hydrocarbons	
Acenaphthene	EPA 8270C
Acenaphthylene	EPA 8270C
Anthracene	EPA 8270C
Benzo(a)anthracene	EPA 8270C
Benzo(a)pyrene	EPA 8270C
Benzo(b)fluoranthene	EPA 8270C
Benzo(ghi)perylene	EPA 8270C
Benzo(k)fluoranthene	EPA 8270C
Chrysene	EPA 8270C
Dibenzo(a,h)anthracene	EPA 8270C
Fluoranthene	EPA 8270C
Fluorene	EPA 8270C
Indeno(1,2,3-cd)pyrene	EPA 8270C
Naphthalene	EPA 8270C

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EPA Lab Code: NY01292

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All approved analytes are listed below:

Polynuclear Aromatic Hydrocarbons	
Phenanthrene	EPA 8270C
Pyrene	EPA 8270C
Priority Pollutant Phenols	
2,4,5-Trichlorophenol	EPA 8270C
2,4,6-Trichlorophenol	EPA 8270C
2,4-Dichlorophenol	EPA 8270C
2,4-Dimethylphenol	EPA 8270C
2,4-Dinitrophenol	EPA 8270C
2-Chlorophenol	EPA 8270C
2-Methyl-4,6-dinitrophenol	EPA 8270C
2-Methylphenol	EPA 8270C
2-Nitrophenol	EPA 8270C
3-Methylphenol	EPA 8270C
4-Chloro-3-methylphenol	EPA 8270C
4-Methylphenol	EPA 8270C
4-Nitrophenol	EPA 8270C
Pentachlorophenol	EPA 8270C
Phenol	EPA 8270C
Purgeable Aromatics	
1,2,4-Trimethylbenzene	EPA 8260B
1,2-Dichlorobenzene	EPA 8260B
1,3,5-Trimethylbenzene	EPA 8260B

Purgeable Aromatics	
1,3-Dichlorobenzene	EPA 8260B
1,4-Dichlorobenzene	EPA 8260B
2-Chlorotoluene	EPA 8260B
4-Chlorotoluene	EPA 8260B
Benzene	EPA 8260B
Bromobenzene	EPA 8260B
Chlorobenzene	EPA 8260B
Ethyl benzene	EPA 8260B
Isopropylbenzene	EPA 8260B
n-Butylbenzene	EPA 8260B
p-Isopropyltoluene (P-Cymene)	EPA 8260B
sec-Butylbenzene	EPA 8260B
Styrene	EPA 8260B
tert-Butylbenzene	EPA 8260B
Toluene	EPA 8260B
Total Xylenes	EPA 8260B
Purgeable Halocarbons	
1,1,1,2-Tetrachloroethane	EPA 8260B
1,1,1-Trichloroethane	EPA 8260B
1,1,2,2-Tetrachloroethane	EPA 8260B
1,1,2-Trichloroethane	EPA 8260B
1,1-Dichloroethane	EPA 8260B

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NEW YORK STATE DEPARTMENT OF HEALTH
WADSWORTH CENTER
RICHARD F. DAINES, M.D.

Expires 12:01 AM April 01, 2008
Issued April 01, 2007

CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

Issued in accordance with and pursuant to section 502 Public Health Law of New York State

MR. JOSEPH P. SHAULYS
SOUTH MALL ANALYTICAL LABS
26 NORTH MALL
PLAINVIEW, NY 11803

NY Lab Id No: 10950
EPA Lab Code: NY01292

is hereby APPROVED as an Environmental Laboratory in conformance with the National Environmental Laboratory Accreditation Conference Standards for the category ENVIRONMENTAL ANALYSES SOLID AND HAZARDOUS WASTE
All approved analytes are listed below:

Purgeable Halocarbons	
1,1-Dichloroethene	EPA 8260B
1,1-Dichloropropene	EPA 8260B
1,2,3-Trichloropropane	EPA 8260B
1,2-Dibromo-3-chloropropane	EPA 8260B
1,2-Dichloroethane	EPA 8260B
1,2-Dichloropropane	EPA 8260B
1,3-Dichloropropane	EPA 8260B
2,2-Dichloropropane	EPA 8260B
2-Chloroethylvinyl ether	EPA 8260B
Bromochloromethane	EPA 8260B
Bromodichloromethane	EPA 8260B
Bromoform	EPA 8260B
Bromomethane	EPA 8260B
Carbon tetrachloride	EPA 8260B
Chloroethane	EPA 8260B
Chloroform	EPA 8260B
Chloromethane	EPA 8260B
cis-1,2-Dichloroethene	EPA 8260B
cis-1,3-Dichloropropene	EPA 8260B
Dibromochloromethane	EPA 8260B
Dibromomethane	EPA 8260B
Dichlorodifluoromethane	EPA 8260B
Methylene chloride	EPA 8260B

Purgeable Halocarbons	
Tetrachloroethene	EPA 8260B
trans-1,2-Dichloroethene	EPA 8260B
trans-1,3-Dichloropropene	EPA 8260B
Trichloroethene	EPA 8260B
Trichlorofluoromethane	EPA 8260B
Vinyl chloride	EPA 8260B

Purgeable Organics	
2-Butanone (Methylethyl ketone)	EPA 8260B
2-Hexanone	EPA 8260B
4-Methyl-2-Pentanone	EPA 8260B
Acetone	EPA 8260B
Carbon Disulfide	EPA 8260B
Ethylene Glycol	EPA 8260B
Methyl tert-butyl ether	EPA 8260B
Vinyl acetate	EPA 8260B

Sample Preparation Methods

EPA 1311	EPA 9010B	EPA 3005A	EPA 3540C
EPA 5030B	EPA 5035	EPA 3060A	

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Acrylates	
Acrolein (Propenal)	EPA 624
	EPA 8260B
Acrylonitrile	EPA 624
	EPA 8260B
Amines	
2-Nitroaniline	EPA 8270C
3-Nitroaniline	EPA 8270C
4-Chloroaniline	EPA 8270C
4-Nitroaniline	EPA 8270C
Carbazole	EPA 8270C
Diphenylamine	EPA 8270C
Pyridine	EPA 8270C
Benzidines	
3,3'-Dichlorobenzidine	EPA 625
	EPA 8270C
Benzidine	EPA 625
	EPA 8270C
Chlorinated Hydrocarbon Pesticides	
4,4'-DDE	EPA 608
	EPA 8081A
4,4'-DDT	EPA 608

Chlorinated Hydrocarbon Pesticides	
4,4'-DDT	EPA 8081A
Aldrin	EPA 608
	EPA 8081A
alpha-BHC	EPA 608
	EPA 8081A
alpha-Chlordane	EPA 8081A
beta-BHC	EPA 608
	EPA 8081A
Chlordane Total	EPA 608
	EPA 8081A
delta-BHC	EPA 608
	EPA 8081A
Dieldrin	EPA 608
	EPA 8081A
Endosulfan I	EPA 608
	EPA 8081A
Endosulfan II	EPA 608
	EPA 8081A
Endosulfan sulfate	EPA 608
	EPA 8081A
Endrin	EPA 608
	EPA 8081A
Endrin aldehyde	EPA 608

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Chlorinated Hydrocarbon Pesticides	
Endrin aldehyde	EPA 8081A
Endrin Ketone	EPA 8081A
gamma-Chlordane	EPA 8081A
Heptachlor	EPA 608
	EPA 8081A
Heptachlor epoxide	EPA 608
	EPA 8081A
Lindane	EPA 608
	EPA 8081A
Methoxychlor	EPA 608
	EPA 8081A
Toxaphene	EPA 608
	EPA 8081A
Chlorinated Hydrocarbons	
1,2,4,5-Tetrachlorobenzene	EPA 8270C
1,2,4-Trichlorobenzene	EPA 625
	EPA 8270C
1-Chloronaphthalene	EPA 8270C
2-Chloronaphthalene	EPA 625
	EPA 8270C
Hexachlorobenzene	EPA 625
	EPA 8270C

Chlorinated Hydrocarbons	
Hexachlorobutadiene	EPA 625
	EPA 8260B
	EPA 8270C
Hexachlorocyclopentadiene	EPA 625
	EPA 8270C
Hexachloroethane	EPA 625
	EPA 8270C
Demand	
Biochemical Oxygen Demand	EPA 405.1
	SM 18-20 5210B
Carbonaceous BOD	SM 18-20 5210B
Chemical Oxygen Demand	EPA 410.1
Fuel Oxygenates	
Ethanol	EPA 8260B
Methyl tert-butyl ether	EPA 8260B
t-Butyl alcohol	EPA 8260B
Haloethers	
4-Bromophenylphenyl ether	EPA 625
	EPA 8270C
4-Chlorophenylphenyl ether	EPA 625
	EPA 8270C

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Haloethers	
Bis (2-chloroisopropyl) ether	EPA 625
	EPA 8270C
Bis(2-chloroethoxy)methane	EPA 625
	EPA 8270C
Bis(2-chloroethyl)ether	EPA 625
	EPA 8270C
Microextractables	
1,2-Dibromo-3-chloropropane	EPA 8260B
1,2-Dibromoethane	EPA 8260B
Mineral	
Acidity	EPA 305.1
Alkalinity	EPA 310.1
Chloride	SM 18-20 4500-Cl B
Fluoride, Total	EPA 340.2
Hardness, Total	EPA 130.2
Sulfate (as SO4)	EPA 375.4
Nitroaromatics and Isophorone	
2,4-Dinitrotoluene	EPA 625
	EPA 8270C
2,6-Dinitrotoluene	EPA 625
	EPA 8270C
Nitroaromatics and Isophorone	
Isophorone	EPA 625
	EPA 8270C
Nitrobenzene	EPA 625
	EPA 8270C
Nitrosoamines	
N-Nitrosodiethylamine	EPA 8270C
N-Nitrosodimethylamine	EPA 625
	EPA 8270C
N-Nitrosodi-n-propylamine	EPA 625
	EPA 8270C
N-Nitrosodiphenylamine	EPA 625
	EPA 8270C
Nutrient	
Ammonia (as N)	LACHAT 10-107-06-1-B
Kjeldahl Nitrogen, Total	LACHAT 10-107-06-2
Nitrate (as N)	LACHAT 10-107-04-1-C
Nitrite (as N)	LACHAT 10-107-04-1-C
Orthophosphate (as P)	SM 18-20 4500-P E
Phosphorus, Total	EPA 365.3
Phthalate Esters	
Benzyl butyl phthalate	EPA 625

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Phthalate Esters	
Benzyl butyl phthalate	EPA 8270C
Bis(2-ethylhexyl) phthalate	EPA 625
	EPA 8270C
Diethyl phthalate	EPA 625
	EPA 8270C
Dimethyl phthalate	EPA 625
	EPA 8270C
Di-n-butyl phthalate	EPA 625
	EPA 8270C
Di-n-octyl phthalate	EPA 625
	EPA 8270C
Polychlorinated Biphenyls	
PCB-1016	EPA 608
	EPA 8082
PCB-1221	EPA 608
	EPA 8082
PCB-1232	EPA 608
	EPA 8082
PCB-1242	EPA 608
	EPA 8082
PCB-1248	EPA 608
	EPA 8082
Polychlorinated Biphenyls	
PCB-1254	EPA 608
	EPA 8082
PCB-1260	EPA 608
	EPA 8082
Polynuclear Aromatics	
Acenaphthene	EPA 625
	EPA 8270C
Acenaphthylene	EPA 625
	EPA 8270C
Anthracene	EPA 625
	EPA 8270C
Benzo(a)anthracene	EPA 625
	EPA 8270C
Benzo(a)pyrene	EPA 625
	EPA 8270C
Benzo(b)fluoranthene	EPA 625
	EPA 8270C
Benzo(ghi)perylene	EPA 625
	EPA 8270C
Benzo(k)fluoranthene	EPA 625
	EPA 8270C
Chrysene	EPA 625

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Polynuclear Aromatics	
Chrysene	EPA 8270C
Dibenzo(a,h)anthracene	EPA 625
	EPA 8270C
Fluoranthene	EPA 625
	EPA 8270C
Fluorene	EPA 625
	EPA 8270C
Indeno(1,2,3-cd)pyrene	EPA 625
	EPA 8270C
Naphthalene	EPA 625
	EPA 8270C
Phenanthrene	EPA 625
	EPA 8270C
Pyrene	EPA 625
	EPA 8270C
Priority Pollutant Phenols	
2,4,5-Trichlorophenol	EPA 625
	EPA 8270C
2,4,6-Trichlorophenol	EPA 625
	EPA 8270C
2,4-Dichlorophenol	EPA 625
	EPA 8270C
Priority Pollutant Phenols	
2,4-Dimethylphenol	EPA 625
	EPA 8270C
2,4-Dinitrophenol	EPA 625
	EPA 8270C
2-Chlorophenol	EPA 625
	EPA 8270C
2-Methyl-4,6-dinitrophenol	EPA 625
	EPA 8270C
2-Nitrophenol	EPA 625
	EPA 8270C
4-Chloro-3-methylphenol	EPA 625
	EPA 8270C
4-Nitrophenol	EPA 625
	EPA 8270C
Cresols, Total	EPA 8270C
Pentachlorophenol	EPA 625
	EPA 8270C
Phenol	EPA 625
	EPA 8270C
Purgeable Aromatics	
1,2-Dichlorobenzene	EPA 624
	EPA 8260B

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Purgeable Aromatics	
1,2-Dichlorobenzene	EPA 8270C
1,3-Dichlorobenzene	EPA 624
	EPA 8260B
	EPA 8270C
1,4-Dichlorobenzene	EPA 624
	EPA 8260B
	EPA 8270C
Benzene	EPA 624
	EPA 8260B
Chlorobenzene	EPA 624
	EPA 8260B
Ethyl benzene	EPA 624
	EPA 8260B
Styrene	EPA 624
	EPA 8260B
Toluene	EPA 624
	EPA 8260B
Total Xylenes	EPA 624
	EPA 8260B
Purgeable Halocarbons	
1,1,1,2-Tetrachloroethane	EPA 8260B
1,1,1-Trichloroethane	EPA 624

Purgeable Halocarbons	
1,1,1-Trichloroethane	EPA 8260B
1,1,2,2-Tetrachloroethane	EPA 624
	EPA 8260B
1,1,2-Trichloroethane	EPA 624
	EPA 8260B
1,1-Dichloroethane	EPA 624
	EPA 8260B
1,1-Dichloroethene	EPA 624
	EPA 8260B
1,1-Dichloropropene	EPA 8260B
1,2,3-Trichloropropane	EPA 8260B
1,2-Dichloroethane	EPA 624
	EPA 8260B
1,2-Dichloropropane	EPA 624
	EPA 8260B
2,2-Dichloropropane	EPA 8260B
2-Chloroethylvinyl ether	EPA 624
	EPA 8260B
Bromochloromethane	EPA 8260B
Bromodichloromethane	EPA 624
	EPA 8260B
Bromoform	EPA 624
	EPA 8260B

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Purgeable Halocarbons	
Bromomethane	EPA 624
	EPA 8260B
Carbon tetrachloride	EPA 624
	EPA 8260B
Chloroethane	EPA 624
	EPA 8260B
Chloroform	EPA 624
	EPA 8260B
Chloromethane	EPA 624
	EPA 8260B
cis-1,2-Dichloroethene	EPA 8260B
cis-1,3-Dichloropropene	EPA 624
	EPA 8260B
Dibromochloromethane	EPA 624
	EPA 8260B
Dibromomethane	EPA 8260B
Dichlorodifluoromethane	EPA 624
	EPA 8260B
Methylene chloride	EPA 624
	EPA 8260B
Tetrachloroethene	EPA 624
	EPA 8260B
trans-1,2-Dichloroethene	EPA 624

Purgeable Halocarbons	
trans-1,2-Dichloroethene	EPA 8260B
trans-1,3-Dichloropropene	EPA 624
	EPA 8260B
Trichloroethene	EPA 624
	EPA 8260B
Trichlorofluoromethane	EPA 624
	EPA 8260B
Vinyl chloride	EPA 624
	EPA 8260B
Purgeable Organics	
2-Butanone (Methylethyl ketone)	EPA 8260B
2-Hexanone	EPA 8260B
4-Methyl-2-Pentanone	EPA 8260B
Acetone	EPA 8260B
Carbon Disulfide	EPA 8260B
Vinyl acetate	EPA 8260B
Residue	
Solids, Total	SM 18-20 2540B
Solids, Total Dissolved	SM 18-20 2540C
Solids, Total Suspended	SM 18-20 2540D

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Wastewater Metals I	
Barium, Total	EPA 200.7
	EPA 6010B
Cadmium, Total	EPA 200.7
	EPA 6010B
Calcium, Total	EPA 200.7
	EPA 6010B
Chromium, Total	EPA 200.7
	EPA 6010B
Copper, Total	EPA 200.7
	EPA 6010B
Iron, Total	EPA 200.7
	EPA 6010B
Lead, Total	EPA 200.7
	EPA 6010B
Magnesium, Total	EPA 200.7
	EPA 6010B
Manganese, Total	EPA 200.7
	EPA 6010B
Nickel, Total	EPA 200.7
	EPA 6010B
Potassium, Total	EPA 200.7
	EPA 6010B
Silver, Total	EPA 200.7

Wastewater Metals I	
Silver, Total	EPA 6010B
Sodium, Total	EPA 200.7
	EPA 6010B
Wastewater Metals II	
Aluminum, Total	EPA 200.7
	EPA 6010B
Antimony, Total	EPA 200.7
	EPA 6010B
Arsenic, Total	EPA 200.7
	EPA 6010B
Beryllium, Total	EPA 200.7
	EPA 6010B
Chromium VI	EPA 7196A
	SM 18-19 3500-Cr D
Mercury, Total	EPA 245.1
	EPA 7470A
Selenium, Total	EPA 200.7
	EPA 6010B
Vanadium, Total	EPA 200.7
	EPA 6010B
Zinc, Total	EPA 200.7
	EPA 6010B

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Wastewater Metals III

Cobalt, Total	EPA 200.7
	EPA 6010B
Gold, Total	EPA 231.2
	SM 18-20 3111B
Molybdenum, Total	EPA 200.7
	EPA 6010B
Palladium, Total	SM 18-20 3111B
Thallium, Total	EPA 200.7
	EPA 6010B
Tin, Total	EPA 200.7
Titanium, Total	EPA 200.7

Wastewater Miscellaneous

Bromide	EPA 320.1
Color	EPA 110.2
Cyanide, Total	LACHAT 10-204-00-1-A
	LACHAT 10-204-00-1-X
Hydrogen Ion (pH)	EPA 9040B
	SM 18-20 4500-H B
Oil & Grease Total Recoverable	EPA 1664A
Phenols	LACHAT 10-210-00-1-A
Silica, Dissolved	EPA 200.7
	EPA 6010B

Wastewater Miscellaneous

Specific Conductance	SM 18-20 2510B
Sulfide (as S)	EPA 376.1
Surfactant (MBAS)	SM 18-20 5540C
Temperature	SM 18-20 2550B

Sample Preparation Methods

EPA 200.2	EPA 9010B	EPA 3010A	EPA 3005A
EPA 3510C	EPA 5030B	EPA 3510C	EPA 5030B

Serial No.: 32624

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NEW YORK STATE DEPARTMENT OF HEALTH
WADSWORTH CENTER
RICHARD F. DAINES, M.D.

Expires 12:01 AM April 01, 2008
Issued April 01, 2007

CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

Issued in accordance with and pursuant to section 502 Public Health Law of New York State

MR. JOSEPH P. SHAULYS
SOUTH MALL ANALYTICAL LABS
26 NORTH MALL
PLAINVIEW, NY 11803

NY Lab Id No: 10950
EPA Lab Code: NY01292

is hereby APPROVED as an Environmental Laboratory in conformance with the National Environmental Laboratory Accreditation Conference Standards for the category ENVIRONMENTAL ANALYSES AIR AND EMISSIONS
All approved analytes are listed below:

Metals I

Lead, Total	**EPA 200.7**

Serial No.: 32626

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APPENDIX D

LABORATORY QA/QC PROCEDURES

organis
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mized.

. Follow the precautions given above on portion sizes
s of tubes per dilution.
re solid or semisolid samples weigh the sample and
to make a 10^{-1} dilution. For example, place 50 g
erile blender jar, add 450 mL sterile phosphate buffer
otone dilution water, and blend for 1 to 2 min at low
speed (8000 rpm). Prepare the appropriate decimal dilutions of the homogenized slurry as quickly as possible to minimize settling.

3. Other Samples

The multiple-tube fermentation technique is applicable to the analysis of salt or brackish waters as well as muds, sediments,

9221 B. Standard Total Coliform Fermentation Technique

1. Presumptive Phase

Use lauryl tryptose broth in the presumptive portion of the multiple-tube test. If the medium has been refrigerated after sterilization, incubate overnight at room temperature (20°C) before use. Discard tubes showing growth and/or bubbles.

a. Reagents and culture medium:

1) *Lauryl tryptose broth:*

Tryptose	20.0 g
Lactose	5.0 g
Dipotassium hydrogen phosphate, K_2HPO_4	2.75 g
Potassium dihydrogen phosphate, KH_2PO_4	2.75 g
Sodium chloride, NaCl	5.0 g

reduce ingredient concentrations below those of the standard medium. Prepare in accordance with Table 9221:I.

b. Procedure:

1) Arrange fermentation tubes in rows of five or ten tubes each in a test tube rack. The number of rows and the sample volumes selected depend upon the quality and character of the water to be examined. For potable water use five 20-mL portions, ten 10-mL portions, or a single bottle of 100 mL portion; for nonpotable water use five tubes per dilution (of 10, 1, 0.1 mL, etc.).

In making dilutions and measuring diluted sample volumes, follow the precautions given in Section 9215B.2. Use Figure 9215:1 as a guide to preparing dilutions. Shake sample and dilutions vigorously about 25 times. Inoculate each tube in a set of

mine acid production, the indicator of a positive result in this part of the coliform test. Close tubes with metal or heat-resistant plastic caps.

Make lauryl tryptose broth of such strength that adding 100-mL, 20-mL, or 10-mL portions of sample to medium will not

signifies a positive presumptive reaction.

c. Interpretation: Production of an acidic reaction or gas in the tubes or bottles within 48 ± 3 h constitutes a positive presumptive reaction. Submit tubes with a positive presumptive reaction to the confirmed phase (9221B.2).

9221:I. Preparation of Lauryl Tryptose Broth

Inoculum mL	Amount of Medium in Tube mL	Volume of Medium + Inoculum mL	Dehydrated Lauryl Tryptose Broth Required g/L
1	10 or more	11 or more	35.6
10	10	20	71.2
10	20	30	53.4
20	10	30	106.8
100	50	150	106.8
100	35	135	137.1
100	20	120	213.6

The absence of acidic reaction or gas formation at the end of 48 ± 3 h of incubation constitutes a negative test. Submit drinking water samples demonstrating growth without a positive gas or acid reaction to the confirmed phase (9221B.2). An arbitrary 48-h limit for observation doubtless excludes occasional members of the coliform group that grow very slowly (see Section 9212).

2. Confirmed Phase

a. Culture medium: Use brilliant green lactose bile broth fermentation tubes for the confirmed phase.

Brilliant green lactose bile broth:

Peptone	10.0	g
Lactose	10.0	g
Oxgall	20.0	g
Brilliant green	0.0133	g
Reagent-grade water	1	L

Add dehydrated ingredients to water, mix thoroughly, and heat to dissolve. pH should be 7.2 ± 0.2 after sterilization. Before sterilization, dispense, in fermentation tubes with an inverted vial, sufficient medium to cover inverted vial at least one-half to two-thirds after sterilization. Close tubes with metal or heat-resistant plastic caps.

b. Procedure: Submit all presumptive tubes or bottles showing growth, any amount of gas, or acidic reaction within 24 ± 2 h of incubation to the confirmed phase. If active fermentation or acidic reaction appears in the presumptive tube earlier than 24 ± 2 h, transfer to the confirmatory medium; preferably examine tubes at 18 ± 1 h. If additional presumptive tubes or bottles show active fermentation or acidic reaction at the end of a 48 ± 3- h incubation period, submit these to the confirmed phase.

Gently shake or rotate presumptive tubes or bottles showing gas or acidic growth to resuspend the organisms. With a sterile loop 3.0 to 3.5 mm in diameter, transfer one or more loopfuls of culture to a fermentation tube containing brilliant green lactose bile broth or insert a sterile wooden applicator at least 2.5 cm into the culture, promptly remove, and plunge applicator to bottom of fermentation tube containing brilliant green lactose bile broth. Remove and discard applicator. Repeat for all other positive presumptive tubes.

Incubate the inoculated brilliant green lactose bile broth tube at 35 ± 0.5°C. Formation of gas in any amount in the inverted vial of the brilliant green lactose bile broth fermentation tube at any time (e.g., 6 ± 1 h, 24 ± 2 h) within 48 ± 3 h constitutes a positive confirmed phase. Calculate the MPN value from the number of positive brilliant green lactose bile tubes as described in Section 9221C.

c. Alternative procedure: Use this alternative only for polluted water or wastewater known to produce positive results consistently.

If all presumptive tubes are positive in two or more consecutive dilutions within 24 h, submit to the confirmed phase only the tubes of the highest dilution (smallest sample inoculum) in which all tubes are positive and any positive tubes in still higher dilutions. Submit to the confirmed phase all tubes in which gas or acidic growth is produced only after 48 h.

3. Completed Phase

To establish the presence of coliform bacteria and to provide quality control data, use the completed test on at least 10% of positive confirmed tubes (see Figure 9221:1). Simultaneous inoculation into brilliant green lactose bile broth for total coliforms and EC broth for fecal coliforms (see Section 9221E below) or EC-MUG broth for *Escherichia coli* may be used. Consider positive EC and EC-MUG broths elevated temperature (44.5°C) results as a positive completed test response. Parallel positive brilliant green lactose bile broth cultures with negative EC or EC-MUG broth cultures indicate the presence of nonfecal coliforms.

a. Culture media and reagents:

1) *LES Endo agar:* See Section 9222B. Use 100- × 15-mm petri plates.

2) *MacConkey agar:*

Peptone	17	g
Proteose peptone	3	g
Lactose	10	g
Bile salts	1.5	g
Sodium chloride, NaCl	5	g
Agar	13.5	g
Neutral red	0.03	g
Crystal violet	0.001	g
Reagent-grade water	1	L

Add ingredients to water, mix thoroughly, and heat to boiling to dissolve. Sterilize by autoclaving for 15 min at 121°C. Temper agar after sterilization and pour into petri plates (100 × 15 mm). pH should be 7.1 ± 0.2 after sterilization.

3) *Nutrient agar:*

Peptone	5.0	g
Beef extract	3.0	g
Agar	15.0	g
Reagent-grade water	1	L

Add ingredients to water, mix thoroughly, and heat to dissolve. pH should be 6.8 ± 0.2 after sterilization. Before sterilization, dispense in screw-capped tubes. After sterilization, immediately place tubes in an inclined position so that the agar will solidify with a sloped surface. Tighten screw caps after cooling and store in a protected, cool storage area.

4) Gram-stain reagents:

a) Ammonium oxalate-crystal violet (Hucker's): Dissolve 2 g crystal violet (90% dye content) in 20 mL 95% ethyl alcohol; dissolve 0.8 g $(NH_4)_2C_2O_4 \cdot H_2O$ in 80 mL reagent-grade water; mix the two solutions and age for 24 h before use; filter through paper into a staining bottle.

b) Lugol's solution, Gram's modification: Grind 1 g iodine crystals and 2 g KI in a mortar. Add reagent-grade water, a few milliliters at a time, and grind thoroughly after each addition until solution is complete. Rinse solution into an amber glass bottle with the remaining water (using a total of 300 mL).

c) Counterstain: Dissolve 2.5 g safranin dye in 100 mL 95% ethyl alcohol. Add 10 mL to 100 mL reagent-grade water.

d) Acetone alcohol: Mix equal volumes of ethyl alcohol (95%) with acetone.

b. Procedure:

1) Using aseptic technique, streak one LES Endo agar (Section 9222B.2) or MacConkey agar plate from each tube of brilliant green lactose bile broth showing gas, as soon as possible after the observation of gas. Streak plates in a manner to insure presence of some discrete colonies separated by at least 0.5 cm. Observe the following precautions when streaking plates to obtain a high

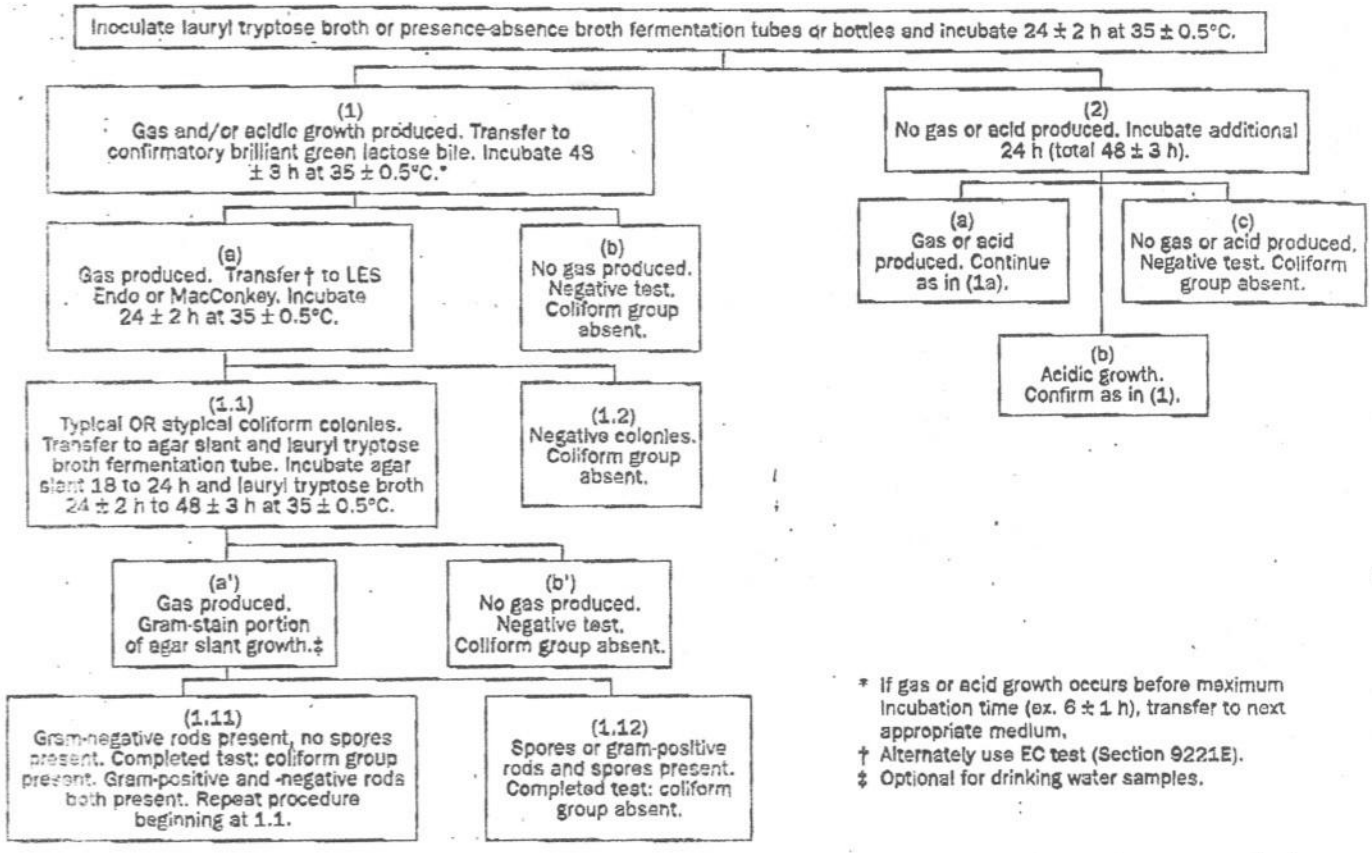

Figure 9221:1. Schematic outline of presumptive, confirmed, and completed phases for total coliform detection.

proportion of successful isolations if coliform organisms are present; (*a*) Use a sterile 3-mm-diam loop or an inoculating needle slightly curved at the tip; (*b*) tap and incline the fermentation tube to avoid picking up any membrane or scum on the needle; (*c*) insert end of loop or needle into the liquid in the tube to a depth of approximately 0.5 cm; and (*d*) streak plate for isolation with curved section of the needle in contact with the agar to avoid a scratched or torn surface. Flame loop between second and third quadrants to improve colony isolation.

Incubate plates (inverted) at 35 ± 0.5°C for 24 ± 2 h.

2) The colonies developing on LES Endo agar are defined as *typical* (pink to dark red with a green metallic surface sheen) or *atypical* (pink, red, white, or colorless colonies without sheen) after 24 h incubation. Typical lactose-fermenting colonies developing on MacConkey agar are red and may be surrounded by an opaque zone of precipitated bile. From each plate pick one or more typical, well-isolated coliform colonies or, if no typical colonies are present, pick two or more colonies considered most likely to consist of organisms of the coliform group, and transfer growth from each isolate to a single-strength lauryl tryptose broth fermentation tube and onto a nutrient agar slant. (The latter is unnecessary for drinking water samples.)

If needed, use a colony magnifying device to provide optimum magnification when colonies are picked from the LES Endo or MacConkey agar plates. When transferring colonies, choose well-isolated ones and barely touch the surface of the colony with a flame-sterilized, air-cooled transfer needle to minimize the danger of transferring a mixed culture.

Incubate secondary broth tubes (lauryl tryptose broth with inverted fermentation vials inserted) at 35 ± 0.5°C for 24 ± 2 h; if gas is not produced within 24 ± 2 h reincubate and examine again at 48 ± 3 h. Microscopically examine Gram-stained preparations from those 24-h nutrient agar slant cultures corresponding to the secondary tubes that show gas.

3) Gram-stain technique—The Gram stain may be omitted from the completed test for potable water samples only because the occurrences of gram-positive bacteria and spore-forming organisms surviving this selective screening procedure are infrequent in drinking water.

Various modifications of the Gram stain technique exist. Use the following modification by Hucker for staining smears of pure culture; include a gram-positive and a gram-negative culture as controls.

Prepare separate light emulsions of the test bacterial growth and positive and negative control cultures on the same slide using drops of distilled water on the slide. Air-dry and fix by passing slide through a flame and stain for 1 min with ammonium oxalate-crystal violet solution. Rinse slide in tap water and drain off excess; apply Lugol's solution for 1 min.

Rinse stained slide in tap water. Decolorize for approximately 15 to 30 s with acetone alcohol by holding slide between the fingers and letting acetone alcohol flow across the stained smear

until the solvent flows colorlessly from the slide. Do not overdecolorize. Counterstain with safranin for 15 s, rinse with tap water, blot dry with absorbent paper or air dry, and examine microscopically. Gram-positive organisms are blue; gram-negative organisms are red. Results are acceptable only when controls have given proper reactions.

c. Interpretation: Formation of gas in the secondary tube of lauryl tryptose broth within 48 ± 3 h and demonstration of gram-negative, nonspore-forming, rod-shaped bacteria from the agar culture constitute a positive result for the completed test, demonstrating the presence of a member of the coliform group.

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9221 C. Estimation of Bacterial Density

1. Precision of Fermentation Tube Test

Unless a large number of sample portions is examined, the precision of the fermentation tube test is rather low. For example, if only 1 mL is examined in a sample containing 1 coliform organism/mL, about 37% of 1-mL tubes may be expected to yield negative results because of random distribution of the bacteria in the sample. When five tubes, each with 1 mL sample, are used under these conditions, a completely negative result may be expected less than 1% of the time.

Consequently, exercise great caution when interpreting the sanitary significance of coliform results obtained from the use of a few tubes with each sample dilution, especially when the number of samples from a given sampling point is limited.

2. Computing and Recording of MPN

To calculate coliform density, compute in terms of the Most Probable Number (MPN). The MPN values, for a variety of planting series and results, are given in Tables 9221:II, III, and IV. Included in these tables are the 95% confidence limits for each MPN value determined. If the sample volumes used are those found in the tables, report the value corresponding to the number of positive and negative results in the series as the MPN/100 mL or report as total or fecal coliform presence or absence.

The sample volumes indicated in Tables 9221:II and III relate more specifically to finished waters. Table 9221:IV illustrates MPN values for combinations of positive and negative results when five 10-mL, five 1.0-mL, and five 0.1-mL volumes of samples are tested. When the series of decimal dilutions is different from that in the table, select the MPN value from Table 9221:IV for the combination of positive tubes and calculate according to the following formula:

$$\text{MPN value (from table)} \times \frac{10}{\text{largest volume tested in dilution series used for MPN determination}} = \text{MPN/100 mL}$$

When more than three dilutions are used in a decimal series of dilutions, use the results from only three of these in computing the MPN. To select the three dilutions to be used in determining the MPN index, choose the highest dilution that gives positive results in all five portions tested (no lower dilution giving any negative results) and the two next succeeding higher dilutions. Use the results at these three volumes in computing the MPN index. In the examples given below, the significant dilution results are shown in boldface. The number in the numerator represents positive tubes; that in the denominator, the total tubes planted; the combination of positives simply represents the total number of positive tubes per dilution:

Example	1 mL	0.1 mL	0.01 mL	0.001 mL	Combination of positives	MPN Index /100 mL
a	**5/5**	**5/5**	**2/5**	**0/5**	5-2-0	5000
b	**5/5**	**4/5**	**2/5**	**0/5**	5-4-2	2200
c	**0/5**	**1/5**	**0/5**	**0/5**	0-1-0	20

In *c*, select the first three dilutions so as to include the positive result in the middle dilution.

with the total time in the autoclave limited to 30 min or less. pH should be 6.8 ± 0.2 after sterilization. When the PA medium is sterilized by filtration a 6× strength medium may be used. Aseptically dispense 20 mL of the 6× medium into a sterile 250-mL dilution bottle or equivalent container.

2) *Lauryl tryptose broth:* See Section 9221B.1.

b. Procedure: Shake sample vigorously for 5 s (approximately 25 times) and inoculate 100 mL into a P-A culture bottle. Mix thoroughly by inverting bottle once or twice to achieve even distribution of the triple-strength medium throughout the sample. Incubate at 35 ± 0.5°C and inspect after 24 and 48 h for acid reactions.

c. Interpretation: A distinct yellow color forms in the medium when acid conditions exist following lactose fermentation. If gas also is being produced, gently shaking the bottle will result in a foaming reaction. Any amount of gas and/or acid constitutes a positive presumptive test requiring confirmation.

2. Confirmed Phase

The confirmed phase is outlined in Figure 9221:1.

a. Culture medium: Use brilliant green lactose bile fermentation tubes (see 9221B.2).

b. Procedure: Transfer all cultures that show acid reaction or acid and gas reaction to brilliant green lactose bile (BGLB) broth for incubation at 35 ± 0.5°C (see Section 9221B.2).

c. Interpretation: Gas production in the BGLB broth culture within 48 ± 3 h confirms the presence of coliform bacteria. Report result as presence-absence test positive or negative for total coliforms in 100 mL of sample.

3. Completed Phase

The completed phase is outlined in Section 9221B.3 and Figure 9221:1.

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9221 E. Fecal Coliform Procedure

Elevated-temperature tests for distinguishing organisms of the total coliform group that also belong to the fecal coliform group are described herein. Modifications in technical procedures, standardization of methods, and detailed studies of the fecal coliform group have established the value of this procedure. The test can be performed by one of the multiple-tube procedures described here or by membrane filter methods as described in Section 9222. The procedure using A-1 broth is a single-step method.

The fecal coliform test (using EC medium) is applicable to investigations of drinking water, stream pollution, raw water sources, wastewater treatment systems, bathing waters, seawaters, and general water-quality monitoring. Prior enrichment in presumptive media is required for optimum recovery of fecal coliforms when using EC medium. The test using A-1 medium is applicable to source water, seawater, and treated wastewater.

1. Fecal Coliform Test (EC Medium)

The fecal coliform test is used to distinguish those total coliform organisms that are fecal coliforms. Use EC medium or, for a more rapid test of the quality of shellfish waters, treated wastewaters, or source waters, use A-1 medium in a direct test.

a. EC medium:

Tryptose or trypticase	20.0 g
Lactose	5.0 g
Bile salts mixture or bile salts No. 3	1.5 g
Dipotassium hydrogen phosphate, K_2HPO_4	4.0 g
Potassium dihydrogen phosphate, KH_2PO_4	1.5 g
Sodium chloride, NaCl	5.0 g
Reagent-grade water	1 L

Add dehydrated ingredients to water, mix thoroughly, and heat to dissolve. pH should be 6.9 ± 0.2 after sterilization. Before sterilization, dispense in fermentation tubes, each with an inverted vial, sufficient medium to cover the inverted vial at least partially after sterilization. Close tubes with metal or heat-resistant plastic caps.

b. Procedure: Submit all presumptive fermentation tubes or bottles showing any amount of gas, growth, or acidity within 48 h of incubation to the fecal coliform test.

1) Gently shake or rotate presumptive fermentation tubes or bottles showing gas, growth, or acidity. Using a sterile 3- or 3.5-mm-diam loop or sterile wooden applicator stick, transfer growth from each presumptive fermentation tube or bottle to EC broth (see Section 9221B.2).

2) Incubate inoculated EC broth tubes in a water bath at 44.5 ± 0.2°C for 24 ± 2 h.

Place all EC tubes in water bath within 30 min after inoculation. Maintain a sufficient water depth in water bath incubator to immerse tubes to upper level of the medium.

c. Interpretation: Gas production with growth in an EC broth culture within 24 ± 2 h or less is considered a positive fecal coliform reaction. Failure to produce gas (with little or no growth) constitutes a negative reaction. If multiple tubes are used, calculate MPN from the number of positive EC broth tubes as described in Section 9221C. When using only one tube for subculturing from a single presumptive bottle, report as presence or absence of fecal coliforms.

2. Fecal Coliform Direct Test (A-1 Medium)

a. A-1 broth: This medium may be used for the direct isolation of fecal coliforms from water. Prior enrichment in a presumptive medium is not required.

Lactose	5.0 g
Tryptone	20.0 g
Sodium chloride, NaCl	5.0 g
Salicin	0.5 g
Polyethylene glycol *p*-isooctylphenyl ether*	1.0 mL
Reagent-grade water	1 L

Heat to dissolve solid ingredients, add polyethylene glycol *p*-isooctylphenyl ether, and adjust to pH 6.9 ± 0.1. Before sterilization dispense in fermentation tubes with an inverted vial sufficient medium to cover the inverted vial at least partially after

Make A-1 broth of such strength that adding 10-mL sample portions to medium will not reduce ingredient concentrations below those of the standard medium. For 10-mL samples prepare double-strength medium.

b. Procedure: Inoculate tubes of A-1 broth as directed in Section 9221B.1*b*1). Incubate for 3 h at 35 ± 0.5°C. Transfer tubes to a water bath at 44.5 ± 0.2°C and incubate for an additional 21 ± 2 h.

c. Interpretation: Gas production in any A-1 broth culture within 24 h or less is a positive reaction indicating the presence of fecal coliforms. Calculate MPN from the number of positive A-1 broth tubes as described in Section 9221C.

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9221 F. *Escherichia coli* Procedure (PROPOSED)

Escherichia coli is a member of the fecal coliform group of bacteria. This organism in water indicates fecal contamination. Enzymatic assays have been developed that allow for the identification of this organism. In this method *E. coli* are defined as coliform bacteria that possess the enzyme β-glucuronidase and are capable of cleaving the fluorogenic substrate 4-methylumbelliferyl-β-D-glucuronide (MUG) with the corresponding release of the fluorogen when grown in EC-MUG medium at 44.5°C within 24 ± 2 h or less. The procedure is used as a confirmatory test after prior enrichment in a presumptive medium for total coliform bacteria. This test is performed as a tube procedure as described here or by the membrane filter method as described in Section 9222. The chromogenic substrate procedure (Section 9223) can be used for direct detection of *E. coli*.

Tests for *E. coli* (using EC-MUG medium) are applicable for the analysis of drinking water, surface and ground water, and wastewater. *E. coli* is a member of the indigenous fecal flora of warm-blooded animals. The occurrence of *E. coli* is considered a specific indicator of fecal contamination and the possible presence of enteric pathogens.

1. *Escherichia coli* Test (EC-MUG medium)

Use EC-MUG medium for the confirmation of *E. coli*.

a. EC-MUG medium:

Tryptose or trypticase	20.0 g
Lactose	5.0 g
Bile salts mixture or bile salts No. 3	1.5 g
Dipotassium hydrogen phosphate, K_2HPO_4	4.0 g

United States Environmental Protection Agency

Office of Water
Washington, DC 20460

EPA-821-R-97-004a
May 1997

EPA

Method 1600: Membrane Filter Test Method for Enterococci In Water

Acknowledgments

This method was developed under the direction of James W. Messer and Alfred P. Dufour of the U.S. Environmental Protection Agency's (EPA) Human Exposure Research Division, National Exposure Research Laboratory, Cincinnati, Ohio. The method document was prepared under EPA Contract 68-C3-0337 by the DynCorp Environmental Programs Division.

Disclaimer

This method has been reviewed and approved for publication by the Office of Science and Technology within EPA's Office of Water. This method is approved for use in ambient water monitoring, but not for wastewater analysis under 40 CFR part 136. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Questions concerning this method or its application should be addressed to:

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Analytical Methods Staff
Engineering and Analysis Division (4303)
USEPA Office of Water

Introduction

EPA has been increasingly concerned with the public health risks of infectious diseases caused by microbial organisms in our nation's beaches. To counteract this problem, EPA has established the Beaches Evironmental Assessment Closure and Health (BEACH) Program. This analytical method is published for use in the BEACH Program.

In 1986, EPA issued a revision to its bacteriological ambient water quality criteria recommendations to include new indicator bacteria, *E. coli* and enterococci, which provide a better correlation with swimming-associated gastrointestinal illness than the previous criteria recommendations for fecal coliform bacteria. These revised criteria are useful to public health officials because they enable quantitative estimates of illness rates associated with swimming in polluted water.

This method is a revision of EPA's previous enterococci method, used since 1985 in ambient water quality monitoring. It reduces analysis time to 24 hours and improves analytical quality. The method has been validated in single- and multi-laboratory studies and has undergone peer review.

Requests for additional copies of this method should be directed to:

USEPA National Center for Environmental
Publications and Information (NCEPI)
11029 Kenwood Road
Cincinnati, OH 45242

Document No. EPA-821-C-97-004

Method 1600: Membrane Filter Test Method for Enterococci in Water

1.0 Scope and Application

1.1 This method describes a membrane filter (MF) procedure for the detection and enumeration of the enterococci bacteria in water. Enterococci are commonly found in the feces of humans and other warm-blooded animals. Although some strains are ubiquitous and not related to fecal pollution, the presence of enterococci in water is an indication of fecal pollution and the possible presence of enteric pathogens.

1.2 The enterococci test measures the bacteriological quality of recreational waters. Epidemiological studies have led to the development of criteria which can be used to promulgate recreational water standards based on the established relationship between health effects and water quality. The significance of finding enterococci in recreational water samples is the direct relationship between the density of enterococci in the water and swimming-associated gastroenteritis studies of marine and fresh water bathing beaches (1,2).

2.1 The MF method provides a direct count of bacteria in water based on the development of colonies on the surface of the membrane filter. A water sample is filtered through the membrane which retains the bacteria. Following filtration, the membrane containing the bacterial cells is placed on a selective medium, mEI agar, and incubated for 24 h at 41°C. All colonies with any blue halo are recorded as enterococci colonies, regardless of colony color. Magnification and a small fluorescent lamp are used for counting to give maximum visibility of colonies.

3.0 Definition

3.1 In this method, enterococci are those bacteria which produce colonies with a blue halo after incubation on mEI agar,

4.0 Interferences

4.1 Water samples containing colloidal or suspended particulate materials can clog the membrane filter and prevent filtration, or cause spreading of bacterial colonies which could interfere with identification of target colonies.

5.0 Safety

5.1 The analyst/technician must know and observe the normal safety procedures required in a microbiology laboratory while preparing, using, and disposing of cultures, reagents, and materials, and while operating sterilization equipment.

5.2 Mouth-pipetting is prohibited.

6.0 Equipment and Supplies

6.1 Glass lens with magnification of 2-5X or stereoscopic microscope.

6.2 Lamp, with a cool, white fluorescent tube.

6.3 Hand tally or electronic counting device.

aluminum foil or kraft paper and sterile.

6.8 Ultraviolet unit for sanitization of the filter funnel between filtrations (optional).

6.9 Line vacuum, electric vacuum pump, or aspirator for use as a vacuum source. In an emergency or in the field, a hand pump or a syringe equipped with a check valve to prevent the return flow of air, can be used.

6.10 Flask, filter, vacuum, usually 1 L, with appropriate tubing. A filter manifold to hold a number of filter bases is optional.

6.11 Flask for safety trap placed between the filter flask and the vacuum source.

6.12 Forceps, straight or curved, with smooth tips to handle filters without damage.

6.13 Ethanol, methanol or isopropanol in a small, wide-mouth container, for flame-sterilizing forceps.

6.14 Burner, Bunsen or Fisher type, or electric incinerator unit for sterilizing loops and needles.

6.15 Thermometer, checked against a National Institute of Standards and Technology (NIST) certified thermometer, or one that meets the requirements of NIST Monograph SP 250-23.

6.16 Petri dishes, sterile, plastic, 50 x 12 mm, with tight-fitting lids.

6.17 Bottles, milk dilution, borosilicate glass, screw-cap with neoprene liners, marked at 99 mL for 1-100 dilutions. Dilution bottles marked at 90 mL or tubes marked at 9 mL may be used for 1-10 dilutions.

6.18 Flasks, borosilicate glass, screw-cap, 250-2000 mL volume.

6.19 Membrane filters, sterile, white, grid marked, 47 mm diameter, with 0.45 + 0.02 μm pore size.

6.20 Inoculation loops, at least 3-mm diameter, and needles, nichrome or platinum wire, 26 B & S gauge, in suitable holders.

6.21 Incubator maintained at 41 ±0.5°C.

7.0 Reagents and Standards

7.1 Purity of Reagents: Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society (3). The agar used in preparation of culture media must be of microbiological grade.

7.2 Whenever possible, use commercial culture media as a means of quality control.

7.3 Purity of Water: Reagent water conforming to Specification D1193, Reagent water conforming Type II, Annual Book of ASTM Standards (4).

7.4 Buffered Dilution Water

7.4.1 Composition:

Sodium Dihydrogen Phosphate	0.58 g
Sodium Monohydrogen Phosphate	2.50 g
Sodium Chloride	8.50 g

7.4.2 Preparation: Dissolve the ingredients in 1 L of reagent water in a flask and dispense in appropriate amounts for dilutions in screw-cap bottles or culture tubes and/or into containers for use as rinse water. Autoclave after preparation at 121 °C (15 lb pressure) for 15 min. The final pH should be 7.4 ± 0.2.

7.5 mEI Agar

7.5.1 Composition of Basal Medium (mE Agar, Difco 0333)

Peptone	10.0 g
Sodium Chloride	15.0 g
Yeast Extract	30.0 g
Esculin	1.0 g
Actidione	0.05 g
Sodium Azide	0.15 g
Agar	15.0 g

tetrazolium chloride separately to the mEI medium and mix.

7.5.4 Preparation of mEI Agar Plates: Pour the mEI agar into 50 mm petri dishes to a 4-5 mm depth (approximately 4-6 mL), and allow to solidify. The final pH of medium should be 7.1 ± 0.2. Store in a refrigerator.

7.6 Brain Heart Infusion (BHI) (Difco 0037-02, BBL 11058)

7.6.1 Composition:

Calf Brain Infusion	200.0 g
Beef Heart Infusion	250.0 g
Peptone	10.0 g
Sodium Chloride	5.0 g
Disodium Phosphate	2.5 g
Dextrose	2.0 g

7.6.2 Preparation: Dissolve 37 g of dehydrated brain heart infusion in 1 L of reagent grade water. Dispense in 8-10 mL volumes in screw-cap tubes and autoclave at 121°C (15 lb pressure) for 15 min. If the medium is not used the same day as prepared and sterilized, heat in boiling water bath for several min to remove absorbed oxygen, and cool quickly without agitation, just prior to inoculation. The final pH should be 7.4 ± 0.2.

7.7 Brain Heart Infusion (BHI) Broth with 6.5% NaCl

7.7.1 Composition: Brain heart infusion broth with 6.5% NaCl is the same as BHI broth in 7.6 with additional NaCl.

7.7.2 Preparation: Add 60.0 g NaCl per liter of medium. Since most commercially available dehydrated media contain sodium chloride, this amount is taken into consideration in determining the final NaCl percentage above.

medium in screw-cap test tubes and sterilize for 15 min at 121 °C (15 lb pressure). Slant after sterilization. The final pH should be 7.4 ± 0.2.

7.9 Bile Esculin Agar (BEA) (Difco 0879)

7.9.1 Composition:

Bacto Beef Extract	3.0 g
Bacto Peptone	5.0 g
Bacto Oxgall	40.0 g
Bacto Esculin	1.0 g
Ferric Citrate	0.5 g
Bacto Agar	15.0 g

7.9.2 Preparation: Add 64.5 g of dehydrated BEA to 1 L reagent water and heat to boiling to dissolve completely. Dispense in 8-10 mL volumes in tubes for slants or into flasks for subsequent plating. Autoclave at 121°C at 15 lb pressure for 15 min. Overheating may cause darkening of the medium. Cool to 44-46°C and dispense into sterile petri dishes. The final pH should be 6.6 ± 0.2. Store in a refrigerator.

8.0 Sample Collection, Preservation, and Storage

8.1 Sampling procedures are described in detail in the USEPA microbiology methods manual, Section II, A (5). Adherence to sample preservation procedures and holding time limits is critical to the production of valid data. Samples shall not be analyzed if these conditions are not met.

8.1.1 Storage Temperature and Handling Conditions

Ice or refrigerate bacteriological samples at a temperature of 1-4°C during transit to the

9.0 Quality Control

9.1 See recommendations on quality control for microbiological analyses in the USEPA microbiology methods manual, Part IV, C (5).

10.0 Calibration and Standardization

10.1 Check temperatures in incubators daily to ensure operation within stated limits.

10.2 Check thermometers at least annually against an NIST certified thermometer or one that meets the requirements of NIST Monograph SP 250-23. Check mercury columns for breaks.

11.0 Procedure

11.1 Prepare the mEI agar as directed in 7.5.

11.2 Mark the petri dishes and report forms with sample identification and sample volumes.

11.3 Place a sterile membrane filter on the filter base, grid-side up and attach the funnel to the base; the membrane filter is now held between the funnel and the base.

11.4 Shake the sample bottle vigorously about 25 times to distribute the bacteria uniformly, and measure the desired volume of sample or dilution into the funnel.

11.5 For ambient surface waters and wastewaters, select sample volumes based on previous knowledge of the pollution level, to produce 20-60 enterococci colonies on membranes. Sample volumes of 1-100 mL are normally tested at half log intervals, for example 100, 30, 10, 3 mL, etc.

11.6 Smaller sample size or sample dilution can be used to minimize the interference of turbidity or high bacterial densities. Multiple volumes of the same sample or dilution of sample may be filtered and the results combined.

11.7 Filter the sample and rinse the sides of the funnel at least twice with 20-30 mL of sterile buffered rinse water. Turn off the vacuum and remove the funnel from the filter base.

11.8 Use sterile forceps to aseptically remove the membrane filter from the filter base and roll it onto the

12.0 Data Analysis and Calculations

Use the following general rules to calculate the enterococci count per 100 mL of sample:

12.1 Select and count membranes with ideally 20-60 colonies with any blue halo as an enterococci colony. Calculate the final value using the formula:

$$Enterococci/100mL = \frac{No.\ of\ enterococci\ colonies}{Volume\ of\ sample\ filtered(mL)} \times 100$$

12.2 See the USEPA microbiology manual, Part II, Section C, 3.5, for general counting rules (5).

13.0 Method Performance

13.1 Specificity - The specificity of the medium used in this method is 6.0% false positive and 6.5% false negative for various environmental water samples (6). The false positive rate was calculated as the percent of colonies which reacted typically, but did not verify as members of the enterococcus group. The false negative rate was calculated as the percent of all verified enterococcus colonies not reacting typically.

13.2 Bias - The persistent positive or negative deviation of the results from the assumed or accepted true value is not significant (6).

13.3 Precision - The precision among laboratories for marine water and surface water was 2.2% and 18.9% (6).

14.0 Reporting Results

14.1 Report the results as enterococci per 100 mL of sample.

15.0 Verification Procedure

15.1 Colonies with any blue halo can be verified as enterococci. Verification of colonies may be required in evidence gathering, and is also recommended as a QC procedure upon initial use of the test and with changes in sample sites or lots of commercial media. The verification procedure follows.

15.2 Using a sterile inoculating needle, transfer cells from the centers of at least 10 well-isolated typical colonies into a brain heart infusion broth (BHI) tube and onto a BHI slant. Incubate broth tubes for 24 h and slants for 48 h at 35 ± 0.5°C.

15.3 After 24 h incubation, transfer a loopful of material from each BHI broth tube to:

15.5 After 48 h incubation, apply a gram stain to growth from each BHI agar slant.

15.6 Gram positive cocci which grow in BEA, BHI Broth at 45°C, and BHI Broth + 6.5% NaCl, and hydrolyze esculin, are verified as enterococci.

16.0 Pollution Prevention

16.1 The solutions and reagents used in this method pose little threat to the environment when recycled and managed properly.

16.2 Solutions and reagents should be prepared in volumes consistent with laboratory use to minimize the volume of expired materials to be disposed.

17.0 Waste Management

17.1 It is the laboratory's responsibility to comply with all federal, state, and local regulations governing waste management, particularly the biohazard and hazardous waste identification rules and land disposal restrictions, and to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

17.2 Samples, reference materials, and equipment known or suspected to have viable enterococci attached or contained must be sterilized prior to disposal.

17.3 Samples preserved with HCl to pH <2 are hazardous and must be neutralized before being disposed, or must be handled as hazardous waste.

17.4 For further information on waste management, consult "The Waste Management Manual for Laboratory Personnel" and "Less Is Better: Laboratory Chemical Management for Waste Reduction," both available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036.

18.0 References

18.1 Cabelli, V. J. 1980. Health Effects Criteria for Marine Recreational Waters, EPA-600/1-80-031. Office of Research and Development, USEPA.

18.2 Dufour, A.P. 1984. Health Effects Criteria for Fresh Recreational Waters, EPA-600/1-84-004. Office of Research and Development, USEPA.

18.3 Reagent Chemicals, American Chemical Society Specifications, American Chemical Society, Washington, DC. For suggestions of the testing of reagents not listed by the American Chemical Society, see Analar Standards for Laboratory Chemicals, BDH Ltd., Poole, Dorset, UK and the United States Pharmacopeia.

18.4 Annual Book of ASTM Standards, Vol. 11.01, American Society for Testing and Materials, Philadelphia, PA 19103.

18.5 Bordner, R., J.A. Winter and P.V. Scarpino (eds.), Microbiological Methods for Monitoring the Environment, Water and Wastes, EPA-600/8-78-017. Office of Research and Development, USEPA.

18.6 Messer, J.W. and A.P. Dufour. 1998. A Rapid, Specific Membrane Filtration Procedure for Enumeration of Enterococci in Recreational Water. Applied and Environmental Microbiology 64:678-680.

LABORATORY QUALITY ASSURANCE SYSTEMS MANUAL

Approved: Joseph P. Shaulys 12/30/05
Laboratory Director – Joseph P. Shaulys Date

Approved: Renee Cohen 12/30/05
Quality Assurance Officer – Renee Cohen Date

Departmental Distribution List:

Organics ..... ☐
Inorganics ..... ☐
Quality Assurance/Quality Control ..... ☐
Administrative Personnel ..... ☐

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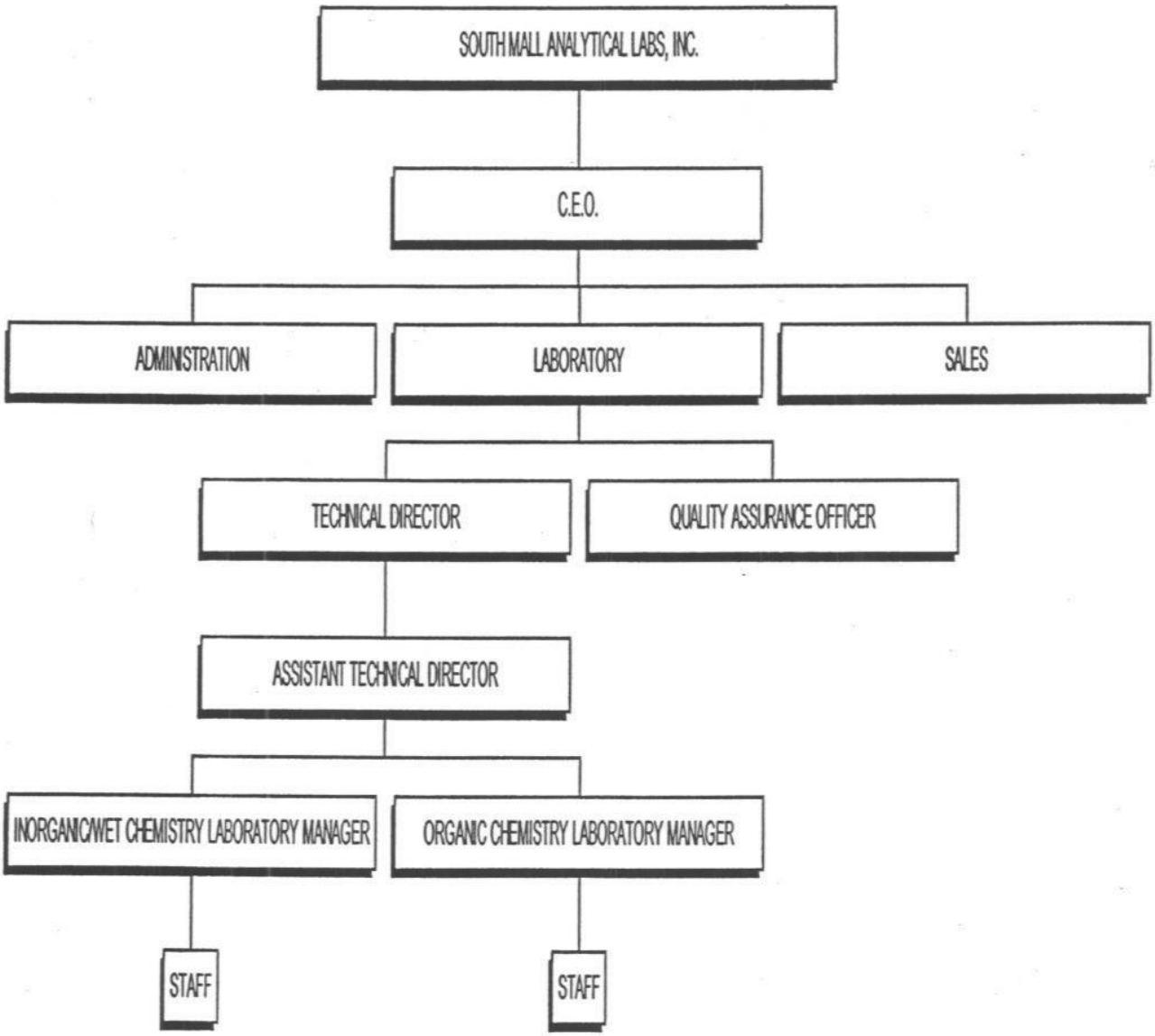
Re:Laboratory SOP's

Section 1.0 Quality Policy Statement

It is the goal of South Mall Analytical labs to generate technically defensible laboratory results that are precise and accurate. The laboratory is committed to routinely producing quality results, which are in conformance with NELAC standards. This will be accomplished by providing:

A) Laboratory results that are supported by quality control data and documented laboratory testing methods.
B) Adequately staffed and equipped laboratory facility.
C) Complete implementation of a NELAC compliant quality assurance system.
D) Successful participation in the ELAP proficiency testing operated by the New York State Department of Health.

Section 2.0 Organizational Chart



Section 3.0 Job Description of Laboratory Personnel

The Technical Director is a full-time member of the staff who exercises day-to-day supervision of laboratory procedures and reporting results. The Director has overall responsibility for the technical operation of the laboratory. The Director must be capable of monitoring standards of performance in quality control and quality assurance, as well as the validity of the analyses performed and data generated in the laboratory to ensure reliable data. The Director must ensure that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory, as well as provide educational direction to laboratory staff. The Director must certify through documentation that personnel with appropriate educational and technical background perform all tests for which the laboratory is accredited. The Director shall meet the requirements specified in the NELAC Accreditation Process (4.1.1.1).

procedures associated with these deficiencies.

The Laboratory Manager is responsible for the daily routine operations of the laboratory. The Manager is responsible for supervising the laboratory, maintaining rigid quality control and ensuring the validity of all reported data.

The Laboratory Staff shall have the necessary education, training, technical knowledge and experience for their assigned functions. They shall be responsible for complying with all quality assurance/quality control requirements that pertain to their technical function. They must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular function, and a general knowledge of laboratory operations, test methods, quality assurance/quality control procedures and records management.

Section 4.0 Relationship of Management to Technical Operations, Support Services and the Quality System

The function of management is to provide all of the required resources and to enable the laboratory to provide analyses that are accurate, precise and incorporate the highest standards of quality assurance/quality control.

The Technical Director has overall responsibility for the technical operation of the lab. The Director is responsible for arranging and overseeing all support services, tecnical services including instrument service contracts, subcontracting sample analyses and physical maintenance of the laboratory. The Director provides supervision to all laboratory personnel to ensure adherence to all of the laboratory's documented procedures. The Director shall ensure that the laboratory's policies and objectives for quality of testing are documented in the Quality

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The Quality Assurance Officer has responsibility for the laboratory quality system and its implementation. Although working with and guiding all laboratory personnel, including the Technical Director, the Quality Assurance Officer is completely independent of laboratory production. The Quality Assurance Officer has direct access to the highest levels of management including the Technical Director and CEO who make decisions on laboratory policy and/or resources.

Section 5.0 Document Control

All Standard Operating Procedure (SOP) manuals and documents are subject to document control. The purpose of the document control is to ensure that only the most recent revisions are available to the appropriate personnel and that revisions are timely and receive the required approval.

The Quality Assurance Officer is responsible for the document control system and keeps a master list of the location of all documents and their current revision. This includes document control of Laboratory SOP's, Laboratory Policies and the Quality System Manual. The Technical Director and Quality Assurance Officer approve all released and revised documents. The Quality Assurance Officer is responsible to remove all obsolete SOPs and documents from the laboratory work area. Only the original document controlled copy will be retained in the files.

Controlled documents will have an approval signature page, revision record page and a distribution list.

The laboratory will maintain a record system in order to reproduce both laboratory test reports and laboratory associated data for a minimum of five (5) years. All records associated with laboratory sample receipt and analyses are maintained on-site at the laboratory. Current data logbooks and associated instrument printouts are stored in the laboratory area in a series of file cabinets and laboratory bench storage areas. Current data associated with instrumentation is stored in the work area of the instrument. Older records/data are stored in either file cabinets or "Bankers Boxes" in the second floor storage area. Records that are stored in this second floor storage area include, but are not limited to; sample receiving logs, chain of custody records, laboratory reports, calibration data, logbooks and instrument generated logs. This area is secure and provides storage of data in an order that will protect the data records from damage or deterioration over time.

During the discard step of outdated laboratory data records, greater than five (5) years old the analyst will remove all paper records. All paper records will be sent to a paper recycling plant for reuse. No additional steps will be taken.

In the event that the laboratory changes ownership or goes out of business, the laboratory plan is to transfer all laboratory records to the new owner. In the event that the laboratory goes out of business or in the event of a closure of the laboratory the owner will maintain storage of all laboratory records. This record retention by the laboratory owner will be for a period of five (5) years from the date the data was generated.

class "S" weights and a NIST traceable thermometer when verifying annual calibration of the thermometers that are utilized prior to use or on daily basis. The laboratory will maintain records of all calibration certificates and reference standard measurements.

The laboratory contracts an outside service to come verify the analytical balance on an annual basis. Automatic Eppendorf Pipettes are calibrated by laboratory personnel on a quarterly basis. Thermometers that are used in refrigerators ovens and incubators are checked on an annual basis. Records of thermometer checks and pipette checks are recorded in a logbook maintained by the QA officer.

Acidity	305.1	7
Alkalinity	310.1	7
Ammonia	10-107-06-1 B	6
Biochemical Oxygen Demand (BOD)	405.1; 5210 B	1; 2
Bromide	320.1	2
Chemical Oxygen Demand (COD)	410.1	2
Chloride	4500-Cl B	2
Chromium, Hexavalent	3500-Cr D	2
Color	110.2	1
Cyanide, Total and Amenable	335.2; 9010B;10-204-00-1-A	1; 3,6
Dissolved Solids, Total (TDS)	2540 C	2
Fluoride	340.2	1
Hardness	130.2	1
Kjeldahl Nitrogen, Total (TKN)	351.3	1
Mercury	245.2; 7470A	1; 3
Metals	200.7; 6010B	1; 3
Nitrate	10-107-04-1	6
Nitrite	10-107-04-1	6
Oil & Grease	1664A; 413.1	4; 1
Organic Carbon, Total	415.2	1
pH	150.1, 9040	1,2
Phenol, Total	10-210-00-1-A	6
Phosphorus	365.3	1
Silica	200.7; 370.1; 6010B	1; 1; 3
Solids, Total (TS)	160.3,2540 B	2
Specific Conductance	2510 B	2
Sulfate	375.4	1
Sulfide	376.1	1
Surfactant (MBAS)	5540 C	2
Suspended Solids, Total (TSS)	160.2,2540 D	2
Temperature	2550 B	2
Purgeable Aromatics	624; 8260B	1; 3
BTEX (Benzene, Ethylbenzene, Toluene, Xylenes)	624; 8260B	1; 1; 3; 3

Priority Pollutant Phenols	625; 8270C	1; 3
PCBs (Polychlorinated Biphenyls)	608; 8082	5; 3
Chlorinated Hydrocarbons Pesticides	608; 8081A	5; 3
Chlordane	608; 8081A	5; 3
Chorophenoxy Acid Pesticides	6640 B; 8151A	2; 3
Total Dissolved Solids	160.1	1; 3
Ortho Phosphate (as P)	4500-P E	2

[1]"Part VIII Environmental Protection Agency, Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Final Rule and Proposed Rule," *40 Code of Federal Regulations*, Part 136, October 26, 1984.
[2]*Standard Methods for the Examination of Water and Wastewater*, 19th edition.
[3]"Test Methods for Evaluating Solid Waste: Physical/Chemical Methods," *SW-846*, 3rd edition, U.S. Environmental Protection Agency, September, 1986.
[4]"Method 1664: N-Hexane Extractable Method (HEM) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM) By Extraction and Gravimetry (Oil and Grease and Total Petroleum Hydrocarbons," *EPA-821-B-94-004b*, U.S. Environmental Protection Agency, April, 1995.
[5]"Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water and Wastewater," U.S. Environmental Protection Agency, September, 1978.
[6]"Lachat Flow Injection Analysis (FIA) Methods Manual
[7]Methods for the Chemical Analysis of Water and Waste (MCAWW), EPA-600/4/79-020

Chromium Hexavalent	7196A	1
Corrosivity Towards Steel	1110	1
Cyanide (Total and Amenable)	9010 B	1
Ignitability	1010	1
Lead in Dust Wipes	6010B	1
Lead in Paint	6010B	1
Mercury	7471A	1
Metals	6010B	1
pH	9040B; 9045C	1; 1
Reactivity – Cyanide	Chap. 7, Sec. 7.3	1
Reactivity – Sulfide	Chap. 7, Sec. 7.3	1
Reactivity – Water	Chap. 8, Sec. 7.3	1
TCLP Extraction	1311	1
Purgeable Aromatics	8260B	1
BTEX (Benzene, Ethylbenzene, Toluene, Xylenes)	8260B	1
Purgeable Halocarbons	8260B	1
TCLP Compounds – Methyl ethyl ketone (2-butanone)	8260B	1
Benzidines	8270C	1
Chlorinated Hydrocarbons	8270C	1
Haloethers	8270C	1
Nitroaromatics/Isophorone	8270C	1
Nitrosamines	8270C	1
Phthalate Esters	8270C	1
Polynuclear Aromatic Hydrocarbons	8270C	1
Priority Pollutant Phenols	8270C	1
TCLP Compounds – Cresol	8270C	1
TCLP Compounds - Pyridine	8270C	1
PCBs (Polychlorinated Biphenyls)	8082	1
Chlorinated Hydrocarbon Pesticides	8081A	1
Chlordane	8081A	1
Chorophenoxy Acid Pesticides	8151A	1

[1]"Test Methods for Evaluating Solid Waste: Physical/Chemical Methods," *SW-846*, 3rd edition, U.S. Environmental Protection Agency, September 1986

method and demonstrate capability to perform these tests. Demonstration of capability includes the preparation and analysis of a method detection limit (MDL) study to determine a laboratory reporting limit. All this should take place prior to reporting results of this new work.

standardization, calculations and acceptance criteria. Each analyst is responsible to check/verify that calibration QC criteria are met prior to field sample analysis.

South Mall Laboratories retains sufficient raw data to reconstruct the calibration used to determine the sample result. This information is maintained for a period of five (5) years. All calibrations are verified with a second source standard which is traceable to NIST when available. Second source standards are to be from a second vendor, or the same vendor, different lot number. When neither of the above is available the same manufacturer/lot number may be used, however the second solution must be prepared by a different analyst. All standard preparations are documented in the standard preparation logbook. Effective September, 2005 the laboratory purchased and implemented the use of Promium/Element . This is a Laboratory Information Management System (LIMS). This system maintains calibration standard information based on an assigned lot number. The preparation information including, but not limited to the solvent, sample volumes, lot numbers and manufacturer information is maintained in a bound logbook that is stored in the work area.

All reported sample results must be within the calibration range. No data is to be reported above the calibration range of any instrument. Calibration standards include a concentration at or below the regulatory level but above the method detection limit. No data associated with an out-of-control calibration should be reported. Promium/Element has information to report a Minimum Reporting Limit (MRL). This MRL is above the method detection limit or is known as the Limit of Quantification (LOQ). South Mall reports all results at the MRL/LOQ. Data is not qualified "J" to indicate a result at the MDL or between the MDL and the LOQ.

The Method Detection Limit (MDL) is established and documented for each method/analyte/matrix. The MDL is determined using the procedure outlined CFR Part 136, Appendix B. The standard deviation of the analysis of a minimum of seven (7) aliquots of a clean matrix spiked reagent is calculated. The spiked reagent is an estimated concentration between the estimated MDL and five times the estimated MDL. The actual MDL is 3.14 times the calculated standard deviation. When more than seven points are used to determine the standard deviation the method lists the number the standard deviation is to be multiplied by. Method Detection Limits (MDL) files are filed in the QA office. The laboratory analyzes annual MDL's for each of the methods reported. The MDL is not used to report sample data. The MDL is used to insure that the MRL that is reported is justified by the annual MDL.

Section 10.0 Sample Handling

Sample Collection

South Mall Analytical Labs has trained field technicians on staff to collect samples when clients request this service. Collection is performed using approved plastic or glass containers of sufficient volume containing any necessary preservatives. All sample bottles are one-time use bottles. Sample bottles are not washed and reused. All field samples are placed in coolers containing ice and are immediately transported to the laboratory following collection. Each container has a water-resistant label on which is recorded the sample site location and the date and time of sample collection. Chain of custody forms are prepared and submitted by all sample collectors.

condition, preservative, custody seals and temperature. Original Chain of Custody documents are maintained in the front office so that they are available for the final report. Any abnormalities or discrepancies are noted, a non-compliance report is generated and the client immediately notified.

Secondary review of the project information is performed by the Technical Director or the QA Officer. Client ID, project ID, sample collection, sample receipt date, sample ID and test requests are checked for accuracy. After this review the sample status is changed from Received to Available.

Sample/Waste Disposal

South Mall Laboratories generates non-hazardous waste as a result of laboratory analyses and data reporting. The laboratory attempts to recycle as much as possible. All paper and cardboard wastes are picked up by a local paper recycler. The laboratory currently uses Ed's Salvage for this task.

All glass and plastic containers are emptied and tripled rinsed with water. All bottles are labeled to indicate a triple rinse has been performed. These glass and plastic containers are collected in plastic garbage pails and are picked up by the Town of Oyster Bay. These containers are treated as regular trash, the plastic and glass containers are recycled by the local town

Sample Collection Requirements

ANALYTE	CONTAINER	PRESERVATION	MAX. HOLDING TIME
INORGANIC TESTS:			
Acidity	P, G	Separate bottle completely filled to the exclusion of air, Cool, 4°C	14 days
Alkalinity	P, G	Separate bottle completely filled to the exclusion of air, Cool, 4°C	14 days
Ammonia	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days

ANALYTE	CONTAINER	PRESERVATION	MAX. HOLDING TIME
Chemical Oxygen Demand	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Chloride	P, G	None	28 days
Color	P, G	Cool, 4°C	48 hours
Cyanide, Total and Amenable to Chlorination	P, G	Cool, 4°C, NaOH to pH>12, 0.6g ascorbic acid	14 days
Fluoride	P	None	28 days
Hardness	P, G	HNO_3 to pH<2; H_2SO_4 to pH<2	6 months
Hydrogen Ion (pH)	P, G	None	Analyze immediately
Kjeldahl and Organic Nitrogen	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Metals, except Boron,	P, G	HNO_3 to pH<2	6 months
Phenols	G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Phosphorus (Elemental)	G	Cool, 4°C	48 hours
Phosphorus, Total	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Residue, Total	P, G	Cool, 4°C	7 days
Residue, Filterable	P, G	Cool, 4°C	7 days
Residue, Nonfilterable	P, G	Cool, 4°C	7 days
Residue, Volatile	P, G	Cool, 4°C	7 days
Silica	P, Quartz	Cool, 4°C	28 days
Specific Conductance	P, G	Cool, 4°C	28 days
Sulfate	P, G	Cool, 4°C	28 days
Sulfide	P, G	Cool, 4°C, add $Zn(Ac)_2$ plus NaOH to pH>9	7 days
Surfactants	P, G	Cool, 4°C	48 hours

ANALYTE	CONTAINER	PRESERVATION	MAX. HOLDING
	Septum	for residual chlorine; Preserve as above and HCl to pH<2	
Acrolein and Acrylonitrile	G, Teflon-Lined Septum	Cool, 4°C, 0.008% $Na_2S_2O_3$ for residual chlorine; Preserve as above and pH to 4-5	3 days for Acrolein, 14 days for Acrylonitrile
Phenols	G, Teflon-Lined Cap	Cool, 4°C, 0.008% $Na_2S_2O_3$ for residual chlorine	7 days until extraction, 40 days after extraction
Benzidines	G, Teflon-Lined Cap	Cool, 4°C, 0.008% $Na_2S_2O_3$ for residual chlorine	7 days until extraction, 7 days after extraction if stored under inert gas
Phthalate Esters	G, Teflon-Lined Cap	Cool, 4°C	7 days until extraction, 40 days after extraction
Haloethers	G, Teflon-Lined Cap	Cool, 4°C, 0.008% $Na_2S_2O_3$ for residual chlorine only	7 days until extraction, 40 days after extraction
Chlorinated Hydrocarbons	G, Teflon-Lined Cap	Cool, 4°C	7 days until extraction, 40 days after extraction

All equipment used for testing, calibration and sampling are maintained to comply with the specification relevant to the processing and testing of environmental samples.

Electronic balances are located away from drafts and doorways where vibrations might occur. Good housekeeping is monitored to avoid the possibility of contamination. Mercury is analyzed by the Cold Vapor Atomic Absorption (CVAA) technique using a spectrophotometer. All other metals are analyzed using an ICP. Several Gas Chromatographs (GC) and GC Mass Specs (MS) are used to analyze for organic analytes. The laboratory maintains stills, heating baths, ovens and incubators for other environmental analyses that the laboratory is certified to perform. A TOC analyzer is used for the analysis of Total Organic Carbon. A variety of wet laboratory equipment and Class "A" glassware are used for various analyses. An Equipment List is maintained and updated. This lists all major equipment used in the laboratory area. A copy of the Equipment list is located in Appendix A if this Quality Systems Manual.

All equipment used during the analysis of environmental samples are maintained and in proper working order. Instrument maintenance logs are kept for the major equipment used in the laboratory. Preventative maintenance as well as major repair work is recorded on these logs. When major equipment is taken out of service due to repair a notation is made on the maintenance log. When equipment does not meet QC criteria, it is taken out of service. It is repaired or replaced as necessary.

Support equipment is calibrated on an annual basis. Support equipment includes analytical balances and thermometers. The laboratory maintains a NIST traceable thermometer on site. When equipment does not meet QC criteria, it is taken out of service. It is repaired or replaced as necessary.

Eppendorf pipettes (or equivalent) or mechanical volumetric dispensing devices are checked for accuracy on a quarterly basis. These records are maintained in a logbook in the QA office.

Section 12.0 Procedures for Calibration, Verification and Maintenance of Equipment

Laboratory equipment is maintained, inspected and cleaned according to Equipment Maintenance procedures. Each piece of major equipment in the laboratory has a discreet preventative maintenance logbook. This logbook is used to record preventative maintenance for the specific instrument. All data relating to maintenance, inspection and cleaning are maintained in a logbook. The logbook lists the item of equipment, manufacturer, serial number, details of maintenance and history of damage, repair or modification. If professional service is called a copy of the service report is included in the PM logbook.

Support equipment is calibrated using NIST-traceable standards. These are calibrated in

ELAP proficiency test program. The results are used to evaluate the ability of the laboratory to produce accurate data. Proficiency results, along with all raw data necessary to reconstruct the analyses, are retained at the laboratory. Laboratory results are submitted electronically to the Department of Health. The New Jersey Department of Environmental Protection (NJ DEP) also requires the analysis of a second source of Pt samples. These Pt samples are purchased by the laboratory analyzed and submitted to NJ for review. These sample analyses are performed twice a year. These Pt samples are used to maintain South Mall Laboratories NJ certification.

The laboratory purchases external reference samples. Reference samples are used by the laboratory to verify calibration curves and act as the Laboratory Control Sample (LCS) for most analytical methods. All reference samples are certified by the commercial vendor. The laboratory retains the manufacturer's Certificate of Analysis. The laboratory LIMS system maintains the Lot # of the LCS sample used for each analysis.

The laboratory plans to begin a single blind proficiency test program. The program will be initiated by the QA Officer to insure that QC samples are handled and reported properly. This single blind proficiency test program will also insure that QC samples are handled in the same manner as standard client samples.

laboratory method SOP's. In addition, general procedures are followed to determine when departures from quality control have occurred. Laboratory policy is not to report sample data when quality control exceeds criteria unless the QC outlier is due to sample matrix interference. When necessary, provisions are made for such deviations and are documented in the data report to the client where necessary. Raw data and logbooks are also notated when discrepancies occur.

Director and the Quality Assurance Officer. The departure will be fully documented on both the Chain of Custody (COC) documents as well the laboratory report pages. The client must be aware of any deviation from standard operating procedures prior to the deviation.

Section 16.0 Procedures for Dealing with Client Inquires and Complaints

A complaint file will be maintained by the laboratory to document complaints about the laboratory's activities received from clients. The file will contain the date of the inquiry, the actual inquiry as well as the client name. The log will record the South Mall Laboratory person receiving the complaint as well as a record of any follow-up action (correspondence).

The complaint is given to the Quality Assurance Officer, who will investigate the complaints and/or inquiry. An audit of the lab area or lab data will be performed. The written results of the investigation including actions taken by the laboratory are reviewed by the Technical Director. The results of the investigation are signed and dated by the Technical Director and Quality Assurance Officer and forwarded to the client.

Section 17.0 Internal Audit

The Quality Assurance Officer arranges for an internal quality system audit of each laboratory area on an annual basis. Each laboratory area is audited and a written report generated. The audit will be carried out by either the QA Officer or trained personnel who are independent where possible of the activity being audited. The Quality Assurance Officer will compare the requirements of the ELAP manual to laboratory operations. In addition the auditor will utilize the NELAC Quality Audit checklist to insure all main QA areas are reviewed. The laboratory operations will also be compared to the Laboratory Quality Manual and current SOPs.

The results of each laboratory area audit will be documented in writing. The laboratory audit report will be submitted within two (2) weeks of the audit. Deficiencies will be noted and documented. The laboratory audit report will be submitted to the Laboratory Director who will

When deficiencies from an internal audit may have affected client data results, the QA Officer must review the effected data and inform the client of this sample result bias.

Section 18.0 Data Review

All data including original observations, calculations, derived data, calibration records, quality control records and a written copy of the test report are maintained and stored for five years at. Storage is on-site on the second floor of the laboratory building. Data is not stored at an off-site facility. All data reports are reviewed by either the Technical Director or Laboratory Director before the final report is sent to the client. The data report is reviewed to ensure that sample ID's, collection and receipt dates, units and methods are correct. This final review is performed to detect transcript errors that may have been missed. Errors detected in the review process are referred to the analyst or typist for corrective action.

The laboratory implemented the use of the Promium/Element LIMS computer system in September, 2005. This LIMS system is used to track all standard information, batch

Section 19. Management Review

In accordance with a predetermined schedule the laboratories Technical Director shall review the laboratory quality system, its testing and calibration procedures to insure that the suitability of test results meets the standards of NELAC. This review of systems is to be performed on an annual basis. This review may lead to changes and/or improvements based on the result of this review. The review will consist of the following:

Review of Policies and Procedures
Review of Reports from the QC officer and staff
Review of recent internal audits
Review of corrective and preventative actions

supervision for a minimum of one month with an experienced analyst for each method they perform. They must have knowledge of laboratory operations including safety, test methods, quality control procedures and record management.

The Quality Assurance Officer maintains the following personnel records:

A) Training File:
   1) A Demonstration of Capability Statement from each employee that they have read, understood and are using the latest version of the Laboratory Manual and SOPs. This statement will be signed and dated. A copy of this document is enclosed in appendix B of this Quality Systems Manual (QSM)
   2) A statement from each employee that they have read, acknowledged and understood their personal, ethical and legal responsibilities, including the potential punishments and penalties for improper, unethical or illegal actions. This statement will be signed and dated.
   3) Documentation of any training courses, seminars and/or workshops.
   4) Documentation of each employee's continued proficiency to perform each test method by one of the following annually:

      a) Acceptable performance of a blind sample for each accredited method.
      b) Another Demonstration of Capability.
      c) A minimum of four consecutive Laboratory Control Samples with acceptable levels of precision and accuracy.

   5) College Diploma, if applicable
   6) College transcripts, if applicable

B) Demonstration of Capability (DOC) for each accredited method the employee performs.

   A DOC must be performed prior to using any test method and at any time there is a change in instrument type, personnel or method. The procedure will follow ELAP Certification Manual Section 233, and the DOC Certificate will be completed for each analyst for each accredited method.

Section 21. Education and Training in Ethical and Legal Responsibilities

Each South Mall Laboratory employee/analyst is educated in the laboratory's expectation of high commitment to ethics involving every step, from accepting the chain of custody form to providing the final analytical results and final disposition of the sample. They are instructed in the proper way to conduct operations as well as improper techniques to avoid.

Each employee is instructed in legal responsibilities that include everything from accepting the chain of custody form to submitting the final analytical results to insure that the data generated is defendable. They are made aware that any departure from legal or ethical actions may result in penalties. This can be anything from internal suspension or removal to the possibility of external internment.

reports include the following information, [illegible] type

the laboratory. The samples that are tested are given a discreet/unique sample identifier. The client name and address are listed on the test result page. The sample test result is reported in the correct units of the method, the method name/reference as well as the date of analysis. A complete copy of the data report is maintained by the laboratory.

Effective September, 2005 the laboratory implemented the use of Promium/Element Laboratory Information Management Software (LIMS). This system is used for all aspects of data handling beginning with the sample login, bench sheet prep, sample analyses, QC analyses and data reporting. This LIMS system is also used to archive all data and report information. Raw data from the majority of laboratory instruments can be electronically transferred into this LIMS system. All data reports are generated from this system. A software package (Crystal) is used to generate all reports. The reporting format may be edited to meet a client specific reporting format.

APPENDIX A

Laboratory Instrumentation/Equipment

Item	Model Number	Serial Number	Location	Software	Instruction Location	Maintenance Info	Date In Service	Condition as Received
Cole-Parmer DigiSense pH/mV/ORP meter	5938-00	L92001845	Receiving Lab	N/A	N/A	Calibrate daily	Prior to 1999	New
Orion pH/ISE meter	710A	2696	Wet Lab	N/A		Calibrate daily	Prior to 1999	New
Sper Scientific Advanced pH meter	840035	L304911	Wet Lab	DataLab	ICP Lab File Cabinet	Calibrate daily	2002	New
Omega pH Recorder	CT485B-110V	CT586PH210106600	2nd Floor Storage	N/A		Calibrate daily	2002	New
Oakton pH Testr 3	35624-30	N/A	ICP Lab	N/A	ICP Lab File Cabinet	Calibrate daily	2000	New
Beckman Conductivity Bridge	Out of Service						Out of Service	
Bradley-James Conductivity Meter	10528	B5144/10/1	Wet Lab	N/A	N/A	Calibrate daily	Out of Service	Used
Denver Instruments Analytical Balance	AA-160	B027626	Extraction Lab	N/A	N/A	See Maintenace Log	Prior to 1999	New
Ohaus Triple-Beam Balance	700	14	Extraction Lab	N/A	N/A	See Maintenace Log	Prior to 1999	Used
AND Pocket Balance	PV-100	9060126186	GC Lab	N/A	GC Lab	See Maintenace Log	2003	New
Spectro ICP-OES	Ciros CCD	112791-01	ICP Lab	Smart Analyzer 3.20	ICP Lab Shelf	See Maintenace Log	2001	New
Dohrmann TOC Analyzer with UV/Persulfate and High Temperature oxidation modules	DC-85 DC-80	Furnace - HE2004 UV Module - HH3561	ICP Lab	N/A	ICP Lab Shelf	See Maintenace Log	2000	Used
PE IR Spectrophotometer	1320	105606	ICP Lab	N/A	ICP Lab Shelf	See Maintenace Log	2000	Refurbished
Parr Oxygen Bomb Calorimeter		394812 50A 102500	Back Lab	N/A	ICP Lab File Cabinet	See Maintenace Log	2001	New
ICM pH Controller with strip chart recorder	Out of Service							
ICM Dissolved Oxygen Meter	Out of Service							
ICM Turbidity Meter	108467	11520	ICP Lab	N/A	ICP Lab File Cabinet	Calibrate daily	2000	New
CSC Sieve Shaker	012708	18480	Back Lab	N/A	ICP Lab File Cabinet	None	2001	New
Sieves (Assorted Sizes)	Various	N/A	GC Lab	N/A	N/A	None	2001	New
Midi-Vap Cyanide Distillation Apparatus	MCVK96284	MCV-103	2nd Floor Storage	N/A	ICP Lab File Cabinet	See Maintenace Log	Out of Service	New
Hach UV-Vis Spectrophotometer	DR4000U	9509U0000248	Wet Lab	HachLink	ICP Lab Shelf	See Maintenace Log	Prior to 1999	New
Leeman Labs Hydra AA Mercury Analyzer	010-0073-1	62459	Wet Lab	WinHg rev. 1.224	ICP Lab Shelf	See Maintenace Log	2001	New
Environmental Express HotBlock Digestion Block	SC100	526CEC0727	Wet Lab	N/A	ICP Lab File Cabinet	Check Temp Daily	2000	New
Organomation Nitrogen Evaporator	Out of Service							
Orion Dissolved Oxygen Probe	97-08-99	N/A	Wet Lab	N/A	ICP Lab Cabinet	See Maintenace Log	Prior to 1999	Refurbished
Orion Temperature probe	917005	N/A	Wet Lab	N/A	ICP Lab Cabinet	See Maintenace Log	Prior to 2000	Used
Orion Fluoride Probe	94-09	N/A	Wet Lab	N/A	ICP Lab Cabinet	See Maintenace Log	Prior to 2001	Used
Orion ORP Probe	97-78-00	N/A	Wet Lab	N/A	ICP Lab Cabinet	See Maintenace Log	Prior to 2002	Used
Orion Ammonia Probe	Out of Service	N/A	Wet Lab	N/A	ICP Lab Cabinet	See Maintenace Log	Prior to 2003	Used
Gra-Lab Universal Timer	171	129438	Wet Lab	N/A	N/A	None	Prior to 1999	Used
Zymark Benchmate	Out of Service							
SSI model 300 LC pump	300	T2906428	Back Lab	N/A	N/A	See Maintenace Log	Prior to 1999	Used
ISCO UA-6 UV-Vis Detector	UA-6	188367	Back Lab	N/A	N/A	See Maintenace Log	Prior to 1999	Used
Foxy 200 X-Y Collector	Out of Service							
Hamilton Bell Centrifuge	1505	4566	Wet Lab	N/A	N/A	None	Prior to 1999	Used
Lab-line L-C Oven	3512	0396-0159	Extraction Lab	N/A	N/A	Check Temp Daily	Prior to 1999	Used
Lab-line Ambi-Lo-Hi Chamber	3550	1085-003	Extraction Lab	N/A	N/A	Check Temp Daily	Prior to 1999	Used
Avanti Refrigerator	863-YW	10936	Wet Lab	N/A	N/A	Check Temp Daily	Prior to 1999	
Kenmore Refrigerator	564.8932520	50900994	GC Lab	N/A	N/A	Check Temp Daily	Prior to 1999	New
Kenmore Freezer	N/A	N/A	GC Lab	N/A	N/A		Prior to 1999	New
Dionex Ion Chromatograph	Out of Service							
Varian Flame AA	Out of Service							
Eberbach Dual Electroanalyzer	Out of Service							
American Scientific Lab Refrigerator	N/A	N/A	Receiving Lab	N/A	N/A	Check Temp Daily	Prior to 1999	Used
Buck Scientific Mercury Analyzer	Out of Service							
Envirochem Thermal Stripper	Out of Service							
Tekmar Automatic Desorber	Out of Service							
Neytech Lab Oven	Out of Service							
Neytech Muffle Furnace	85A	AGB10110	GC Lab	N/A	N/A	None	Prior to 1999	Used
Environmental Express TCLP Tumbler	N/A	N/A	Back Lab	N/A	N/A		Prior to 1999	Used
Environmental Express TCLP Filter - Metals	N/A	24-910484	Wet Lab	N/A	N/A		Prior to 1999	New
Environmental Express TCLP Filter - Volatiles	ZHE-1000	N/A	Wet Lab	N/A	N/A		Prior to 1999	New
Miele Stainless Steel Lab Washer	N/A	G7733	Wet Lab	N/A	N/A	None	Prior to 1999	Used
Heron Groundwater Measuring Tape	H.2OL	899	Receiving Lab	N/A	N/A	None	Prior to 1999	New
Sigma Automatic Water Sampler	800 SL	G089410483	Receiving Lab	N/A	ICP Lab File Cabinet	See Maintenace Log	Prior to 1999	New
Spec 20 Spectrophotometer	Out of Service							
Schuco Vacuum Pump	5711 130	0585150	Wet Lab	N/A	N/A	None	Prior to 1999	Used
Schuco Vacuum Pump	5711 130	04891024	Wet Lab	N/A	N/A	None	Prior to 2000	Used
Environmental Express StepSaver	Various	N/A	Extraction Lab	N/A	ICP Lab File Cabinet	See Maintenace Log	2002	New
Eppendorf Micropipet	20uL	01135	Wet Lab	N/A	N/A	See Pippette/Thermometer Log	Prior to 2004	New
Eppendorf Micropipet	1mL	054085	Wet Lab	N/A	N/A	See Pippette/Thermometer Log	Prior to 2004	New
Eppendorf Micropipet	100uL	N/A	Wet Lab	N/A	N/A	See Pippette/Thermometer Log	Prior to 2004	New
Eppendorf Micropipet	50uL	62164	Wet Lab	N/A	N/A	See Pippette/Thermometer Log	Prior to 2004	New
Eppendorf Micropipet	500uL	N/A	Wet Lab	N/A	N/A	See Pippette/Thermometer Log	Prior to 2004	New
Eppendorf Micropipet	200uL	1015113	Wet Lab	N/A	N/A	See Pippette/Thermometer Log	Prior to 2004	New
Brinkmann Macropipet	N/A	N/A	Wet Lab	N/A	N/A	See Pippette/Thermometer Log	Prior to 1999	Used
Millipore Water Treatment System	N/A	N/A	GC Lab	N/A	GC Lab	See Maintenace Log	Prior to 1999	Used
Ultrasonic Bath	FS14H	N/A	Extraction Lab	N/A	N/A	None	Prior to 1999	New
4 Position SS Steambath	Out of Service							

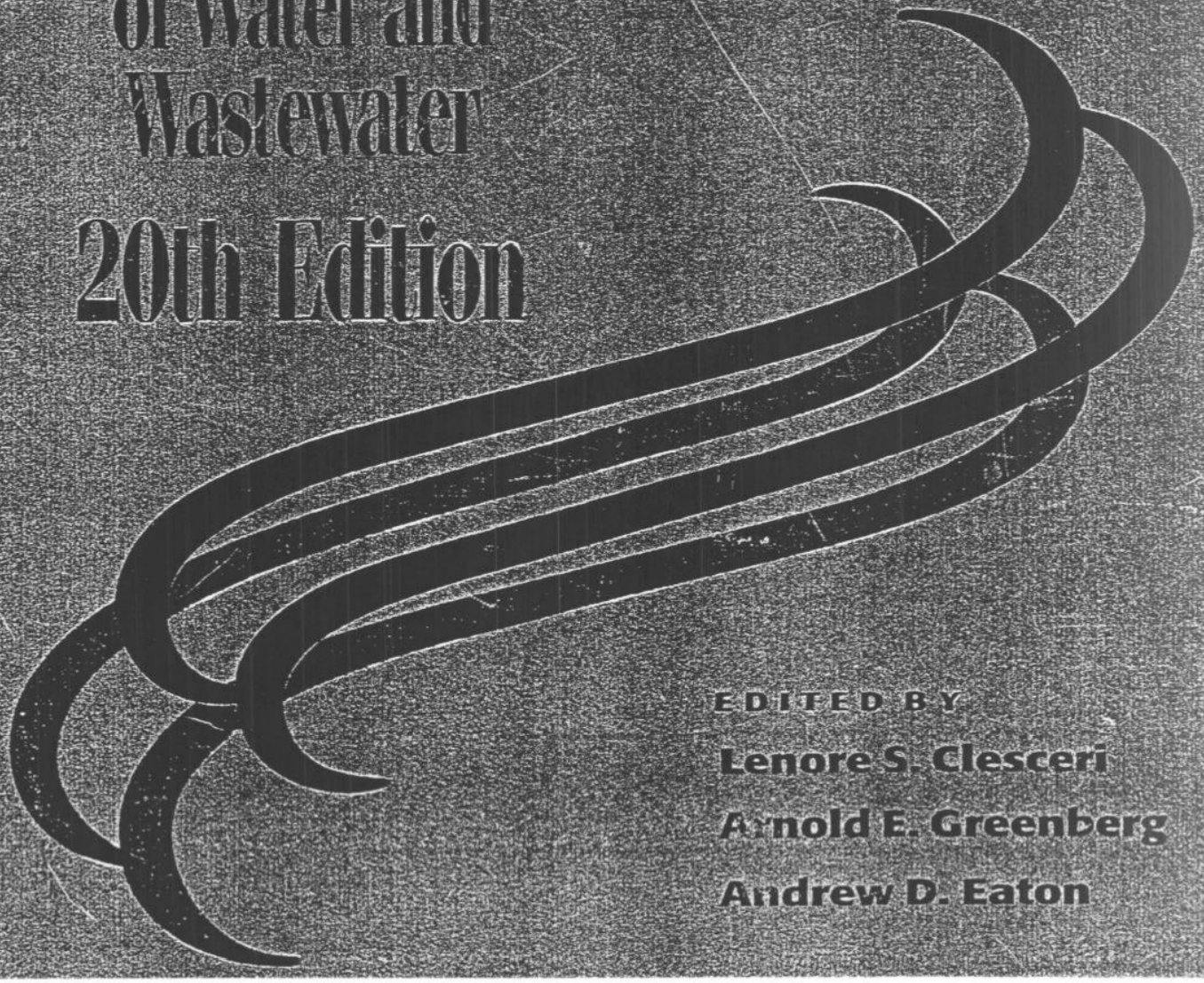
Item	Model Number	Serial Number	Location	Software	Instruction Location	Maintenance Info	Date In Service	Condition as Received
Pensky-Martens Flashpoint Tester	13-497-5	1619	Wet Lab	N/A	N/A		Prior to 1999	Used
Hach COD Reactor	Out of Service							
Christian Becker Class A Weight Set		701193	Extraction Lab	N/A	N/A	Check Calibration Annually	Prior to 1999	New
Tensiometer	Out of Service							
Chantillion Tensile Strength Tester	Out of Service							
NIST Traceable Thermometer		22747	ICP Lab	N/A	N/A	Check Calibration Annually	Prior to 1999	New
NIST Traceable Thermometer		1Y5102	ICP Lab	N/A	N/A	Check Calibration Annually	Prior to 2000	New
Fisher Traceable Thermometer	14-648-44	240043429	BOD Incubator	N/A	GC Lab	Check Calibration Annually	2004	New
Fisher Traceable Thermometer	14-648-44	240043435	Lab Frige #2	N/A	GC Lab	Check Calibration Annually	2004	New
Fisher Traceable Thermometer	14-648-44	240175888	Org. Std. Fridge	N/A	GC Lab	Check Calibration Annually	2004	New
Fisher Traceable Thermometer	14-648-44	240043436	Glass Front Fridge	N/A	GC Lab	Check Calibration Annually	2004	New
Fisher Traceable Thermometer	14-648-44	240175886	Rcv. Lab Fridge	N/A	GC Lab	Check Calibration Annually	2004	New
Fisher Traceable Thermometer	14-648-44	240043576	Receiving Lab	N/A	GC Lab	Check Calibration Annually	2004	New
Corning Stirrer	PC-410	3.504E+11	Wet Lab	N/A	N/A	None	2000	New
Corning Stirrer/Hotplate	PC-351	N/A	Extraction Lab	N/A	N/A	None	Prior to 1999	Used
Corning Stirrer/Hotplate	PC-351	N/A	Extraction Lab	N/A	N/A	None	Prior to 1999	Used
Buck Scientific Personal Air Sampler	A9100UL	28421	2nd Floor Storage	N/A	In Box	Calibrate prior to use	Prior to 1999	New
Equimeter Dry Air Meter	T-110	30614	2nd Floor Storage	N/A	N/A	None	Prior to 1999	New
Gast Air Sampling Pump	0523-V3-G582DX	971101429	2nd Floor Storage	N/A	N/A	Calibrate prior to use	Prior to 1999	New
Humboldt Soil Hydrometer Analysis Set	H-4265	335701	Wet Lab	N/A	N/A	None	Prior to 1999	New
Humboldt Liquid Limits Test Set	H-4228	2104228	Wet Lab	N/A	N/A	Calibrate prior to use	Prior to 1999	New
Oakton Conductivity Meter	510	137093	Receiving Lab	N/A	ICP Lab File Cabinet	See Maintenace Log	2003	New
SRI 8610 Gas Chromatograph with PID/FID/DELCD and P&T	Out of Service							
Lachat Micro Distillation System	1700-000	2000-278	Wet Lab	N/A	ICP Lab File Cabinet		2004	New
Zymark TurboVap II	103187/0	TV0313N11597	Extraction Lab	N/A	GC Lab	See Maintenace Log	2004	Used
Tecator Soxtec System HT	1043	1748	Extraction Lab	N/A	GC Lab	See Maintenace Log	2004	Used
Tecator Service Module	1046	1039	Extraction Lab	N/A	GC Lab	See Maintenace Log	2004	Used
Lachat Quickchem	8500	470000024	Wet Lab	Omnion rev. 3.0.219F	ICP Lab Shelf	See Maintenace Log	2004	New
HP Gas Chromatograph w/EPC (SVOA-2)	5890 Series II	2921A23412	GC Lab	Chemstation G1701AA v. A.03.00	GC Lab	See Maintenace Log	2003	Refurbished
HP Mass Selective Detector (SVOA-2)	5972	N/A	GC Lab	Chemstation G1701AA v. A.03.01	GC Lab	See Maintenace Log	2003	Refurbished
HP Gas Chromatograph (SVOA-1)	5890 Series II	2938A2471	GC Lab	Chemstation G1701AA v. A.03.02	GC Lab	See Maintenace Log	Prior to 1999	Refurbished
HP Mass Selective Detector (SVOA-1)	5971A	8W17-365RR	GC Lab	Chemstation G1701AA v. A.03.03	GC Lab	See Maintenace Log	Prior to 1999	Refurbished
HP Gas Chromatograph (GC-ECD)	5890A	2843A20952	GC Lab	Chemstation G1701AA v. A.03.04	GC Lab	See Maintenace Log	Prior to 1999	Refurbished
HP Gas Chromatograph (GC-FID)	5890A	2750A16710	GC Lab	Chemstation G1701AA v. A.03.05	GC Lab	See Maintenace Log	2000	Used
HP Gas Chromatograph w/EPC (VOA-1)	5890 Series II	3336A61094	GC Lab	Chemstation G1701AA v. A.03.06	GC Lab	See Maintenace Log	Prior to 1999	Refurbished
HP Mass Selective Detector (VOA-1)	5972	2W42D-25	GC Lab	Chemstation G1701AA v. A.03.07	GC Lab	See Maintenace Log	Prior to 1999	Refurbished
Tekmar 3000 Purge and Trap Concentrator	14-3000-00T	95112007	GC Lab	Teklink 3000 v. 1.09	GC Lab	See Maintenace Log	Prior to 1999	Refurbished
Tekmar ALS2016 Autosamplers	14-2962-200	92102003	GC Lab	Teklink 3000 v. 1.09	GC Lab	See Maintenace Log	Prior to 1999	Refurbished
HP Gas Chromatograph (VOA-2)	5890 Series II	3140A39485	GC Lab	Chemstation G1701AA v. A.03.08	GC Lab	See Maintenace Log	2001	Used
HP Mass Selective Detector (VOA-2)	5971A	4W12-138R	GC Lab	Chemstation G1701AA v. A.03.09	GC Lab	See Maintenace Log	2001	Used
HP Purge and Trap Concentrator	G1901-60500	3529 A 10387	GC Lab	Teklink 3000 v. 1.09	GC Lab	See Maintenace Log	Prior to 1999	Refurbished
Tekmar ALS2016 Autosamplers	14-2962-200	91345003	GC Lab	Teklink 3000 v. 1.09	GC Lab	See Maintenace Log	2001	Used
Tekmar Heater Socks for ALS2016			GC Lab	Teklink 3000 v. 1.09	GC Lab	See Maintenace Log	2001	Used
Tekmar 2000 Purge and Trap Concentrator	Out of Service		GC Lab	N/A	GC Lab	See Maintenace Log	2001	Used
Frigidaire Refrigerator	FRT18B1BW2	BA40309228	Receiving Lab	N/A	N/A	Check Temp Daily	2004	New

Standard Methods

FOR THE

Examination of Water and Wastewater

20th Edition



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continues to be expanded.

The bacteriological methods in Part 9000, developed primarily to permit prompt and rapid examination of water samples, have gations to establish their specificity, improve their procedural details, and expand their application to the measurement of the sanitary quality of water supplies or polluted waters.

9020 QUALITY ASSURANCE/QUALITY CONTROL*

9020 A. Introduction

1. General Considerations

The growing emphasis on microorganisms in water quality standards and enforcement activities and their continuing role in research, process control, and compliance monitoring require the establishment and effective operation of a quality assurance (QA) program to substantiate the validity of analytical data.

A laboratory quality assurance program is the integration of intralaboratory and interlaboratory quality control (QC), standardization, and management practices into a formal, documented program with clearly defined responsibilities and duties to ensure that the data are of the type, quality, and quantity required.

The program must be practical and require only a reasonable resources, assume a leadership role, and involve staff in development and operation of the QA program. Management should meet with the laboratory supervisor and staff to develop and maintain a comprehensive program and establish specific responsibility for management, supervisors, and analysts.

b. Quality assurance officer: In large laboratories, a QA officer has the authority and responsibility for application of the QA program. Ideally, this person should have a staff position reporting directly to upper management, not a line position. The QA officer should have a technical education, be acquainted with all aspects of laboratory work, and be familiar with statistical techniques for data evaluation. The QA officer is responsible for initiating the program, convincing staff of its value, and providing

trol tools used by chemists, such as reference standards, instrument calibration, and quality control charts, may not be available to the microbiologist.

Because QA programs vary among laboratories as a result of differences in organizational mission, responsibilities, and objectives; laboratory size, capabilities, and facilities; and staff skills and training, this provides only general guidance. Each laboratory should determine the appropriate QA level for its purpose.

2. Guidelines for a Quality Assurance Program

Develop a QA program to meet the laboratory's specific needs and the planned use of the data. Emphasis on the use of data is particularly important where significant and costly decisions depend on analytical results. An effective QA program will confirm the quality of results and increase confidence in the data.

a. Management responsibilities: Management must recognize the need for quality assurance, commit monetary and personnel procedures, and most importantly, implementing the QC program in their daily tasks of collecting samples, conducting analyses, performing quality control checks, and calculating and reporting results. Because the staffs are the first to see potential problems, they should identify them and work with the supervisor to correct and avoid them. It is critical to the success of the QA program that staff understand and actively support it.

3. Quality Assurance Program Objectives

The objectives of a QA program include providing data of known quality, ensuring a high quality of laboratory performance, maintaining continuing assessment of laboratory operations, identifying weaknesses in laboratory operations, detecting training needs, and improving documentation and recordkeeping.

4. Elements of a Quality Assurance Program

Each laboratory should develop and implement a written QA plan describing the QA program and QC activities of the labo-

* Approved by Standard Methods Committee, 1997.

ratory. The plan should address the following basic common aspects:

a. Statement of objectives, describing the specific goals of the laboratory.

b. Sampling procedures, including selection of representative sites and specified holding time and temperature conditions. If data may be subjected to litigation, use chain-of-custody procedures.

c. Personnel policies, describing specific qualification and training requirements for supervisors and analysts.

d. Equipment and instrument requirements, providing calibration procedures and frequency and maintenance requirements.

e. Specifications for supplies, to ensure that reagents and supplies are of high quality and are tested for acceptability.

f. Analytical methods, i.e., standardized methods established by a standards-setting organization and validated. Ideally, these laboratory methods have documented precision, bias, sensitivity, selectivity, and specificity.

g. Analytical quality control measures, including such analytical checks as duplicate analyses, positive and negative controls, sterility checks, and verification tests.

h. Standard operating procedures (SOPs), i.e., written statement and documentation of all routine laboratory operations.

i. Documentation requirements, concerning data acquisition, recordkeeping, traceability, and accountability.

j. Assessment requirements:

1) Internal audits of the laboratory operations, performed by the QA officer and supervisor.

2) On-site evaluations by outside experts to ensure that the laboratory and its personnel are following an acceptable QA program.

3) Performance evaluation studies, in which the QA officer works with the supervisor to incorporate unknown challenge samples into routine analytical runs and laboratories are encouraged to participate in state and national proficiency testing and accreditation programs. The collaborative studies confirm the abilities of a laboratory to generate acceptable data comparable to those of other laboratories and identify potential problems.

k. Corrective actions: When problems are identified by the staff, supervisor, and/or QA coordinator, use standard stepwise procedures to determine the causes and correct them. Nonconformances identified by external laboratory evaluation are corrected, recorded, and signed off by the laboratory manager and QA officer.

Detailed descriptions of quality assurance programs are available.[1–4]

The QC guidelines discussed in 9020B and 9020C are recommended as useful source material, but all elements need to be addressed in developing a QA program.

5. References

1. GASKIN, J.E. 1992. Quality Assurance in Water Quality Monitoring. Inland Water Directorate, Conservation & Protection, Ottawa, Ont., Canada.
2. RATLIFF, T.A., JR. 1990. The Laboratory Quality Assurance System. A Manual of Quality Procedures with Related Forms. Van Nostrand Reinhold, New York, N.Y.
3. GARFIELD, F.M. 1984. Quality Assurance Principles of Analytical Laboratories. Assoc. Official Analytical Chemists, Arlington, Va.
4. DUX, J.P. 1983. Quality assurance in the analytical laboratory. *Amer. Lab.* 26:54.

9020 B. Intralaboratory Quality Control Guidelines

All laboratories have some intralaboratory QC practices that have evolved from common sense and the principles of controlled experimentation. A QC program applies practices necessary to minimize systematic and random errors resulting from personnel, instrumentation, equipment, reagents, supplies, sampling and analytical methods, data handling, and data reporting. It is especially important that laboratories performing only a limited amount of microbiological testing exercise strict QC. A listing of key QC practices is given in Table 9020:I. Other sources of QC practices are available.[1–3] These practices and guidelines will assist laboratories in establishing and improving QC programs. Laboratories should address all of the QC guidelines discussed herein, but the depth and details may differ for each laboratory.

1. Personnel

Microbiological testing should be performed by a professional microbiologist or technician trained in environmental microbiology whenever possible. If not, a professional microbiologist should be available for guidance. Train and evaluate the analyst in basic laboratory procedures. The supervisor periodically should review procedures of sample collecting and handling, media and glassware preparation, sterilization, routine analytical testing, counting, data handling, and QC techniques to identify and eliminate problems. Management should assist laboratory personnel in obtaining additional training and course work to advance their skills and career.

2. Facilities

a. Ventilation: Plan well-ventilated laboratories that can be maintained free of dust, drafts, and extreme temperature changes. Whenever possible, laboratories should have air conditioning to reduce contamination, permit more stable operation of incubators, and decrease moisture problems with media and instrumentation.

b. Space utilization: Design and operate the laboratory to minimize through traffic and visitors, with a separate area for preparing and sterilizing media, glassware, and equipment. Use a vented laminar-flow hood for dispensing and preparing sterile media, transferring microbial cultures, or working with pathogenic materials. In smaller laboratories it may be necessary, although undesirable, to carry out these activities in the same room.

c. Laboratory bench areas: Provide at least 2 m of linear bench space per analyst and additional areas for preparation and support activities. For stand-up work, typical bench dimensions are 90 to 97 cm high and 70 to 76 cm deep. For sit-down activities such

Table 9020:I. Key Quality Control Practices

Item	Action	Frequency	Further Information in Section 9020B, ¶
Reagent water	Monitor quality	See Table 9020:II	
Bench surface	Monitor for contamination	Weekly	2*e*
Air in workplace	Monitor bacterial density	Monthly	2*e*
Thermometers	Check accuracy	Semiannually	3*a*
Balances and weights	Check accuracy	Monthly	3*b*
Balances	Service and recalibrate	Annually	3*b*
pH meter	Standardize	Each use	3*c*
	Check against another meter	Monthly	3*c*
Media-dispensing apparatus	Check volume accuracy	Each use	3*f*
Hot-air oven	Check performance	Monthly	3*g*
Autoclave	Check performance	Each use	3*h*
Refrigerator	Check temperature	Daily	3*i*
Freezer	Check temperature	Daily	3*j*
	Defrost	Semiannually	3*j*
Membrane filtration equipment	Check for leaks and surface scratches	Each use	3*k*
UV lamps	Test with UV meter	Quarterly	3*l*
Biohazard hood	Monitor air and UV lamps	Monthly	3*m*
	Inspect for airflow	Quarterly	3*m*
Incubator	Check temperature	Twice daily	3*n* and *o*
Microscope	Clean optics and stage	Each use	3*p*
Glassware	Inspect for cleanliness, chips, and etching	Each use	4*a*
	Check pH	Each batch	4*a*1)
	Conduct inhibitory residue test	Annually	4*a*2)
Dilution water bottles	Check pH and volume	Each use	4*c*
Media	Check pH and appearance	Each use	4*f*1)
Autoclave	Check performance	Weekly	4*f*2)
Plate counts	Perform duplicate analyses	Weekly	8*a*4)
	Repeat counts	Monthly	8*a*2)

as microscopy and plate counting, benches are 75 to 80 cm high. Specify bench tops of stainless steel, epoxy plastic, or other smooth, impervious surface that is inert and corrosion-resistant, has a minimum number of seams, and has adequate sealing of any crevices. Install even, glare-free lighting with about 1000 lux (100 ft-candles) intensity at the working surface.

d. Walls and floors: Assure that walls are covered with a smooth finish that is easily cleaned and disinfected. Specify floors of smooth concrete, vinyl, asphalt tile, or other impervious, sealed washable surfaces.

e. Work-area monitoring: Maintain high standards of cleanliness in work areas. Monitor air, at least monthly, with air density plates. The number of colonies on the air density plate test should not exceed 160/m²/15 min exposure (15 colonies/plate/15 min).

Plate or the swab method[1] can be used weekly or more frequently to monitor bench surface contamination. Although uniform limits for bacterial density have not been set, each laboratory can use these tests to establish a base line and take action on a significant increase.

f. Laboratory cleanliness: Regularly clean laboratory rooms and wash benches, shelves, floors, and windows. Wet-mop floors and treat with a disinfectant solution; do not sweep or dry-mop. Wipe bench tops and treat with a disinfectant before and after use. Do not permit laboratory to become cluttered.

3. Laboratory Equipment and Instrumentation

Verify that each item of equipment meets the user's needs for precision and minimization of bias. Perform equipment maintenance on a regular basis as recommended by the manufacturer or obtain preventive maintenance contracts on autoclave, balances, microscopes, and other equipment. Directly record all quality control checks in a permanent log book.

Use the following quality control procedures:

a. Thermometer/temperature-recording instruments: Check accuracy of thermometers or temperature-recording instruments semiannually against a certified National Institute of Standards and Technology (NIST) thermometer or one traceable to NIST and conforming to NIST specifications. For general purposes use thermometers graduated in increments of 0.5°C or less. Maintain in water or glycerol for air incubators and refrigerators and glycerol for freezers and seal in a flask. For a 44.5°C water bath, use a submersible thermometer graduated to 0.2°C or less. Record temperature check data in a quality control log. Mark the necessary NIST calibration corrections on each thermometer and incubator, refrigerator, or freezer. When possible, equip incubators and water baths with temperature-recording instruments that provide a continuous record of operating temperature.

b. Balances: Follow manufacturer's instructions in operation and routine maintenance of analytical and top-loading balances. Balances should be serviced and recalibrated by a manufacturer technician annually or more often as conditions change or problems occur. In weighing 2 g or less, use an analytical balance with a sensitivity less than 1 mg at a 10-g load. For larger quantities use a pan balance with sensitivity of 0.1 g at a 150-g load.

Wipe balance before use with a soft brush. Clean balance pan after use and wipe spills up immediately with a laboratory tissue. Inspect weights with each use and replace if corroded. Use only a plastic-tip forceps to handle weights. Check balance and working weights monthly against a set of reference weights (ANS

ASTM Class 1 or NIST Class S) for accuracy, precision, and linearity.[4] Record results.

c. pH meter: Use a meter graduated in 0.1 pH units or less, that includes temperature compensation. Preferably use digital meters and commercial buffer solutions. With each use, standardize meter with two buffers that bracket the pH of interest and record. Date buffer solutions when opened and check monthly against another pH meter. Discard solution after each use and replace buffer supply before expiration date. For full details of pH meter use and maintenance, see Section 4500-H+.

d. Water purification system: Commercial systems are available that include some combination of prefiltration, activated carbon, mixed-bed resins, and reverse-osmosis with final filtration to produce a reagent-grade water. The life of such systems can be extended greatly if the source water is pretreated by distillation or by reverse osmosis to remove dissolved solids. Such systems tend to produce the same quality water until resins or activated carbon are near exhaustion and quality abruptly becomes unacceptable. Some deionization components are available now that automatically regenerate the ion exchange resins. Do not store reagent water unless a commercial UV irradiation device is installed and is confirmed to maintain sterility.

Monitor reagent water continuously or daily with a calibrated conductivity meter and analyze at least annually for trace metals. Replace cartridges at intervals recommended by the manufacturer based on the estimated usage and source water quality. Do not wait for column failure. If bacteria-free water is desired, include aseptic final filtration with a 0.22-µm-pore membrane filter and collect in a sterile container. Monitor treated water for contamination and replace the filter as necessary.

e. Water still: Stills produce water of a good grade that characteristically deteriorates slowly over time as corrosion, leaching, and fouling occur. These conditions can be controlled with proper maintenance and cleaning. Stills efficiently remove dissolved substances but not dissolved gases or volatile organic chemicals. Freshly distilled water may contain chlorine and ammonia (NH_3). On storage, additional NH_3 and CO_2 are absorbed from the air. Use softened water as the source water to reduce frequency of cleaning the still. Drain and clean still and reservoir according to manufacturer's instructions and usage.

f. Media dispensing apparatus: Check accuracy of volumes dispensed with a graduated cylinder at start of each volume change and periodically throughout extended runs. If the unit is used more than once per day, pump a large volume of hot reagent water through the unit to rinse between runs. Correct leaks, loose connections, or malfunctions immediately. At the end of the work day, break apparatus down into parts, wash, rinse with reagent water, and dry. Lubricate parts according to manufacturer's instructions or at least once per month.

g. Hot-air oven: Test performance monthly with commercially available *Bacillus subtilis* spore strips or spore suspensions. Monitor temperature with a thermometer accurate in the 160 to 180°C range and record results. Use heat-indicating tape to identify supplies and materials that have been exposed to sterilization temperatures.

h. Autoclave: Record items sterilized, temperature, pressure, and time for each run. Optimally use a recording thermometer. Check and record operating temperature weekly with a minimum/maximum thermometer. Test performance with *Bacillus stearothermophilus* spore strips, suspensions, or capsules monthly. Use heat-indicating tape to identify supplies and materials that have been sterilized.

i. Refrigerator: Maintain temperature at 1 to 4°C. Check and record temperature daily and clean monthly. Identify and date materials stored. Defrost as required and discard outdated materials quarterly.

j. Freezer: Maintain temperature at −20°C to −30°C. Check and record temperature daily. A recording thermometer and alarm system are highly desirable. Identify and date materials stored. Defrost and clean semiannually; discard outdated materials.

k. Membrane filtration equipment: Before use, assemble filtration units and check for leaks. Discard units if inside surfaces are scratched. Wash and rinse filtration assemblies thoroughly after use, wrap in nontoxic paper or foil, and sterilize.

l. Ultraviolet lamps: Disconnect lamps monthly and clean bulbs with a soft cloth moistened with ethanol. Test lamps quarterly with an appropriate (short- or long-wave) UV light meter* and replace bulbs if output is less than 70% of the original. For short-wave lamps used in disinfecting work areas, expose plate count agar spread plates containing 200 to 300 organisms of interest, for 2 min. Incubate plates at 35°C for 48 h and count colonies. Replace bulb if count is not reduced 99%.

CAUTION: *Although short-wave (254-nm) UV light is known to be more dangerous than long-wave UV (365-nm), both types of UV light can damage eyes and skin and potentially are carcinogenic.[5] Protect eyes and skin from exposure to UV light. (See Section 1090B.)*

m. Biohazard hood: Once per month expose plate count agar plates to air flow for 1 h. Incubate plates at 35°C for 48 h and examine for contamination. A properly operating biohazard hood should produce no growth on the plates. Disconnect UV lamps and clean monthly by wiping with a soft cloth moistened with ethanol. Check lamps' efficiency as specified above. Inspect cabinet for leaks and rate of air flow quarterly. Use a pressure monitoring device to measure efficiency of hood performance. Have laminar-flow safety cabinets containing HEPA filters serviced by the manufacturer. Maintain hoods as directed by the manufacturer.

n. Water bath incubator: Verify that incubators maintain test temperature, such as 35 ± 0.5°C or 44.5 ± 0.2°C. Keep an appropriate thermometer (¶ 3*a*, above) immersed in the water bath; monitor and record temperature twice daily (morning and afternoon). For optimum operation, equip water bath with a gable cover. Use only stainless steel, plastic-coated, or other corrosion-proof racks. Clean bath as needed.

o. Incubator (air, water jacketed, or aluminum block): Verify that incubators maintain appropriate test temperatures. Also, verify that cold samples are incubated at the test temperature for the required time. Check and record temperature twice daily (morning and afternoon) on the shelves in use. If a glass thermometer is used, submerge bulb and stem in water or glycerine to the stem mark. For best results use a recording thermometer and alarm system. Place incubator in an area where room temperature is maintained between 16 and 27°C (60 to 80°F).

p. Microscopes: Use lens paper to clean optics and stage after each use. Cover microscope when not in use.

Permit only trained technicians to use fluorescence microscope and light source. Monitor fluorescence lamp with a light meter

* Fisher Scientific, short wave meter (Cat. No. 11-924-54) and long wave meter (Cat. No. 11-984-53), Pittsburgh, PA 15219-4785, or equivalent.

and replace when a significant loss in fluorescence is observed. Log lamp operation time, efficiency, and alignment. Periodically check lamp alignment, particularly when the bulb has been

Prepare a culture of *E. aerogenes* known to contain 50 to 150 colony-forming units/mL. Preliminary testing may be necessary to achieve this count range. Inoculate three dishes from each test

rewash if necessary. Make the following tests for clean glassware as necessary:

1) pH check—Because some cleaning solutions are difficult to remove completely, spot check batches of clean glassware for pH reaction, especially if soaked in alkali or acid. To test clean glassware for an alkaline or acid residue add a few drops of 0.04% bromthymol blue (BTB) or other pH indicator and observe the color reaction. BTB should be blue-green (in the neutral range).

To prepare 0.04% bromthymol blue indicator solution, add 16 mL 0.01*N* NaOH to 0.1 g BTB and dilute to 250 mL with reagent water.

2) Test for inhibitory residues on glassware and plasticware—Certain wetting agents or detergents used in washing glassware may contain bacteriostatic or inhibiting substances that require 6 to 12 rinsings to remove all traces and insure freedom from residual bacteriostatic action. Perform this test annually and before using a new supply of detergent. If prewashed, presterilized plasticware is used, test it for inhibitory residues. Although the following procedure describes testing of petri dishes for inhibitory residue, it is applicable to other glass or plasticware.

a) Procedure—Wash and rinse six petri dishes according to usual laboratory practice and designate as Group A.

Wash six petri dishes as above, rinse 12 times with successive portions of reagent water, and designate as Group B.

Rinse six petri dishes with detergent wash water (in use concentration), and air-dry without further rinsing, and designate as Group C.

Sterilize dishes in Groups A, B, and C by the usual procedure.

For presterilized plasticware, set up six plastic petri dishes and designate them as Group D.

Prepare and sterilize 200 mL plate count agar and hold in a 44 to 46°C water bath.

Groups A and B and greater than 15% between Groups A and C indicate that the cleaning detergent has inhibitory properties that are eliminated during routine washing. Differences between B and D greater than 15% indicate an inhibitory residue.

b. Utensils and containers for media preparation: Use utensils and containers of borosilicate glass, stainless steel, aluminum, or other corrosion-resistant material (see Section 9030). Do not use copper utensils.

c. Dilution water bottles: Use scribed bottles made of nonreactive borosilicate glass or plastic with screwcaps containing inert liners. Clean before use. Disposable plastic bottles prefilled with dilution water are available commercially and are acceptable. Before use of each lot, check pH and volume and examine sterile bottles of dilution water for a precipitate; discard if present. Reclean bottles with acid if necessary, and remake the dilution water. If precipitate repeats, procure a different source of bottles.

d. Reagent-grade water quality: The quality of water obtainable from a water purification system differs with the system used and its maintenance. See 3*d* and *e* above. Recommended limits for reagent water quality are given in Table 9020:II. If these limits are not met, investigate and correct or change water source. Although pH measurement of reagent water is characterized by drift, extreme readings are indicative of chemical contamination.

e. Use test for evaluation of reagent water, media, and membranes: When a new lot of culture medium, membrane filters, or a new source of reagent-grade water is to be used make comparison tests, at least quarterly, of the current lot in use (reference lot) against the new lot (test lot).

1) Procedure—Use a single batch of control water (redistilled or distilled water polished by deionization), glassware, membrane filters, or other needed materials to control all variables except the one factor under study. Make parallel pour or spread plate or

TABLE 9020:II. QUALITY OF REAGENT WATER USED IN MICROBIOLOGY TESTING

Test	Monitoring Frequency	Maximum Acceptable Limit
Chemical tests:		
Conductivity	Continuously or with each use	>0.5 megohms resistance or <2 μmhos/cm at 25°C
pH	With each use	5.5–7.5
Total organic carbon	Monthly	<1.0 mg/L
Heavy metals, single (Cd, Cr, Cu, Ni, Pb, and Zn)	Annually*	<0.05 mg/L
Heavy metals, total	Annually*	<0.10 mg/L
Ammonia/organic nitrogen	Monthly	<0.10 mg/L
Total chlorine residual	Monthly or with each use	<0.01 mg/L
Bacteriological tests:		
Heterotrophic plate count (See Section 9215)	Monthly	< 1000 CFU/mL

membrane filter plate tests on reference lot and test lot, according to procedures in Sections 9215 and 9222. As a minimum, make single analyses on five different water samples positive for the target organism. Replicate analyses and additional samples can be tested to increase the sensitivity of detecting differences between reference and test lots.

When conducting the use test on reagent water, perform the quantitative bacterial tests in parallel using a known high-quality water as a control water. Prepare dilution/rinse water and media with new source of reagent and control water. Test water for all uses (dilution, rinse, media preparation, etc.).

2) Counting and calculations—After incubation, compare bacterial colonies from the two lots for size and appearance. If colonies on the test lot plates are atypical or noticeably smaller than colonies on the reference lot plates, record the evidence of inhibition or other problem, regardless of count differences. Count plates and calculate the individual count per 1 mL or per 100 mL. Transform the count to logarithms and enter the log-transformed results for the two lots in parallel columns. Calculate the difference, d, between the two transformed results for each sample, including the + or − sign, the mean, $\bar{d}$ and the standard deviation s_d of these differences (see Section 1010B).

Calculate Student's t statistic, using the number of samples as

h. Membrane filters and pads: The quality and performance of membrane filters vary with the manufacturer, type, brand, and lot. These variations result from differences in manufacturing methods, materials, quality control, storage conditions, and application.

1) Membrane filters and pads for water analyses should meet the following specifications:

a) Filter diam 47 mm, mean pore diam 0.45 µm. Alternate filter and pore sizes may be used if the manufacturer provides data verifying performance equal to or better than that of 47- mm-diam, 0.45-µm-pore size filter. At least 70% of filter area must be pores.

b) When filters are floated on reagent water, the water diffuses uniformly through the filters in 15 s with no dry spots on the filters.

c) Flow rates are at least 55 mL/min/cm^2 at 25°C and a differential pressure of 93 kPa.

d) Filters are nontoxic, free of bacterial-growth-inhibiting or stimulating substances, and free of materials that directly or indirectly interfere with bacterial indicator systems in the medium; ink grid is nontoxic. The arithmetic mean of five counts on filters must be at least 90% of the arithmetic mean of the counts on five agar spread plates using the same sample volumes and agar me-

icals of ACS or equivalent grade because impurities can inhibit bacterial growth, provide nutrients, or fail to produce the desired reaction. Date chemicals and reagents when received and when first opened for use. Make reagents to volume in volumetric flasks and transfer for storage to good-quality inert plastic or borosilicate glass bottles with borosilicate, polyethylene, or other plastic stoppers or caps. Label prepared reagents with name and concentration, date prepared, and initials of preparer. Include positive and negative control cultures with each series of cultural or biochemical tests.

g. Dyes and stains: In microbiological analyses, organic chemicals are used as selective agents (e.g., brilliant green), as indicators (e.g., phenol red), and as microbiological stains (e.g., Gram stain). Dyes from commercial suppliers vary from lot to lot in percent dye, dye complex, insolubles, and inert materials. Because dyes for microbiology must be of proper strength and stability to produce correct reactions, use only dyes certified by the Biological Stain Commission. Check bacteriological stains before use with at least one positive and one negative control culture and

4*e*) on new lots of filters.

2) Standardized tests:

Standardized tests are available for evaluating retention, recovery, extractables, and flow rate characteristics of membrane filters.[7]

Some manufacturers provide information beyond that required by specifications and certify that their membranes are satisfactory for water analysis. They report retention, pore size, flow rate, sterility, pH, percent recovery, and limits for specific inorganic and organic chemical extractables. Although the standard membrane filter evaluation tests were developed for the manufacturers, a laboratory can conduct its own tests.

To maintain quality control inspect each lot of membranes before use and during testing to insure they are round and pliable, with undistorted gridlines after autoclaving. After incubation, colonies should be well-developed with well-defined color and shape as defined by the test procedure. The gridline ink should not channel growth along the ink line nor restrict colony development. Colonies should be distributed evenly across the membrane sur-

i. Culture media: Because cultural methods depend on properly prepared media, use the best available materials and techniques in media preparation, storage, and application. For control of quality, use commercially prepared media whenever available but note that such media may vary in quality among manufacturers and even from lot to lot from the same manufacturer.

Order media in quantities to last no longer than 1 year. Use media on a first-in, first-out basis. When practical, order media in quarter pound (114 g) multiples rather than one pound (454 g) bottles, to keep the supply sealed as long as possible. Record kind, amount, and appearance of media received, lot number, expiration date, and dates received and opened. Check inventory quarterly for reordering.

Store dehydrated media at an even temperature in a cool dry place, away from direct sunlight. Discard media that cake, discolor, or show other signs of deterioration. If expiration date is given by manufacturer, discard unused media after that date. A conservative time limit for unopened bottles is 2 years at room temperature. Compare recovery of newly purchased lots of media against proven lots, using recent pure-culture isolates and natural samples.

Use opened bottles of media within 6 months. Dehydrated me-

TABLE 9020:III. TIME AND TEMPERATURE FOR AUTOCLAVE STERILIZATION

Material	Time at 121°C*
Membrane filters and pads	10 min
Carbohydrate-containing media (lauryl tryptose, BGB broth, etc.)	12–15 min
Contaminated materials and discarded cultures	30 min
Membrane filter assemblies (wrapped), sample collection bottles (empty)	15 min
Buffered dilution water, 99 mL in screw-cap bottle	15 min
Rinse water, volume > 100 mL	Adjust for volume

* Except for media, times are guidelines; check for sterility.

sure time varies with form and type of material, type of medium, presence of carbohydrates, and volume. Table 9020:III gives guidelines for typical items. Do not expose media containing carbohydrates to the elevated temperatures for more than 45 min. Exposure time is defined as the period from initial exposure to removal from the autoclave.

Some currently available autoclave models are automatic and

formulation. If the pH difference is larger than 0.5 units, discard the batch and check preparation instructions and pH of reagent water to resolve the problem. Incorrect pH values may be due to reagent water quality, medium deterioration, or improper preparation. Review instructions for preparation and check water pH. If water pH is unsatisfactory, prepare a new batch of medium using water from a new source (see 9020B.3*d* and *e*). If water is satisfactory, remake medium and check; if pH is again incorrect, prepare medium from another bottle.

Record pH problems in the media record book and inform the manufacturer if the medium is indicated as the source of error. Examine prepared media for unusual color, darkening, or precipitation and record observations. Consider variations of sterilization time and temperature as possible causes for problems. If any of the above occur, discard the medium.

2) Sterilization—Sterilize media at 121 to 124°C for the minimum time specified. A double-walled autoclave permits maintenance of full pressure and temperature in the jacket between loads and reduces chance for heat damage. Follow manufacturer's

incubator is available commercially.†

Sterilize heat-sensitive solutions or media by filtration through a 0.22-μm-pore-diam filter in a sterile filtration and receiving apparatus. Filter and dispense medium in a safety cabinet or biohazard hood if available. Sterilize glassware (pipets, petri dishes, sample bottles) in an autoclave or an oven at 170°C for 2 h. Sterilize equipment, supplies, and other solid or dry materials that are heat-sensitive, by exposing to ethylene oxide in a gas sterilizer. Use commercially available spore strips or suspensions to check dry heat and ethylene oxide sterilization.

3) Use of agars and broths—Temper melted agars in a water bath at 44 to 46°C until used but do not hold longer than 3 h. To monitor agar temperature, expose a bottle of water or medium to the same heating and cooling conditions as the agar. Insert a thermometer in the monitoring bottle to determine when the temperature is 45 to 46°C and suitable for use in pour plates. If possible, prepare media on the day of use. After pouring agar plates for streaking, dry agar surfaces by keeping dish slightly open for at

least 15 min in a bacteriological hood to avoid contamination. Discard unused liquid agar; do not let harden or remelt for later use.

Handle tubes of sterile fermentation media carefully to avoid entrapping air in inner tubes, thereby producing false positive reactions. Examine freshly prepared tubes to determine that gas bubbles are absent.

4) Storage of media—Prepare media in amounts that will be used within holding time limits given in Table 9020:IV. Protect media containing dyes from light; if color changes occur, discard the media. Refrigerate poured agar plates not used on the day of preparation. Seal agar plates with loose-fitting lids in plastic bags if held more than 2 d. Prepare broth media that will be stored for more than 2 weeks in screw-cap tubes, other tightly sealed tubes, or in loose-capped tubes placed in a sealed plastic bag or other tightly sealed container to prevent evaporation.

Mark liquid level in several tubes and monitor for loss of liquid. If loss is 10% or more, discard the batch. If media are refrigerated, incubate overnight at test temperature before use and reject the batch if false positive responses occur. Prepared sterile broths and agars available from commercial sources may offer advantages when analyses are done intermittently, when staff is not available

6. Sampling

a. Planning: Microbiologists should participate in the planning of monitoring programs that will include microbial analyses. They can provide valuable expertise on the selection of sampling sites, number of samples and analyses needed, workload, and equipment and supply needs. For natural waters, knowledge of the probable microbial densities, and the impact of season, weather, tide and wind patterns, known sources of pollution, and other variables, are needed to formulate the most effective sampling plan.

b. Methods: Sampling plans must be specific for each sampling site. Prior sampling guidance can be only general in nature, addressing the factors that must be considered for each site. Sampling SOPs describe sampling equipment, techniques, frequency, holding times and conditions, safety rules, etc., that will be used under different conditions for different sites. From the information in these SOPs sampling plans will be drawn up.

7. Analytical Methods

a. Method selection: Because minor variations in technique

dures, as well as methods of sampling, analysis, and quality control. The SOPs are unique to the laboratory. They describe the tasks as performed on a day-to-day basis, tailored to the laboratory's own equipment, instrumentation, and sample types. The SOPs guide routine operations by each analyst, help to assure uniform operations, and provide a solid training tool.

TABLE 9020:IV. HOLDING TIMES FOR PREPARED MEDIA

Medium	Holding Time
Membrane filter (MF) broth in screw-cap flasks at 4°C	96 h
MF agar in plates with tight-fitting covers at 4°C	2 weeks
Agar or broth in loose-cap tubes at 4°C	2 weeks
Agar or broth in tightly closed screw-cap tubes or other sealed containers	3 months
Poured agar plates with loose-fitting covers in sealed plastic bags at 4°C	2 weeks
Large volume of agar in tightly closed screw-cap	

sample type, equipment, and instrumentation used in the laboratory.

8. Analytical Quality Control Procedures

a. General quality control procedures:

1) New methods—Conduct parallel tests with the standard procedure and a new method to determine applicability and comparability. Perform at least 100 parallel tests across seasons of the year before replacement with the new method for routine use.

2) Comparison of plate counts—For routine performance evaluation, repeat counts on one or more positive samples at least monthly and compare the counts with those of other analysts testing the same samples. Replicate counts for the same analyst should agree within 5% and those between analysts should agree within 10%. See 9020B.10*b* for a statistical calculation of data precision.

3) Control cultures—For each lot of medium check analytical procedures by testing with known positive and negative control

TABLE 9020:V. CONTROL CULTURES FOR MICROBIOLOGICAL TESTS

Group	Control Culture: Positive	Control Culture: Negative
Total coliforms	*Escherichia coli*	*Staphylococcus aureus*
	Enterobacter aerogenes	*Pseudomonas* sp.
Fecal coliforms	*E. coli*	*E. aerogenes*
		Streptococcus faecalis
Escherichia coli	*E. coli*	*E. aerogenes*
Fecal streptococci	*Enterococcus faecalis*	*Staphylococcus aureus*
		E. coli
Enterococci	*S. faecalis*	*S. mitis/salivarius*

4) Duplicate analyses—Perform duplicate analyses on 10% of samples and on at least one sample per test run. A test run is defined as an uninterrupted series of analyses. If the laboratory conducts less than 10 tests/week, make duplicate analyses on at least one sample each week.

5) Sterility checks—For membrane filter tests, check sterility of media, membrane filters, buffered dilution and rinse water, pipets, flasks and dishes, and equipment as a minimum at the end of each series of samples, using sterile reagent water as the sam-

TABLE 9020:VI. CALCULATION OF PRECISION CRITERION

Sample No.	Duplicate Analyses D_1	Duplicate Analyses D_2	Logarithms of Counts L_1	Logarithms of Counts L_2	Range of Logarithms (R_{log}) $(L_1 - L_2)$
1	89	71	1.9494	1.8513	0.0981
2	38	34	1.5798	1.5315	0.0483
3	58	67	1.7634	1.8261	0.0627
...					
14	7	6	0.8451	0.7782	0.0669
15	110	121	2.0414	2.0828	0.0414

Calculations:

1) Σ of R_{log} = 0.0981 + 0.0483 + 0.0627 + ... + 0.0669 + 0.0414
= 0.718 89

2) $\bar{R} = \frac{\Sigma R_{log}}{n} = \frac{0.718\,89}{15} = 0.0479$

3) Precision criterion = 3.27 $\bar{R}$ = 3.27 (0.0479) = 0.1566

If there is more than one analyst, include all analysts regularly running the tests, with each analyst performing approximately an equal number of tests. Record duplicate analyses as D_1 and D_2.

2) Calculate the logarithm of each result. If either of a set of duplicate results is <1, add 1 to both values before calculating the logarithms.

3) Calculate the range (R) for each pair of transformed duplicates as the mean ($\bar{R}$) of these ranges.

See sample calculation in Table 9020:VI.

4) Thereafter, analyze 10% of routine samples in duplicate. Transform the duplicates as in ¶ 2) and calculate their range. If the range is greater than 3.27 $\bar{R}$, there is greater than 99% probability that the laboratory variability is excessive. Determine if increased imprecision is acceptable; if not, discard all analytical results since the last precision check (see Table 9020:VII). Identify and resolve the analytical problem before making further analyses.

5) Update the criterion used in ¶ 4) by periodically repeating the procedures of ¶s 1) through 3) using the most recent sets of

2) Enzyme substrate coliform test (total coliform/*E. coli*) (9223B)

a) Drinking water—Verify at least 5% of total coliform positive results from enzyme substrate coliform tests by inoculating growth from a known positive sample and testing for lactose fermentation or for β-D-galactopyranosidase by the *o*-nitrophenyl-β-D-galactopyranoside (ONPG) test and indophenol by the cyto-

TABLE 9020:VII. DAILY CHECKS ON PRECISION OF DUPLICATE COUNTS*

Date of Analysis	Duplicate Analyses D_1	Duplicate Analyses D_2	Logarithms of Counts L_1	Logarithms of Counts L_2	Range of Logarithms	Acceptance of Range†
8/29	71	65	1.8513	1.8129	0.0383	A
8/30	110	121	2.0414	2.0828	0.0414	A
8/31	73	50	1.8633	1.6990	0.1643	U

* Precision criterion = (3.27$\bar{R}$) = 0.1566

chrome oxidase (CO) test. See 9225D for these tests. Coliforms are ONPG-positive and cytochrome-oxidase-negative. Verify *E. coli* using the EC MUG test (see 9221F).

b) Other water types—Verify at least 10% of total coliform positive samples as in ¶ 2*a* above.

3) Fecal streptococci procedure—Verify as in 9230C.5. Growth of catalase-negative, gram-positive cocci on bile esculin agar at 35°C and in brain-heart infusion broth at 45°C verifies the organisms as fecal streptococci. Growth at 45°C and in 6.5% NaCl broth indicates the streptococci are members of the enterococcus group.

4) Include known positive and negative pure cultures as a QC check.

b. Membrane filter methods:

1) Total coliform procedures

a) Drinking water—Pick all, up to 5 typical and 5 atypical (nonsheen) colonies from positive samples on M-Endo medium and verify as in 9222B.5*g*. Also verify any positives for fecal coliforms or *E. coli*. If there are no positive samples, test at least one known positive source water quarterly.

b) Other water types—Verify positives monthly by picking at least 10 sheen colonies from a positive water sample as in

ing the citrate test and the indole test as described in 9225D, but incubate indole test at 44.5°C. *E. coli* are indole-positive and yield no growth on citrate.

b) Other water types—Verify one positive sample monthly as in ¶ a) above. Adjust counts based on percentage of verification.

4) Fecal streptococci procedure—Pick to verify monthly at least 10 isolated esculin-positive red colonies from m-Enterococcus agar to brain heart infusion (BHI) media. Verify as described in 9230C. Adjust counts based on percentage of verification.

5) *Enterococci* procedures—Pick to verify monthly at least 10 well-isolated pink to red colonies with black or reddish-brown precipitate from EIA agar. Transfer to BHI media as described in 9230C. Adjust counts based on percentage of verification.

6) Include known positive and negative pure cultures as a quality control check.

10. Documentation and Recordkeeping

a. QA plan: The QA program documents management's commicies, organization, objectives, and functional responsibilities for achieving the quality goals. In addition, the program should develop a project plan that specifies the QC requirements for each project. The plan specifies the QC activities required to achieve the data representativeness, completeness, comparability, and compatibility. Also, the QA plan should include a program implementation plan that ensures maximum coordination and integration of QC activities within the overall program (sampling, analyses, and data handling).

b. Sampling records: A written SOP for sample handling records sample collection, transfer, storage, analyses, and disposal. The record is most easily kept on a series of printed forms that prompt the user to provide all the necessary information. It is especially critical that this record be exact and complete if there is any chance that litigation may occur. Such record systems are called chain of custody. Because laboratories do not always know whether analytical results will be used in future litigation, some maintain chain-of-custody on all samples. Details on chain of custody are available in Section 1060B and elsewhere.[1]

c. Recordkeeping: An acceptable recordkeeping system provides needed information on sample collection and preservation,

11. Data Handling

a. Distribution of bacterial populations: In most chemical analyses the distribution of analytical results follows the Gaussian curve, which has symmetrical distribution of values about the mean (see Section 1010B). Microbial distributions are not necessarily symmetrical. Bacterial counts often are characterized as having a skewed distribution because of many low values and a few high ones. These characteristics lead to an arithmetic mean that is considerably larger than the median. The frequency curve of this distribution has a long right tail, such as that shown in Figure 9020:1, and is said to display positive skewness.

Application of the most rigorous statistical techniques requires the assumption of symmetrical distributions such as the normal curve. Therefore it usually is necessary to convert skewed data so that a symmetrical distribution resembling the normal distribution results. An approximately normal distribution can be ob-

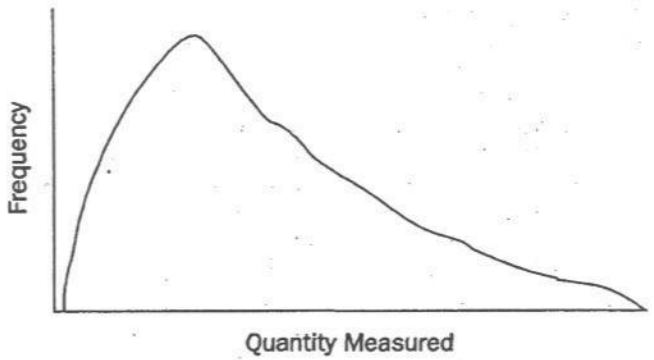

Figure 9020:1. Frequency curve (positively skewed distribution).

quency tables for the original data (Table 9020:IX) and their logarithms (Table 9020:X) shows that the logarithms approximate a symmetrical distribution.

b. Central tendency measures of skewed distribution: If the

TABLE 9020:IX. COMPARISON OF FREQUENCY OF MPN DATA

Class Interval	Frequency (MPN)
0 to 400	11
400 to 800	2
800 to 1200	1
1200 to 1600	0
1600 to 2000	0
2000 to 2400	0
2400 to 2800	0
2800 to 3200	0

calculated from the data in Table 9020:VIII are drastically different.

$$\log \bar{x}_g = \frac{\sum (\log x_i)}{n} = \frac{32.737}{15} = 2.1825$$

geometric mean

$$\bar{x}_g = \text{antilog } (2.1825) = 152$$

TABLE 9020:VIII. COLIFORM COUNTS AND THEIR LOGARITHMS

MPN Coliform Count *No./100 mL*	log MPN
11	1.041
27	1.431
36	1.556
48	1.681
80	1.903
85	1.929
120	2.079
130	2.114
136	2.134
161	2.207
317	2.501
601	2.779
760	2.881
1020	3.009
3100	3.491

halfway between zero and the "less than" value, or assigning the "less than" value itself, i.e., changing <1 values to 1, ½, or 0.

There are valid reasons for not including < values, whether modified or not. If the database is fairly large with just a few < values, the influence of these uncertain values will be minimal

TABLE 9020:X. COMPARISON OF FREQUENCY OF LOG MPN DATA

Class Interval	Frequency (log MPN)
1.000 to 1.300	1
1.300 to 1.600	2
1.600 to 1.900	1
1.900 to 2.200	5
2.200 to 2.500	1
2.500 to 2.800	2
2.800 to 3.100	2
3.100 to 3.400	0

and of no benefit. If the database is small or has a relatively large number of < values, inclusion of modified < values would exert an undue influence on the final results and could result in an artificial negative or positive bias. Including < values is particularly inappropriate if the < values are <100, <1000, or higher because the unknown true values could be anywhere from 0 to 99, 0 to 999, etc. When < values are first noted, adjust or expand test volumes. The only exception to this caution would be regulatory testing with defined compliance limits, such as the <1/100 mL values reported for drinking water systems where the 100-mL volume is required.

12. References

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program, and external proficiency testing.

2. Uniform Criteria

Interlaboratory quality control programs begin as a volunteer or mandatory means of establishing uniform laboratory standards for a specific purpose. The participants may be from one organization or a group of organizations having common interests or falling under common regulations. Often one group or person may agree to draft the criteria. If under regulation, the regulating authority may set the criteria for compliance-monitoring analyses.

Uniform sampling and analytical methods and quality control criteria for personnel, facilities, equipment, instrumentation, supplies, and data handling and reporting are proposed, discussed, reviewed, modified if necessary, and approved by the group for common use. Criteria identified as necessary for acceptable data quality should be mandatory. A formal document is prepared and provided to all participants.

informs the organization and a qualified external QA person or team arranges an on-site visit to evaluate the QA program for acceptability and to work with the laboratory to solve any problems. An acceptable rating confirms that the laboratory's QA program is operating properly and that the laboratory has the capability of generating valid defensible data. Such on-site evaluations are repeated and may be announced or unannounced.

4. External Proficiency Testing

Whenever practical, the external organization conducts formal performance evaluation studies among all participant laboratories. Challenge samples are prepared and sent as unknowns on a set schedule for analyses and reporting of results. The reported data are coded for confidentiality and evaluated according to an agreed-upon scheme. The results are summarized for all laboratories and individual laboratory reports are sent to participants. Results of such studies indicate the quality of routine analyses of each laboratory as compared to group performance. Also, results

5. Example Program

In the Federal Drinking Water Laboratory Certification Program, public water supply laboratories must be certified according to minimal criteria and procedures and quality assurance described in the EPA manual on certification:[1] criteria are established for laboratory operations and methodology; on-site inspections are required by the certifying state agency or its surrogate to verify minimal standards; annually, laboratories are required to perform acceptably on unknown samples in formal studies, as samples are available; the responsible authority follows up on problems identified in the on-site inspection or performance evaluation and requires corrections within a set period of time. Individual state programs may exceed the federal criteria.

On-site inspections of laboratories in the present certification program show that primary causes for discrepancies in drinking water laboratories have been inadequate equipment, improperly prepared media, incorrect analytical procedures, and insufficiently trained personnel.

6. References

1. U.S. ENVIRONMENTAL PROTECTION AGENCY. 1997. Manual for the Certification of Laboratories Analyzing Drinking Water, 4th ed. EPA-814B-92-002, U.S. Environmental Protection Agency, Cincinnati, Ohio.

9030 LABORATORY APPARATUS*

9030 A. Introduction

This section contains specifications for microbiological laboratory equipment. For testing and maintenance procedures related to quality control, see Section 9020.

* Approved by Standard Methods Committee, 1993.

9030 B. Equipment Specifications

1. Incubators

Incubators must maintain a uniform and constant temperature at all times in all areas, that is, they must not vary more than ±0.5°C in the areas used. Obtain such accuracy by using a water-jacketed or anhydric-type incubator with thermostatically controlled low-temperature electric heating units properly insulated and located in or adjacent to the walls or floor of the chamber and preferably equipped with mechanical means of circulating air.

Incubators equipped with high-temperature heating units are unsatisfactory, because such sources of heat, when improperly placed, frequently cause localized overheating and excessive drying of media, with consequent inhibition of bacterial growth. Incubators so heated may be operated satisfactorily by replacing high-temperature units with suitable wiring arranged to operate at a lower temperature and by installing mechanical air-circulation devices. It is desirable, where ordinary room temperatures vary excessively, to keep laboratory incubators in special rooms maintained at a few degrees below the recommended incubator temperature.

Alternatively, use special incubating rooms well insulated and equipped with properly distributed heating units, forced air circulation, and air exchange ports, provided that they conform to desired temperature limits. When such rooms are used, record the daily temperature range in areas where plates or tubes are incubated. Provide incubators with open metal wire or perforated sheet shelves so spaced as to assure temperature uniformity throughout the chamber. Leave a 2.5-cm space between walls and stacks of dishes or baskets of tubes.

Maintain an accurate thermometer, traceable to the National Institute of Standards and Technology (NIST), with the bulb immersed in liquid (glycerine, water, or mineral oil) on each shelf in use within the incubator and record daily temperature readings (preferably morning and afternoon). It is desirable, in addition, to maintain a maximum and minimum registering thermometer within the incubator on the middle shelf to record the gross temperature range over a 24-h period. At intervals, determine temperature variations within the incubator when filled to maximum capacity. Install a recording thermometer whenever possible, to maintain a continuous and permanent record of temperature.

Ordinarily, a water bath with a gabled cover to reduce water and heat loss, or a solid heat sink incubator, is required to maintain a temperature of 44.5 ± 0.2°C. If satisfactory temperature control is not achieved, provide water recirculation. Keep water

2. Hot-Air Sterilizing Ovens

Use hot-air sterilizing ovens of sufficient size to prevent internal crowding; constructed to give uniform and adequate sterilizing temperatures of 170 ± 10°C; and equipped with suitable thermometers. Optionally use a temperature-recording instrument.

3. Autoclaves

Use autoclaves of sufficient size to prevent internal crowding; constructed to provide uniform temperatures within the chambers (up to and including the sterilizing temperature of 121°C); equipped with an accurate thermometer the bulb of which is located properly on the exhaust line so as to register minimum temperature within the sterilizing chambers (temperature-recording instrument is optional); equipped with pressure gauge and properly adjusted safety valves connected directly with saturated-steam supply lines equipped with appropriate filters to remove particulates and oil droplets or directly to a suitable special steam generator (do not use steam from a boiler treated with amines for corrosion control); and capable of reaching the desired temperature within 30 min. Confirm, by chemical or toxicity tests, that the steam supply has not been treated with amines or other corrosion-control chemicals that will impart toxicity.

Use of a vertical autoclave or pressure cooker is not recommended because of difficulty in adjusting and maintaining sterilization temperature and the potential hazard. If a pressure cooker

5. Optical Counting Equipment

a. Pour and spread plates: Use Quebec-type colony counter, dark-field model preferred, or one providing equivalent magnification (1.5 diameters) and satisfactory visibility.

b. Membrane filters: Use a binocular microscope with magnification of 10 to 15×. Provide daylight fluorescent light source at angle of 60 to 80° above the colonies; use low-angle lighting for nonpigmented colonies.

c. Mechanical tally.

6. pH Equipment

Use electrometric pH meters, accurate to at least 0.1 pH units, for determining pH values of media.

7. Balances

Use balances providing a sensitivity of at least 0.1 g at a load of 150 g, with appropriate weights. Use an analytical balance having a sensitivity of 1 mg under a load of 10 g for weighing small quantities (less than 2 g) of materials. Single-pan rapid-weigh balances are most convenient.

8. Media Preparation Utensils

Use borosilicate glass or other suitable noncorrosive equipment

halation, ingestion, and contact with the skin. Also, ethylene oxide forms an explosive mixture with air at 3-80% proportion.) diluted to 10 to 12% with an inert gas. Provide an automatic control cycle to evacuate sterilizing chamber to at least 0.06 kPa, to hold the vacuum for 30 min, to adjust humidity and temperature, to charge with the ethylene oxide mixture to a pressure dependent on mixture used, to hold such pressure for at least 4 h, to vent gas, to evacuate to 0.06 kPa, and finally, to bring to atmospheric pressure with sterile air. The humidity, temperature, pressure, and time of sterilizing cycle depend on the gas mixture used.

Store overnight sample bottles with loosened caps that were sterilized by gas, to allow last traces of gas mixture to dissipate. Incubate overnight media sterilized by gas, to insure dissipation of gas.

In general, mixtures of ethylene oxide with chlorinated hydrocarbons such as freon are harmful to plastics, although at temperatures below 55°C, gas pressure not over 35 kPa, and time of sterilization less than 6 h, the effect is minimal. If carbon dioxide is used as a diluent of ethylene oxide, increase exposure time and pressure, depending on temperature and humidity that can be used.

pipets having graduations distinctly marked and with unbroken tips. Bacteriological transfer pipets or pipets conforming to APHA standards may be used. *Do not pipet by mouth; use a pipet aid.*

Use graduated cylinders meeting ASTM Standards (D-86 and D-216) and with accuracy limits established by NIST where appropriate.

10. Pipet Containers

Use boxes of aluminum or stainless steel, end measurement 5 to 7.5 cm, cylindrical or rectangular, and length about 40 cm. When these are not available, paper wrappings for individual pipets may be substituted. To avoid excessive charring during sterilization, use best-quality sulfate pulp (kraft) paper. *Do not use copper or copper alloy cans or boxes as pipet containers.*

11. Refrigerator

Use a refrigerator maintaining a temperature of 1 to 4.4°C to store samples, media, reagents, etc. Do not store volatile solvents, food, or beverages in a refrigerator with media. Frost-free refrig-

erators may cause excessive media dehydration on storage longer than 1 week.

12. Temperature-Monitoring Devices

Use glass or metal thermometers graduated to 0.5°C to monitor most incubators and refrigerators. Use thermometers graduated to 0.1°C for incubators operated above 40°C. Use continuous recording devices that are equally sensitive. Verify accuracy by comparison with a NIST-certified thermometer, or equivalent.

13. Dilution Bottles or Tubes

Use bottles or tubes of resistant glass, preferably borosilicate glass, closed with glass stoppers or screw caps equipped with liners that do not produce toxic or bacteriostatic compounds on sterilization. Do not use cotton plugs as closures. Mark graduation levels indelibly on side of dilution bottle or tube. Plastic bottles of nontoxic material and acceptable size may be substituted for glass provided that they can be sterilized properly.

quired.

16. Fermentation Tubes and Vials

Use fermentation tubes of any type, if their design permits conforming to medium and volume requirements for concentration of nutritive ingredients as described subsequently. Where tubes are used for a test of gas production, enclose a shell vial, inverted. Use tube and vial of such size that the vial will be filled completely with medium, at least partly submerged in the tube, and large enough to make gas bubbles easily visible.

17. Inoculating Equipment

Use wire loops made of 22- or 24-gauge nickel alloy* or platinum-iridium for flame sterilization. Use loops at least 3 mm in diameter. Sterilize by dry heat or steam. Single-service hardwood or plastic applicators also may be used. Make these 0.2 to 0.3 cm in diameter and at least 2.5 cm longer than the fermentation tube; sterilize by dry heat and store in glass or other nontoxic containers.

18. Sample Bottles

For bacteriological samples, use sterilizable bottles of glass or plastic of any suitable size and shape. Use bottles capable of holding a sufficient volume of sample for all required tests and an adequate air space, permitting proper washing, and maintaining samples uncontaminated until examinations are completed. Ground-glass-stoppered bottles, preferably wide-mouthed and of resistant glass, are recommended. Plastic bottles of suitable size, wide-mouthed, and made of nontoxic materials such as polypropylene that can be sterilized repeatedly are satisfactory as sample containers. Presterilized plastic bags, with or without dechlorinating agent, are available commercially and may be used. Plastic containers eliminate the possibility of breakage during shipment and reduce shipping weight.

Metal or plastic screw-cap closures with liners may be used on sample bottles provided that no toxic compounds are produced

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9040 WASHING AND STERILIZATION*

Cleanse all glassware thoroughly with a suitable detergent and hot water, rinse with hot water to remove all traces of residual washing compound, and finally rinse with laboratory-pure water. If mechanical glassware washers are used, equip them with influent plumbing of stainless steel or other nontoxic material. Do not use copper piping to distribute water. Use stainless steel or other nontoxic material for the rinse water system.

Sterilize glassware, except when in metal containers, for not less than 60 min at a temperature of 170°C, unless it is known from recording thermometers that oven temperatures are uniform, under which exceptional condition use 160°C. Heat glassware in metal containers to 170°C for not less than 2 h.

Sterilize sample bottles not made of plastic as above or in an autoclave at 121°C for 15 min.

For plastic bottles loosen caps before autoclaving to prevent distortion.

* Approved by Standard Methods Committee, 1993.

9050 PREPARATION OF CULTURE MEDIA*

9050 A. General Procedures

Liquid media in fermentation tubes, if stored at refrigeration or even moderately low temperatures, may dissolve sufficient air to produce, upon incubation at 35°C, a bubble of air in the tube. Incubate fermentation tubes that have been stored at a low temperature overnight before use and discard tubes containing air.

Fermentation tubes may be stored at approximately 25°C; but because evaporation may proceed rapidly under these conditions—resulting in marked changes in concentration of the ingredients—do not store at this temperature for more than 1 week. Discard tubes with an evaporation loss exceeding 1 mL.

2. Adjustment of Reaction

State reaction of culture media in terms of hydrogen ion concentration, expressed as pH.

The decrease in pH during sterilization will vary slightly with the individual sterilizer in use, and the initial reaction required to obtain the correct final reaction will have to be determined. The decrease in pH usually will be 0.1 to 0.2 but occasionally may

pecially of rehydrated selective media, regularly to insure quality control and media specifications.

3. Sterilization

After rehydrating a medium, dispense promptly to culture vessels and sterilize within 2 h. Do not store nonsterile media.

Sterilize all media, except sugar broths or broths with other specifications, in an autoclave at 121°C for 15 min after the temperature has reached 121°C. When the pressure reaches zero, remove medium from autoclave and cool quickly to avoid decomposition of sugars by prolonged exposure to heat. To permit uniform heating and rapid cooling, pack materials loosely and in small containers. Sterilize sugar broths at 121°C for 12 to 15 min. The maximum elapsed time for exposure of sugar broths to any heat (from time of closing loaded autoclave to unloading) is 45 min. Preferably use a double-walled autoclave to permit preheating before loading to reduce total needed heating time to within

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9050 B. Water

1. Specifications

To prepare culture media and reagents, use only distilled or demineralized reagent-grade water that has been tested and found free from traces of dissolved metals and bactericidal or inhibitory compounds. Toxicity in distilled water may be derived from fluoridated water high in silica. Other sources of toxicity are silver, lead, and various unidentified organic complexes. Where condensate return is used as feed for a still, toxic amines or other boiler compounds may be present in distilled water. Residual chlorine or chloramines also may be found in distilled water prepared from deionizing columns in need of recharging, solder flux residues in new piping, dust and chemical fumes, and storage of water in unclean bottles. Store distilled water out of direct sunlight to prevent growth of algae and turn supplies over as rapidly as possible. Aged distilled water may contain toxic volatile organic compounds absorbed from the atmosphere if stored for prolonged periods in unsealed containers. Good housekeeping practices usually will eliminate nutrient contamination.

See Section 9020.

2. Bibliography

to give equivalent results. See Section 9020 for quality-control specifications.

The terms used for protein source in most media, for example, peptone, tryptone, tryptose, were coined by the developers of the media and may reflect commercial products rather than clearly defined entities. It is not intended to preclude the use of alternative materials provided that they produce equivalent results.

NOTE—The term "percent solution" as used in these directions is to be understood to mean "grams of solute per 100 mL solution."

1. Dilution Water

a. Buffered water: To prepare stock phosphate buffer solution, dissolve 34.0 g potassium dihydrogen phosphate (KH_2PO_4), in 500 mL reagent-grade water, adjust to pH 7.2 ± 0.5 with 1*N* provide 99 ± 2.0 mL or 9 ± 0.2 mL after autoclaving for 15 min.

b. Peptone water: Prepare a 10% solution of peptone in distilled water. Dilute a measured volume to provide a final 0.1% solution. Final pH should be 6.8.

Dispense in amounts to provide 99 ± 2.0 mL or 9 ± 0.2 mL after autoclaving for 15 min.

Do not suspend bacteria in any dilution water for more than 30 min at room temperature because death or multiplication may occur.

2. Culture Media

Specifications for individual media are included in subsequent sections. Details are provided where use of a medium first is described.

Potassium dihydrogen phosphate, KH_2PO_4	1.5 g
Sodium chloride, NaCl	5.0 g
4-methylumbelliferyl-β-D-glucuronide (MUG)	0.05 g
Reagent-grade water	1 L

Add dehydrated ingredients to water, mix thoroughly, and heat to dissolve. pH should be 6.9 ± 0.2 after sterilization. Before sterilization, dispense in tubes that do not fluoresce under long-wavelength (366 nm) ultraviolet (UV) light. An inverted tube is not necessary. Close tubes with metal or heat-resistant plastic caps.

b. Procedure: Submit all presumptive fermentation tubes or bottles showing growth, gas, or acidity within 48 ± 3 h of incubation to the *E. coli* test.

1) Gently shake or rotate presumptive fermentation tubes or bottles showing growth, gas, or acidity. Using a sterile 3- or 3.5-mm-diam metal loop or sterile wooden applicator stick, transfer growth from presumptive fermentation tube or bottle to EC-MUG broth.

2) Incubate inoculated EC-MUG tubes in a water bath or incubator maintained at 44.5 ± 0.2°C for 24 ± 2 h. Place all EC-MUG tubes in water bath within 30 min after inoculation. Maintain a sufficient water depth in the water-bath incubator to immerse tubes to upper level of medium.

c. Interpretation: Examine all tubes exhibiting growth for fluorescence using a long-wavelength UV lamp (preferably 6 W). The presence of bright blue fluorescence is considered a positive response for *E. coli*. A positive control consisting of a known *E. coli* (MUG-positive) culture, a negative control consisting of a thermotolerant *Klebsiella pneumoniae* (MUG-negative) culture, and an uninoculated medium control may be necessary to interpret the results and to avoid confusion of weak auto-fluorescence of the medium as a positive response. If multiple tubes are used, calculate MPN from the number of positive EC-MUG broth tubes as described in Section 9221C. When using only one tube or subculturing from a single presumptive bottle, report as presence or absence of *E. coli*.

2. Bibliography

FENG, P.C.S. & P.A. HARTMAN. 1982. Fluorogenic assays for immediate confirmation of *Escherichia coli*. *Appl. Environ. Microbiol.* 43:1320.

HARTMAN, P.A. 1989. The MUG (glucuronidase) test for *E. coli* in food and water. *In* A. Balows et al., eds., Rapid Methods and Automation in Microbiology and Immunology. Proc. 5th Intl. Symp. on Rapid Methods and Automation in Microbiology & Immunology, Florence, Italy, Nov. 4–6, 1987.

SHADIX, L.C. & E.W. RICE. 1991. Evaluation of β-glucuronidase assay for the detection of *Escherichia coli* from environmental waters. *Can. J. Microbiol.* 37:908.

9222 MEMBRANE FILTER TECHNIQUE FOR MEMBERS OF THE COLIFORM GROUP*

9222 A. Introduction

The membrane filter (MF) technique is highly reproducible, can be used to test relatively large sample volumes, and usually yields numerical results more rapidly than the multiple-tube fermentation procedure. The MF technique is extremely useful in monitoring drinking water and a variety of natural waters. However, the MF technique has limitations, particularly when testing waters with high turbidity or large numbers of noncoliform (background) bacteria. When the MF technique has not been used previously, it is desirable to conduct parallel tests with the method the laboratory is using currently to demonstrate applicability and comparability.

1. Definition

As related to the MF technique, the coliform group is defined as those facultative anaerobic, gram-negative, non-spore-forming, rod-shaped bacteria that develop red colonies with a metallic (golden) sheen within 24 h at 35°C on an Endo-type medium containing lactose. Some members of the total coliform group may produce dark red, mucoid, or nucleated colonies without a metallic sheen. When verified these are classified as atypical coliform colonies. When purified cultures of coliform bacteria are tested, they produce negative cytochrome oxidase and positive β-galactosidase test reactions.† Generally, pink (non-mucoid), blue, white, or colorless colonies lacking sheen are considered noncoliforms by this technique.

2. Applications

Turbidity caused by the presence of algae, particulates, or other interfering material may not permit testing of a sample volume sufficient to yield significant results. Low coliform estimates may be caused by the presence of high numbers of noncoliforms or of toxic substances. The MF technique is applicable to the examination of saline waters, but not wastewaters that have received only primary treatment followed by chlorination because of turbidity in high volume samples or wastewaters containing toxic metals or toxic organic compounds such as phenols. For the detection of stressed total coliforms in treated drinking water and chlorinated secondary or tertiary wastewater effluents, use a method designed for stressed organism recovery (see Section 9212B.1). A modified MF technique for fecal coliforms (Section 9212) in chlorinated wastewater may be used if parallel testing over a 3-month period with the multiple-tube fermentation technique shows comparability for each site-specific type of sample.

* Approved by Standard Methods Committee, 1997.

† ONPG is a substrate for the β-galactosidase test.

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Date:

Demonstration of Capability

This document identifies that the analyst has read and understands the latest version of the analytical method cited and has read and understands the latest version of the Laboratory SOP for the analytical method. This requirement is stated in NELAC 2002 (5.6.2.c.4)

Analytical Method:

Laboratory SOP:

Analyst Name:

Analyst Signature:

APPENDIX E

QUANTA MANUAL

Water Quality Monitoring System

Operating Manual
February 2002
(Revision C)

Hydrolab Corporation®
8700 Cameron Road, Suite 100
Austin, Texas 78754 USA

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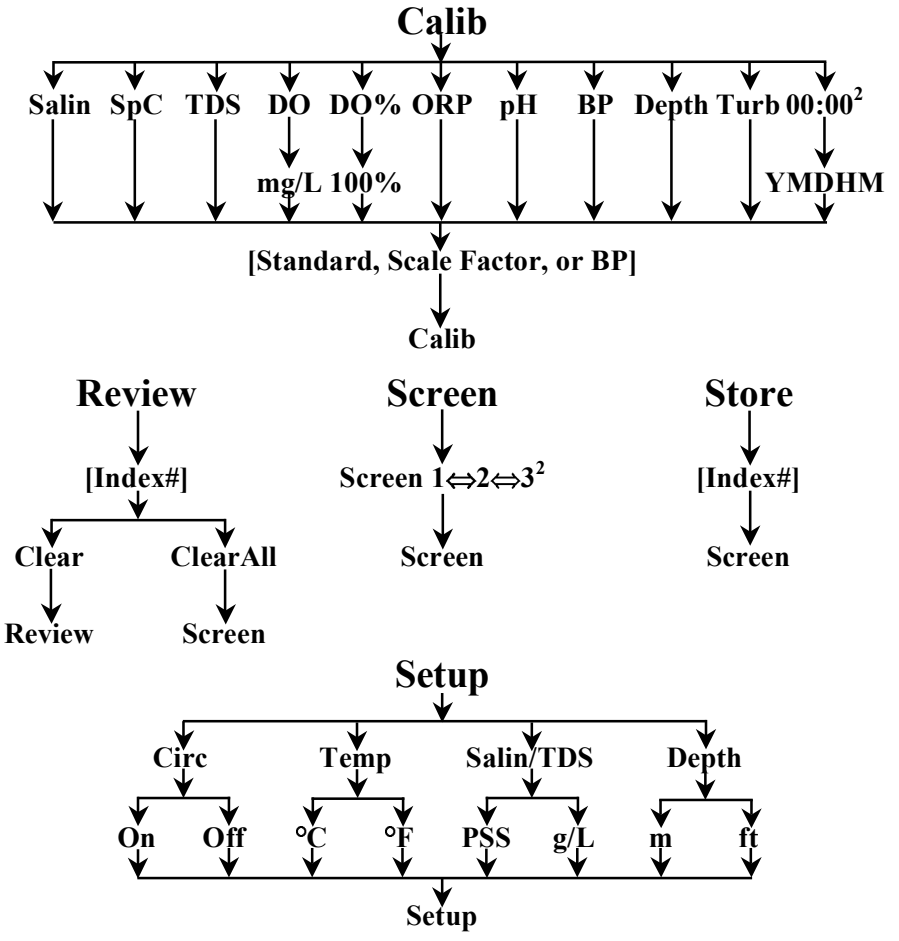
www.hydrolab.com

Quanta Display Operations Tree



***Notes*:**

1. Pressing the **Esc ∞** key always exits to the previous operation level except at the top level where it toggles the circulator on or off.
2. RTC calibration (**Calib ➔ 00:00**) and **Screen 3** are only available if the RTC/PC-Dump option is installed.
3. If the RTC/PC-Dump option is installed, pressing and holding the **Esc ∞** key down during power-up causes the Quanta Display to enter PC-Dump mode.

Table of Contents

1 INTRODUCTION

1.1 Foreword

The Hydrolab Quanta Water Quality Monitoring System includes a sensor package (the Transmitter) and an optional data package (the Display). For this manual, the Quanta System will refer to the combination of the Transmitter and the Display.

The Quanta Transmitter includes sensors for temperature, pH, dissolved oxygen (DO), specific conductance (SpC), depth, oxidation-reduction potential (ORP), turbidity, salinity, and total dissolved solids (TDS). In-situ measurements can be made in lakes, rivers, streams, process pipes, bays, estuaries, tanks, aquaria, sewers, or other large or small water bodies. Highly portable and field-worthy, it can be used for profiling, sampling, and long- or short-term monitoring. The Transmitter can be connected to the Display or any SDI-12 receiving device, including data loggers, data collection platforms, and other monitoring instruments.

The Quanta Display includes battery power and a liquid-crystal screen for viewing up to five parameters at one time. The Display is also used for configuring and calibrating the sensors and can store up to 200 data frames. The Display's RTC/PC-Dump option stamps each data frame with date-time and dumps all data frames in a comma-separated value (CSV) format for easy import into spreadsheet or database programs.

1.2 Specifications

Performance Specifications

	Range	Accuracy	Resolution
Temperature	-5ºC to 50ºC	±0.2ºC	0.01ºC
Dissolved Oxygen	0 to 50 mg/L	±0.2 mg/L ≤ 20 mg/L ±0.6 mg/L > 20 mg/L	0.01 mg/L
Specific Conductance	0 to 100 mS/cm	±1% of reading ±1 count	4 digits
pH	2 to 12 units	±0.2 units	0.01 units
ORP	-999 to 999 mV	±25 mV	1 mV
Vented Depth (10m)	0 to 10 m	±0.003 m (±0.01 ft)	0.001 m
Depth (25m)	0 to 25 m	±0.1 m	0.1 m
Depth (100m)	0 to 100 m	±0.3 m	0.1 m
Turbidity	0 to 1000 NTU	±5% of reading ±1 NTU	0.1 NTU < 100 NTU 1 NTU ≥ 100 NTU
Salinity	0 to 70 PSS	±1% of reading ±1 count	0.01 PSS

Instrument Specifications

Quanta Transmitter

Diameter:	7.6 cm (3 in)
Length:	22.9cm (9 in)
Weight:	1.2 kg (2.6 lbs)
Maximum Submersion:	100 m (328 ft)
Operating Temperature (non-freezing):	-5ºC to 50ºC
Operating Voltage Range:	7 to 14 VDC

Quanta Transmitter

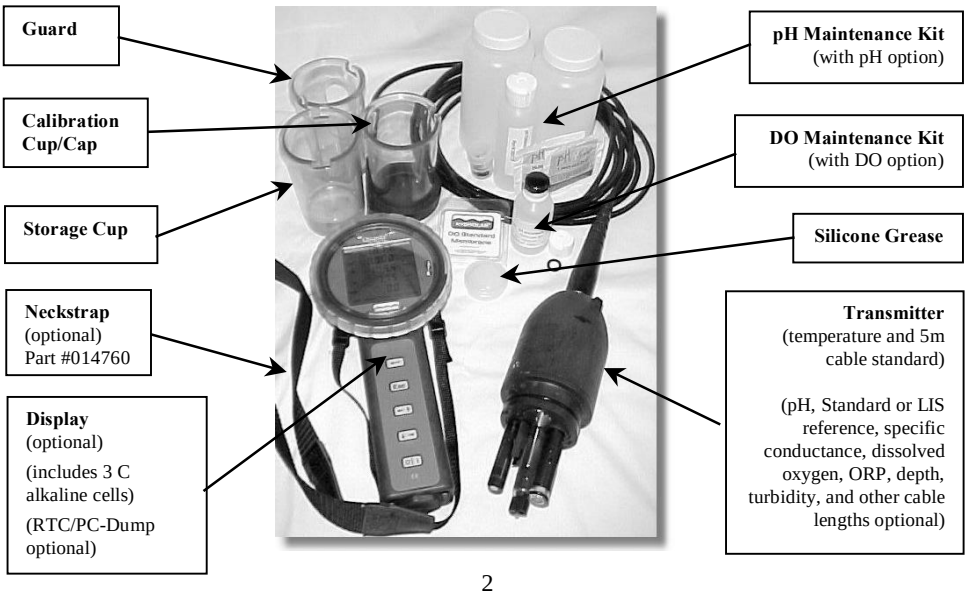
SDI-12 Standby Current (@+12VDC, without turbidity):	< 350 µA
SDI-12 Standby Current (@+12VDC, with turbidity):	< 700 µA
Operating Current (circulator off @+12VDC, without turbidity):	< 40 mA
Operating Current (circulator off @+12VDC, with turbidity):	< 90 mA
Operating Current (circulator on @+12VDC, without turbidity):	< 90 mA
Operating Current (circulator on @+12VDC, with turbidity):	< 140 mA

Quanta Display

Screen Size (diagonal):	8.9 cm (3.5 in)
Width (screen section):	12.7 cm (5 in)
Width (handle section):	6.4 cm (2.5 in)
Length:	26.9cm (10.6in)
Weight (with batteries):	0.95 kg (2.1 lbs)
Operating Temperature (non-freezing):	-5ºC to 50ºC
Batteries:	3 C Alkaline
Battery Life (circulator on, without turbidity):	> 20 hours
Battery Life (circulator on, with turbidity):	> 13 hours
Memory (1 frame stores all parameter values):	200 data frames (Non-volatile FLASH)
Waterproof Rating:	NEMA 6 (IP67)
Real-Time Clock Life	> 10 years
Real-Time Clock Accuracy (@ 25°C)	±2 minutes per month

1.3 Components

The following picture identifies the main components of a Quanta System. The Quanta System is a configurable product and not all components shown are included with every system.



The Quanta System ships in a custom reusable box and also includes this manual and MSDS datasheets. If the Transmitter includes the optional Vented Depth, the cable also includes a dryer assembly. If the Display includes the optional RTC/PC-Dump, the Quanta Display/PC Interface Cable is also included. Optional accessories, not shown, are a Secchi Disk (part #014180), a Backpack (part #014770), a FlowCell (part #014200), an SDI-12 Interface Adapter (part #014190), and Turbidity Quick-Cal Cube™ (part #014250).

1.4 Assembly

1.4.1 Quanta System Assembly

To assemble your Quanta System, simply uncap the Display connector and connect the Transmitter cable connector to the Display connector. These connectors are keyed for proper alignment (don't force them). The retaining ring will make a 'click' when rotated to the correct position to capture the connectors.

Press the Display's O|I key (on/off) and the LCD shows the Display and Transmitter software revisions. The LCD's index digits (see Section 2.1.2) count up from '*L0*' up to '*L9*' as the Display searches SDI-12 addresses for the Transmitter. After finding the Transmitter's SDI-12 address(es), the LCD's parameter digits show the Display and Transmitter software revisions and the index digits count up as the Display interrogates for Transmitter configuration. After a few seconds, the LCD begins showing current Transmitter data. If not, please refer to Section 7.

Notes:

- The Display and Transmitters software revisions show as '*d A.B*', '*S C.D*', and '*U E.F*' where '*d*' is the Display's software revision, '*S*' is the Transmitter's software revision for non-turbidity measurements, and '*U*' is the Transmitter's software revision for turbidity measurements.

1.4.2 Transmitter/SDI-12 Datalogger Assembly

To assemble your Transmitter to your SDI-12 datalogger, simply connect the Transmitter cable connector to the SDI-12 Interface Adapter connector. These connectors are keyed for proper alignment (don't force them). The retaining ring will make a 'click' when rotated to the correct position to capture the connectors. With power off, connect the bare wires at the end of the SDI-12 Interface Adapter to the appropriate connections on your SDI-12 datalogger. The label on the SDI-12 Interface Adapter shows its wire colors/SDI-12 functions. Please consult your datalogger manual for its connection details.

To test the SDI-12 communications, apply power to the datalogger and enter its transparent mode. Issue the '*a*I!' command, where '*a*' is the Transmitter's SDI-12 address, to request the identification of the Transmitter. A properly connected Transmitter will respond with its address, manufacturer name, product name, and SDI-12 revision. If not, please refer to Section 7. Section 6 contains complete details on the Transmitter's SDI-12 capabilities.

Notes:

- All five wires (three grounds) must be connected for correct SDI-12 operation.

- If equipped with the turbidity option, the Transmitter will occupy two SDI-12 addresses. All parameters except turbidity are on one SDI-12 address and turbidity is on another SDI-12 address.
- The Transmitter's factory default SDI-12 address is '0' for all parameters except turbidity and '1' for turbidity. In this manual, '*a*' refers to the SDI-12 address for all parameters except turbidity and '*b*' refers to the SDI-12 address for turbidity.

1.5 Introductory Exercise

1.5.1 Calibrating Specific Conductance using the Display

Assemble the Quanta System as described in Section 1.4.1. Turn on the System by pressing the Display's **O|I** (on/off) key. If the circulator is on, press the **Esc** ∞ (escape/circulator) key (or **Esc** key on early production models) to toggle the circulator off, so that it doesn't splash your calibration standard.

Next, install the Calibration Cup on the Transmitter. With the Transmitter sensors pointing up (towards the ceiling), fill the Calibration Cup with a specific conductance calibration standard. Wait for the specific conductance readings to stabilize in the calibration solution, which may require one or two minutes.

After power-up, the Display's **Screen** icon, in the lower center of the screen, is blinking. Press either of the ◄▲ or ▼► (arrow) keys to cause **Calib** (calibrate) to blink instead of **Screen**. Press the ↵ (enter) key to select calibration. Use the ◄▲ or ▼► keys to cause **SpC** (specific conductance) to blink, and press the ↵ key.

Next, use the ◄▲ or ▼► keys to raise or lower the specific conductance reading to match the calibration standard in mS/cm. Press the ↵ key to finish calibration of specific conductance. If the Transmitter accepts the calibration, the Display returns to the **Calib** screen. If the Transmitter rejects the calibration, the Display LCD shows '**FAIL**' before returning to the **Calib** screen. Press **Esc** ∞ to return to the real-time data screen. Now, check the specific conductance value to confirm calibration.

1.5.2 Calibrating Specific Conductance with an SDI-12 Datalogger

Assemble the Transmitter and SDI-12 datalogger as described in Section 1.4.2. Using the datalogger's transparent mode, issue the '*a*X1!' command to turn the Transmitter's sensors on. If the circulator is on, issue the '*a*XSS0!' command to turn the circulator off, so that it doesn't splash your calibration standard.

Next, install the Calibration Cup on the Transmitter. With the Transmitter sensors pointing up (toward the ceiling), fill the Calibration Cup with a specific conductance calibration standard. Wait for the specific conductance readings to stabilize in the calibration solution, which may require one or two minutes. Monitor the current specific conductance value by issuing the '*a*R0!' command repeatedly. The specific conductance value is the third data value displayed in the SDI-12 response.

Issue the '*a*XCC+*value*!' command, with *value* being the numeric value of the calibration standard in mS/cm, to finish the calibration of specific conductance. Now, issue the '*a*R0!' command and

check the specific conductance value to confirm calibration. Finally, issue the '*a*X0!' command to turn the Transmitter's sensors off and, if needed, issue the '*a*XSS1!' command to turn the circulator back on.

Notes:

- Both the sensors and the circulator must be turned on for the circulator to operate.
- If equipped with the turbidity option, the Transmitter will occupy two SDI-12 addresses. All parameters except turbidity are on one SDI-12 address and turbidity is on another SDI-12 address.
- The Transmitter's factory default SDI-12 address is '0' for all parameters except turbidity and '1' for turbidity. In this manual, '*a*' refers to the SDI-12 address for all parameters except turbidity and '*b*' refers to the SDI-12 address for turbidity.

1.6 Important Note

Although you have now performed the basic operations available on the Quanta System and/or Quanta Transmitter/SDI-12 datalogger, please read Sections 2 and 3 to discover the Quanta System's other features and Sections 3 and 6 to discover the Quanta Transmitter's other SDI-12 capabilities. Be sure to read Section 3, since only a well-maintained and carefully calibrated instrument will provide quality data.

2 QUANTA DISPLAY

2.1 Components

The following picture identifies the main components of a Quanta Display.

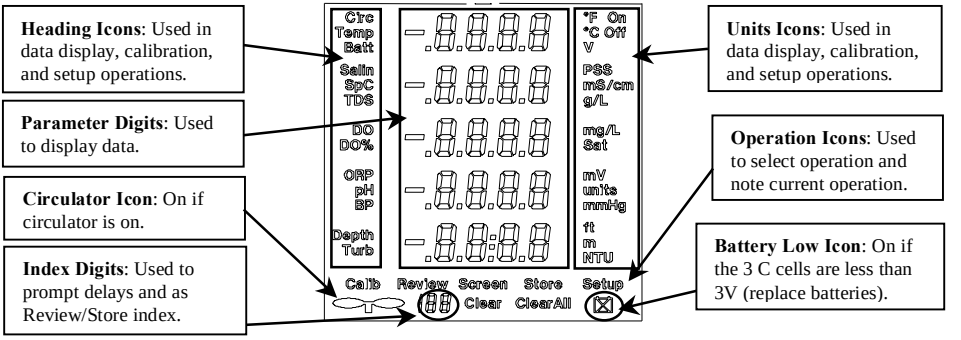
2.1.1 Contrast Control

The Contrast Control is accessed by pressing the Lens down slightly and twisting counterclockwise to disengage the bayonet. Adjust the Contrast Control to suit lighting conditions, thermal conditions, and personal preference. Reattach the Lens by first insuring the o-ring is in the groove around the outside of the Lens. Then align the bayonet, press down slightly, and twist clockwise until you feel the bayonet engage.

Warning: If the o-ring is on the main housing when the Lens is installed, the Display will not properly seal. Severe damage to the Display can occur if water leaks into the main housing.

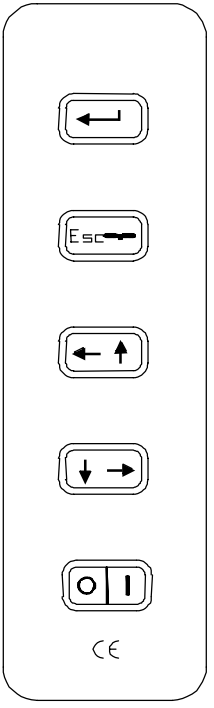
2.1.2 LCD

The Display's LCD provides all the visual information for the Quanta System. The following picture shows all the segments used in operating the Quanta Display.



2.1.3 Keypad

The Quanta Display only uses five keys and their functions are defined as follows:



↵ **Enter:** Pressing ↵ executes the action of the blinking icon.

Esc ∞ **Escape/Circulator:** Pressing **Esc** ∞ returns to the previous operation without executing anything. At the top level, pressing **Esc** ∞ toggles the circulator on or off. If the RTC/PC-Dump option is installed, pressing and holding the **Esc** ∞ key down during power-up causes the Quanta Display to enter PC-Dump mode.

◄▲ **Left/Up:** For menu operations, ◄▲ moves the blinking icon left or up as required by the current menu. For numeric operations, ◄▲ increments the number based on an acceleration algorithm.

▼► **Down/Right:** For menu operations, ▼► moves the blinking icon down or right as required by the current menu. For numeric operations, ▼► decrements the number based on an acceleration algorithm.

O|I **On/Off:** O|I will turn the display on if currently off. If currently on, pressing and holding O|I until the index digits count down to zero, will turn the display off. If turning off, the current operation is aborted.

Note: Each key press produces an audible tone for user feedback.

2.1.4 Batteries

To access the batteries, remove the Battery Cap using a coin. Tilt the Display and the three spent C cells will easily slide out. Inspect the o-ring and o-ring surface and clean if necessary. Insert three brand-new alkaline C cells, positive terminal first and reattach the Battery Cap using a coin. The Display may turn on as a result of battery installation, but this is normal.

Note:

- Changing batteries does not affect stored data frames or the real-time clock. Data frames are stored in non-volatile FLASH memory and do not require batteries for data retention. The RTC/PC-Dump option includes a lithium battery for maintaining the real-time clock.
- Hydrolab recommends high-quality alkaline batteries to provide the maximum operating time. Other C cells can be used (i.e., rechargeable NiCad, rechargeable NiMH, etc.), but

shorter operating time may result. All three C cells must be of the same type and brand and total battery voltage must not exceed 5V.

- Without turbidity installed, the Quanta System provides at least 20 hours of continuous operation at 20°C on one set of brand-new Duracell® brand alkaline C cells.
- With turbidity installed, the Quanta System provides at least 13 hours of continuous operation at 20°C on one set of brand-new Duracell® brand alkaline C cells.
- Derate 25% for operation at 0°C.
- Dispose of spent cells properly.

2.1.5 Neckstrap

The optional Neckstrap (part #014760) is installed on the Display using two 'D' rings in the 'ears' located on the back of the main housing. To install, place the 'D' rings in the strap loops and align with the holes in the 'ears' on the main housing. Squeeze shut with a pair of large needle-nose pliers. Wear the Display with Neckstrap and adjust the buckles until comfortable.

Warning: The 'D' rings and/or 'ears' may breakaway during a sharp tug on the Display. This breakaway is a safety feature. The operator must use extreme caution while using the Neckstrap to prevent injury to the neck or from loss of balance.

2.1.6 RTC/PC-Dump

The optional RTC/PC-Dump is factory installed inside the Display. If installed, the bottom row in the Parameter Digits shows "CL:PC" during display of the software revisions at power-up. The RTC/PC-Dump option stamps each data frame with date-time and dumps all data frames in a comma-separated value (CSV) format for easy import into spreadsheet or database programs.

Note:

- The real-time clock maintains date-time through 31-Dec 2099 23:59:59, including leap years.
- Daylight Savings Time is not supported.

If the RTC/PC-Dump option is purchased, the Quanta Display/PC Interface Cable is also included. During PC-Dump, the 4-pin male connector attaches to the connector on the Quanta Display and the 9-pin female 'D' connector plugs into PC RS232 port with a 9-pin male 'D' connector.

2.2 Operations

After power-up, the Heading Icons, Parameter Digits, and Units Icons display real-time data provided a Transmitter is connected. Also, the top row of Operation Icons is on with the **Screen** icon blinking. The Circulator and Battery Low icons show the circulator and battery status on this and all other operation screens. **Exception**: During data review, the Circulator icon shows the circulator state at the time the data was stored.

By pressing the ◄▲ or ▼► keys, the blinking moves to a different icon. If you press ↵ , you select the operation associated with the blinking icon. Using the ◄▲, ▼►, and ↵ keys, to move to and select an operation is called selecting the operation. If you accidentally select an undesired operation, press **Esc** ∞ to return to the previous operation.

Note:

- If no Transmitter is connected, the Parameter Digits show dashes.
- See the inside front cover of this manual for a graphical Operations Tree.
- The Display automatically powers off if no keys are pressed for 30 minutes.

2.2.1 Screen

After power-up, the Heading Icons, Parameter Digits, and Units Icons display real-time data containing temperature, specific conductance, DO (mg/L), pH, and depth. This screen is called **Screen 1**.

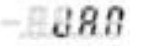
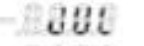
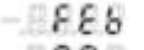
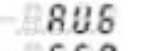
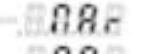
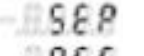
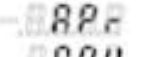
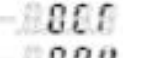
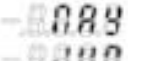
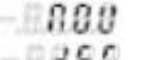
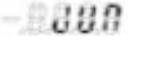
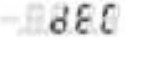
Selecting the **Screen** icon toggles the real-time display to show battery voltage, salinity or TDS, DO (%Saturation), ORP, and turbidity. This screen is called **Screen 2**.

Selecting the **Screen** icon again toggles the real-time display to show day, month, year, hours, and minutes. This screen is called **Screen 3**. Selecting the **Screen** icon again toggles the real-time display back to **Screen 1**.

Screen 1 can be configured to display temperature in °C or °F and depth in m or ft. **Screen 2** can be configured to display salinity or TDS. Section 2.2.2 describes these Setup operations.

Note:

- If no Transmitter is connected, the Parameter Digits show dashes.
- If the Transmitter was purchased without one or more parameters, then the missing parameters' heading, digits, and units are blank.
- If the Display was purchased without the RTC/PC-Dump option, **Screen 3** is not displayed and selecting the **Screen** icon from **Screen 2** toggles the real-time display back to **Screen 1**.
- **Screen 3** displays real-time clock data as day, month, year, hour, and minute. Seconds are not displayed, but are included with PC-Dump data. The hours and minutes are in 24-hour format (00:00 – 23:59). The months are represented as:

Month	Display	Month	Display
January		July	
February		August	
March		September	
April		October	
May		November	
June		December	

2.2.2 Setup

Selecting the **Setup** icon allows setup, or configuration, of circulator state, temperature units, salinity or TDS display, and depth units. After selecting **Setup**, only the **Setup** icon will remain lit from the Operation Icons and the Parameter Digits will blank. The Headings Icons display the configurable options and the Units Icons will display the current setup.

From the displayed Headings Icons, select the configuration to be changed. Now, all Headings and Units Icons except the selected one will blank. The Units icons show the configuration options available. After selecting the configuration desired, the Display returns to the **Setup** screen.

The following configurations are available:

Setup	Default	Alternate
Circulator	On	Off
Temperature	°C	°F
Salinity/TDS	Salinity in PSS	TDS in g/L
Depth	m	ft

Notes:

- All configurations are stored in the Transmitter and retrieved by the Display during power-up.
- Pressing **Esc** ∞ while displaying **Screen 1**, **Screen 2**, or **Screen 3** will toggle the circulator state without accessing **Setup**.

2.2.3 Calib

Selecting the **Calib** icon allows calibration of salinity, specific conductance, TDS scale factor, DO, ORP, pH, barometric pressure (BP), depth, turbidity, and date-time. After selecting **Calib**, only the **Calib** icon will remain lit from the Operation Icons and the Parameter Digits and the Units Icons will blank. The Headings Icons will display the items that can be calibrated.

From the displayed Headings Icons, select the item to be calibrated. Now, all Headings and Units Icons except the selected one will blank. The Parameter Digits show the current value for the item selected. Press the ◄▲ or ▼► keys to change the numeric value to match the calibration standard. Once the value is correct, press the ↵ key to send the updated calibration value to the Transmitter or Display. If the Transmitter or Display accepts the calibration, the Display returns to the **Calib** screen. If the Transmitter or Display rejects the calibration, the Display LCD shows '**FAIL**' before returning to the **Calib** screen. Press **Esc** ∞ to return to **Screen 1**. Now, review **Screen 1**, **Screen 2,** and/or **Screen 3** to confirm calibration.

Some calibrations require multiple values. After updating the first value and pressing ↵, the second value starts blinking. Update it and press↵ . Repeat for all values to complete calibration.

The following calibrations are available:

Calibration	First Value	Second Value	Third Value	Fourth Value	Fifth Value
Salinity	PSS	-	-	-	-
Specific Conductance	mS/cm	-	-	-	-
TDS	Scale Factor (0.64 default)	-	-	-	-
DO/BP	mg/L	mmHg	-	-	-
DO%/BP	100% (fixed)	mmHg	-	-	-

Calibration	First Value	Second Value	Third Value	Fourth Value	Fifth Value
ORP	mV	-	-	-	-
pH	units	-	-	-	-
Barometric Pressure (BP)	mmHg	-	-	-	-
Depth	m or ft	-	-	-	-
Turbidity	NTU	-	-	-	-
Date-Time	Year	Month	Day	Hour	Minute

Notes:

- Holding the ◄▲ or ▼► keys causes the numeric rate of change to accelerate.
- Calibrating salinity or specific conductance causes calibration of salinity, specific conductance, and TDS.
- Calibrating TDS only changes the TDS scale factor.
- Calibrating DO mg/L or DO %Saturation causes calibration of DO mg/L, DO %Saturation, and barometric pressure.
- Calibrating barometric pressure updates the barometric pressure used in calculating DO %Saturation without changing the DO calibration.
- pH is a two-point calibration. A pH standard between 6.8 and 7.2 is treated as the "zero" and all other values are treated as the "slope". First calibrate "zero", then calibrate "slope".
- Turbidity is a two-point calibration. A turbidity standard of 0.0 is treated as the "zero" and all other values are treated as the "slope". First calibrate "zero", then calibrate "slope".
- If the RTC/PC-Dump option was purchased, date-time calibration sets the real-time clock inside the Display and seconds are set to '00'.

2.2.4 Store

Selecting the **Store** icon causes the Display to capture the current real-time data frame for storage to its non-volatile FLASH memory. A data frame includes all current data values and circulator state on **Screen 1**, **Screen 2**, and **Screen 3**. After selecting **Store**, only the **Store** icon remains lit from the Operation Icons. The Headings Icons, Parameter Digits, and the Units Icons toggle between **Screen 1** and **Screen 2** and show the data frame to be stored. The Index Digits show the index of the location where the data frame is to be stored.

If the data frame is correct, note the index for later reference and press ↵ to store the data frame and return to **Screen 1**. Press **Esc** ∞ to return to **Screen 1** without storing the data frame.

Note:

- The Display can store up to 200 data frames ranging from index '00' to '199'.
- An index of '--' is displayed in the Index Digits if the memory is full.
- '**FAIL**' will be momentarily displayed in the Parameter Digits if the data frame could not be stored, most likely due to a full memory.
- If the RTC/PC-Dump option was not purchased, **Screen 3** is not stored with the data frame.
- **Screen 3** is not displayed during **Store** to allow easier data frame verification.

2.2.5 Review

Selecting the **Review** icon causes the Display to display data frames previously stored using the **Store** operation. After selecting **Review**, only the **Review** icon remains lit from the Operation Icons. The Headings Icons, Parameter Digits, and the Units Icons toggle between **Screen 1**, **Screen 2**, and **Screen 3** for the data frame with the lowest index. The blinking Index Digits show the index of the displayed data frame.

Press the ◄▲ or ▼► keys to review other data frames. Press **Esc** ∞ to return to **Screen 1**. Pressing ↵ selects the indexed data frame for erasure using the **Clear** operation. All data frames can be erased using the **ClearAll** operation.

Note:

- When at the highest or lowest index, pressing the ◄▲ or ▼► keys cause the Display to respectively "wrap-around" to the lowest or highest index.
- If no data frames are stored when **Review** is selected, '--' will appear in the Index Digits and the Parameter Digits will be blank.
- If the Display was purchased without the RTC/PC-Dump option, **Screen 3** is not displayed.

2.2.5.1 Clear and ClearAll

From the Review operation, pressing ↵ causes the Index Digits to stop blinking and the **Clear** and **ClearAll** icons to appear. Selecting the **Clear** icon causes the Display to erase the indexed data frame and return to the **Review** operation indexed to the next data frame. If the erased indexed data frame was the last data frame, the Display will return to **Screen 1**.

Selecting the **ClearAll** icon causes the display to erase all data frames and return to **Screen 1**.

Warning: Exercise extreme caution when accessing the **ClearAll** operation. There is no undo operation and up to 200 valuable data frames could be lost!

2.2.6 PC-Dump

The PC-Dump feature dumps all data frames in a CSV format for easy import into spreadsheet or database programs. A PC is required with an available 9-pin 'D' male RS232 COM port and must be loaded with serial communications software (e.g., HyperTerminal®).

Note:

- The PC-Dump feature is only available if the RTC/PC-Dump option was purchased.

To setup PC-Dump, turn the PC on and launch the communications software. Configure the communications software to use the available COM port and configure the COM properties to:

Port Settings	Value
Bits per second	1200
Data bits	7
Parity	Even
Stop bits	1
Flow-control	None

Connect the 9-pin 'D' female RS232 connector on the Quanta Display/PC Interface cable to the available 9-pin 'D' male RS232 COM port. With the Quanta Display off, connect the 4-pin male connector on the Quanta Display/PC Interface cable to the 4-pin female connector on the Quanta Display.

To enter PC-Dump mode, make sure the Quanta Display is off. Press and hold the **Esc ∞** key, then press the **O|I** key. When all segments on the LCD are on, release the **Esc ∞** key. The Parameter Digits display "OPEN CSV FILE PUSH ESC" confirming PC-Dump mode.

Start capture text in the serial communications software. To easily import into spreadsheets (e.g., Excel®), give the capture text file a ".CSV" extension.

Press the **Esc ∞** key to start the data transfer. The Parameter Digits display "DISP -- PC" to confirm transfer in progress. The Display transmits a header line containing column labels for all possible data values. Next, the Display transmits a data line for each data frame stored. If a data frame is empty, no data line is transmitted. During transmission, the Index Digits update to reflect the index of the data frame currently being transmitted. The Parameter Digits display "SAVE CSV FILE PUSH ESC" after all data has been transmitted.

Stop capture text in the serial communications software. Press the **Esc ∞** key and the Display powers down.

From the file manager, double-click the captured text file with the ".CSV" extension to launch your spreadsheet program and open the file. Alternately, within the spreadsheet's file open operation, select file type of text files (i.e., *.csv) and open the captured text file with the ".CSV" extension. The resulting worksheet contains a copy of the Quanta Display's memory and is ready for analysis.

If using Microsoft Windows® and HyperTerminal®:

- Microsoft Windows® includes serial communications software called HyperTerminal®. The HyperTerminal® folder can opened from the *Desktop* via *Start:Programs:Accessories: HyperTerminal*. Double-click on the *Hypertrm.exe* icon to launch HyperTerminal®.
- The available COM port is selected under the *File:Properties* menus and choosing the *Connect using* option. The port settings are accessed via the *Configure* button under the *Connect using* option.
- If you change COM port settings, you generally have to *Disconnect* and *Connect* for the new settings to take affect.
- The COM port selection and settings can be saved and opened under *File* menu.
- The text capture function is started and stopped under the *Transfer:Capture Text…* menu.

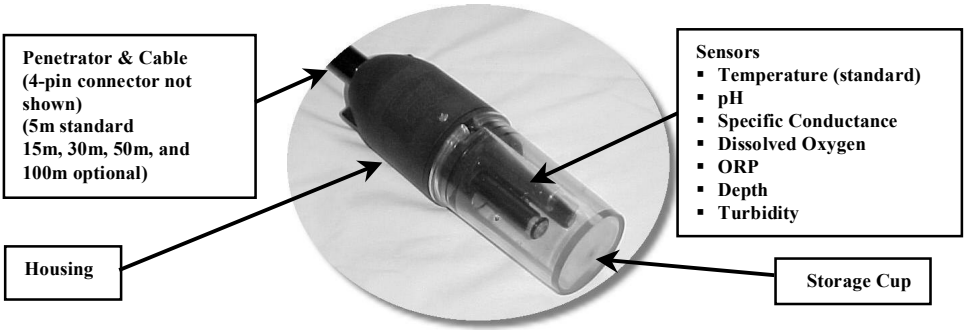
2.3 Display Care

The Display should be kept as clean as possible, especially of grit and grease. Wash the Display with soap and water as needed. The Display should be stored between –5°C and 50°C.

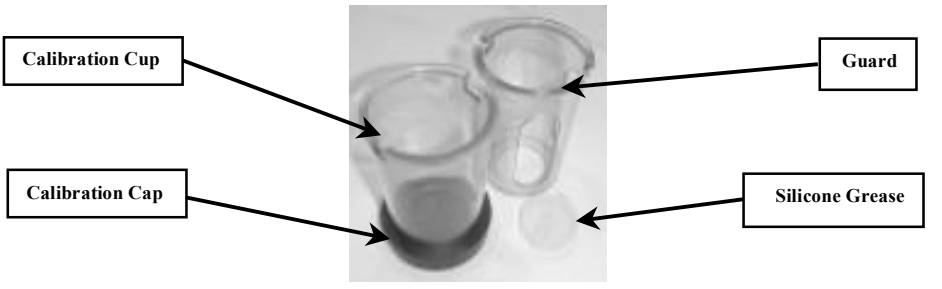
3 QUANTA TRANSMITTER

3.1 Components

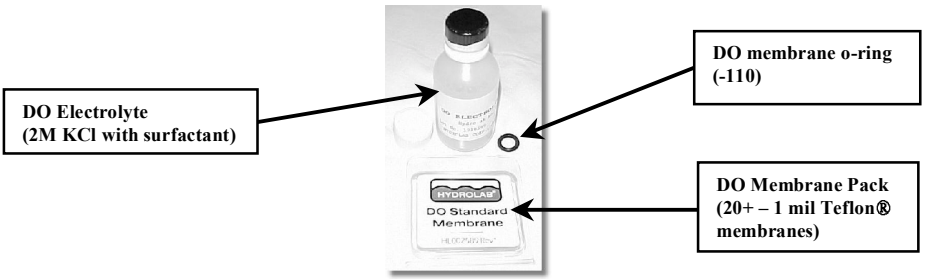
The following pictures identify the main components of a Quanta Transmitter and maintenance items supplied with each Quanta Transmitter.



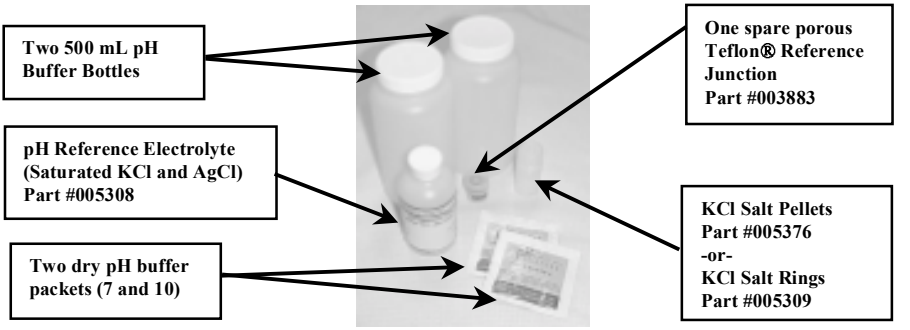
Quanta Transmitter



Standard Maintenance Items

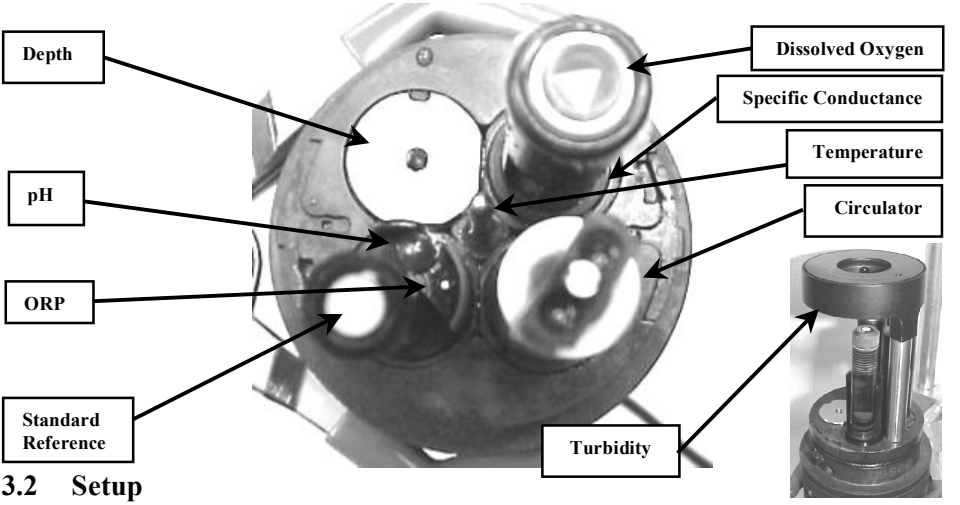


Dissolved Oxygen Maintenance Items (only with DO option)



pH Maintenance Items (only with pH option)

Only temperature is standard on all Transmitters. All other sensors are optional and, if not purchased, are replaced with a sensor plug filling the unused locations. Please consult the following picture showing the sensor array for a fully configured Transmitter.



3.2 Setup

The Transmitter can be setup, or configured, for circulator state, temperature units, salinity or TDS output, depth units, SDI-12 address, and SDI-12 delay. The setup can be changed via the Display or an SDI-12 datalogger.

3.2.1 Setup with Display

See Section 2.2.2 for setup of the Transmitter with the Display.

Note:

- The SDI-12 address and the SDI-12 delay cannot be changed via the Display.

3.2.2 Setup with SDI-12 Datalogger

If using an SDI-12 datalogger for setup, you must enter transparent mode. Please see your datalogger manual for instructions on how to use transparent mode.

The following configurations are available:

Setup	Default	Alternate(s)
Circulator	On	Off
Temperature	°C	°F
Salinity/TDS	Salinity in PSS	TDS in g/L
Depth	m	ft
SDI-12 Address	0	1 to 9
SDI-12 Delay	30 seconds	5 to 994 seconds

Notes:

- All configurations are stored in a nonvolatile memory in the Transmitter.

Within the datalogger's transparent mode, issue the SDI-12 commands to the Transmitter from the following table:

Setup	Options	SDI-12 Command
Circulator	On	'*a*XSS1!'
	Off	'*a*XSS0!'
Temperature	°C	'*a*XTC!'
	°F	'*a*XTF!'
Salinity/TDS	Salinity in PSS	'*a*XSTS!'
	TDS in g/L	'*a*XSTT!'
Depth	m	'*a*XDM!'
	ft	'*a*XDF!'
SDI-12 Address	*c*	'*a*A*c*!'
	d (0 to 9)	'*b*A*d*!'
SDI-12 Delay	*ddd* (005 to 994)	'*a*XL*ddd*!'
		'*b*XL*ddd*!'

Notes:

- Both the sensors and the circulator must be turned on for the circulator to operate.
- If equipped with the turbidity option, the Transmitter will occupy two SDI-12 addresses. All parameters except turbidity are on one SDI-12 address and turbidity is on another SDI-12 address.
- The Transmitter's factory default SDI-12 address is '0' for all parameters except turbidity and '1' for turbidity. In this manual, '*a*' refers to the SDI-12 address for all parameters except turbidity and '*b*' refers to the SDI-12 address for turbidity.

3.3 Circulator

The Transmitters are optionally equipped with a circulator to assist with reliable dissolved oxygen measurements. The circulator also continuously supplies fresh sample to all sensors, and tends to keep the sensors clean by sweeping debris away. The circulator also speeds sensor response by ensuring rapid temperature equilibration.

From **Screen 1** or **Screen 2** on the Display, press **Esc** ∞ to toggle the circulator state. Alternately, select **Setup**, **Circ**, and **On** or **Off** to set the circulator state. From an SDI-12 datalogger, issue the '*a*XSS0!' command to turn the circulator off and the '*a*XSS1!' command to turn the circulator on.

Remember to turn the circulator on during field deployment. Generally, the circulator should be on except during calibration.

Notes:

- The circulator's impeller (part #005306), impeller screw (part #005307), and impeller bearing (part #003594) are non-warranty consumables, which require regular replacement.
- In SDI-12 operation, both the sensors and the circulator must be turned on for the circulator to operate. The sensors are automatically turned on with standard SDI-12 measurement commands. The '*a*X1!' and '*a*X0' commands are available to force the sensors on and off through the transparent mode.
- If equipped with the turbidity option, the Transmitter will occupy two SDI-12 addresses. All parameters except turbidity are on one SDI-12 address and turbidity is on another SDI-12 address.
- The Transmitter's factory default SDI-12 address is '0' for all parameters except turbidity and '1' for turbidity. In this manual, '*a*' refers to the SDI-12 address for all parameters except turbidity and '*b*' refers to the SDI-12 address for turbidity.

3.4 Calibration

Fundamentally, the Transmitter is calibrated by pouring a calibration standard into the calibration cup or by immersing the entire Transmitter in a bucket of standard. Then, watching the readings for the parameter to be calibrated. When the readings stabilize, send the calibration information to the Transmitter via the Display or SDI-12 datalogger. Then confirm the data calibration.

Note: You may notice that the Transmitter has built-in checks for calibration acceptance. If for any reason you cannot complete calibration for any parameter, the Transmitter will continue to use the calibration from the last time that particular parameter was calibrated successfully. However, you should try to determine why the Transmitter did not accept the new calibration (faulty sensor, bad standard, low battery, mistyped standard value, incorrect units, etc.).

3.4.1 Calibration with the Display

If the circulator is on, press the **Esc** ∞ key to toggle the circulator off, so that it doesn't splash your calibration standard. Place the sensors in the appropriate calibration standard for the parameter being calibrated. Monitor the parameter's stability on **Screen 1** and/or **Screen 2**, select **Calib**, then the item to calibrate. Enter the one or two values as required to complete calibration. If the Transmitter rejects the calibration, the Display LCD shows 'FAIL' before returning to the **Calib**

screen. Return to **Screen 1** and/or **Screen 2** to confirm calibration. See Section 2.2.3 for details on using the Display to perform calibrations.

The following table details what can be calibrated with the Display.

Calibration	First Value	Second Value
Salinity	PSS	-
Specific Conductance	mS/cm	-
TDS	Scale Factor (0.64 default)	-
DO/BP	mg/L	mmHg
DO%/BP	100% (fixed)	mmHg
ORP	mV	-
pH	units	-
Barometric Pressure (BP)	mmHg	-
Depth	m or ft	-
Turbidity	NTU	-

3.4.2 Calibration with an SDI-12 Datalogger

If using an SDI-12 datalogger for calibration, you must enter transparent mode. Please see your datalogger manual for instructions on how to use transparent mode.

Within the datalogger's transparent mode, issue the '*a*X1!' command to turn the Transmitter's non-turbidity sensors on and, if turbidity installed, issue the '*b*X1!' command to turn the turbidity sensor on. If the circulator is on, issue the '*a*XSS0!' command to turn the circulator off, so that it doesn't splash your calibration standard.

Repeatedly issue the '*a*R0!' and '*a*R1!' commands and, if turbidity installed, the '*b*R0!' command to monitor the stability of the parameter being calibrated. Once stable, issue the '*c*XC*d*+*value*!' command with '*c*' being the SDI-12 address, '*d*' the code letter of item to calibrate and '*value*' being the numeric value of the calibration standard. Again, issue the '*a*R0!' and '*a*R1!' commands and, if turbidity installed, the '*b*R0!' command to confirm calibration.

Finally, issue the '*a*X0!' command and, if turbidity installed, the '*b*X0' command to turn the Transmitter's sensors off and, if needed, issue the '*a*XSS1!' command to turn the circulator back on.

The following table details the SDI-12 calibration commands available.

Calibration	SDI-12 Command	Units for *value*
Salinity	'*a*XCS+*value*!'	PSS
Specific Conductance	'*a*XCC+*value*!'	mS/cm
TDS	'*a*XCt+*value*!'	Scale Factor (0.64 default)
DO (must calibrate BP first!)	'*a*XCO+*value*!'	mg/L

Calibration	SDI-12 Command	Units for *value*
DO%	'*a*XC%+*value*!'	mmHg
ORP	'*a*XCR+*value*!'	mV
pH	'*a*XCP+*value*!'	units
Barometric Pressure (BP)	'*a*XCB+*value*!'	mmHg
Depth	'*a*XCD+*value*!'	m or ft (per depth setup)
Turbidity	'*b*XCT+*value*!'	NTU

Notes:

- Both the sensors and the circulator must be turned on for the circulator to operate.
- If equipped with the turbidity option, the Transmitter will occupy two SDI-12 addresses. All parameters except turbidity are on one SDI-12 address and turbidity is on another SDI-12 address.
- The Transmitter's factory default SDI-12 address is '0' for all parameters except turbidity and '1' for turbidity. In this manual, '*a*' refers to the SDI-12 address for all parameters except turbidity and '*b*' refers to the SDI-12 address for turbidity.

3.4.3 Calibration Preparation

The following is a general outline of the steps required to calibrate all the sensors:

- **Select a calibration standard whose value is near that of your field samples**.
- Remove the Storage Cup from the Transmitter.
- **Clean and prepare the sensors** as detailed in Sections 3.4.4 through 3.4.9.
- Attach the Calibration Cup.
- Using the Calibration Cap, thoroughly **rinse the sensors several times** by half-filling the calibration cup **with deionized water** and shaking the Transmitter to make sure each sensor is free from contaminants that might alter your calibration standard.

- In a similar manner, **rinse the sensors twice with a small portion of the calibration standard**, each time discarding the rinse.

- With the Transmitter sensors pointing up (toward the ceiling), **fill the Calibration Cup with the calibration standard**. See Sections 3.4.4 through 3.4.8 for sensor specific details.

- **Complete the calibration as per Sections 3.4.1 and/or 3.4.2**.
- Finally, **discard used calibration standards** appropriately. Do not attempt to reuse calibration standards.

Warning: **Sensor preparation is probably the most important action you can take to maintain or improve the quality of your field measurements.** A contaminated, worn-out, or damaged sensor simply will not produce a reliable reading. It is well worth your time to set up a routine in which all sensors are serviced frequently and then allowed to rest in tap water overnight before calibration.

Generally, you should calibrate all Quanta parameters as often as your accuracy requirements dictate. If you want exceptionally accurate data, you must calibrate frequently. Calibration requirements also vary with deployment conditions – in very turbid or biologically-active waters, for instance, generally require more frequent calibrations than do cleaner waters

Notes:

- The optional turbidity sensor has a rotating sealed shaft to make maintenance of other sensors easier. With the storage cup, calibration cup, and guard removed, the turbidity sensor rotates ≈135° in each direction before engaging the internal stop. This feature makes maintenance of the other sensors easier. After maintenance of these other sensors, insure the turbidity sensor is rotated back to the nominal position before reinstalling the storage cup, calibration cup, or guard. **Do not use excessive force or sensor will break!**

3.4.4 Temperature

Cleaning and Preparation

- Soap or rubbing alcohol may be used to remove grease, oil, or biological material.
- Rinse with water.

Calibration Standard

- Factory-set and no recalibration required.

3.4.5 Specific Conductance, Salinity, and TDS

Cleaning and Preparation

- **Clean the oval measurement cell** on the specific conductance sensor with a small, non-abrasive brush or cotton swab.
- Soap or rubbing alcohol may be used to remove grease, oil, or biological material.
- **Rinse with water**.

Calibration Standard

- Pour the specific conductance or salinity standard to within a centimeter of the top of the cup.
- Make sure there are **no bubbles** in the measurement cell of the specific conductance sensor.

Notes:

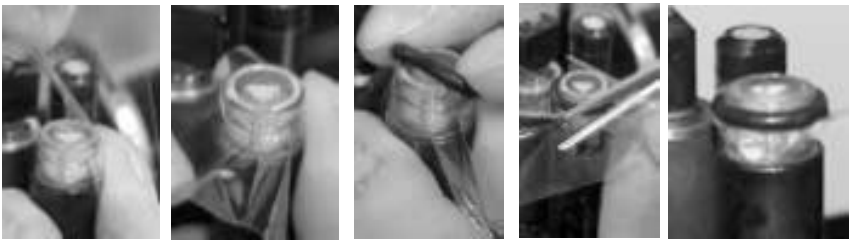
- TDS measurements are based on specific conductance and a user defined scale factor. For TDS calibrations, first calibrate specific conductance, then calibrate the Transmitter with a site-specific scale factor. The factory default scale factor is 0.64 g/L / mS/cm.

3.4.6 Dissolved Oxygen %Saturation and mg/L

Cleaning and Preparation

- Remove the o-ring securing the DO membrane.
- Shake out the old electrolyte and rinse with fresh DO electrolyte.
- Refill with fresh DO electrolyte until there is a perceptible meniscus of electrolyte rising above the entire electrode surface of the sensor.
- Make sure there are **no bubbles** in the electrolyte.

- Hold one end of a new membrane against the body of the DO sensor with your thumb and with a smooth, firm motion, stretch the other end of the membrane over the sensor surface and hold it in place with your index finger.
- Secure the membrane with the o-ring.
- Make sure there are **no wrinkles in the membrane or bubbles** in the electrolyte.
- Trim away the excess membrane extending below the o-ring.
- Ideally, let the sensor soak overnight to allow the membrane to relax to its final shape.



DO %Saturation Calibration Standard (Saturated-Air Method)

- Fill the Calibration Cup with deionized or tap water (specific conductance less than 0.5 mS/cm) until the water is just level with the o-ring used to secure the membrane.
- Carefully remove any water droplets from the membrane with the corner of a tissue.
- Turn the black calibration cup cover upside down (concave upward) and lay it over the top of the Calibration Cup.
- Determine the barometric pressure for entry as the calibration standard. See Section 5.1.3 for computation details on barometric pressure.

Notes:

- Calibration of DO %Saturation also calibrates DO mg/L.
- DO can also be calibrated in a well-stirred bucket of temperature-stable, air-saturated water. This situation more closely resembles the actual field measurement conditions, but is more difficult to accomplish reliably. Be sure the circulator is turned on when calibrating in a water bath.

DO mg/L Calibration Standard (Known Concentration Method)

- Immerse the sensor in a water bath for which the DO concentration in mg/L is known (for instance by Winkler titration). This calibration method is more difficult to perform than the saturated-air method.
- Make sure the circulator is turned on.
- Determine the barometric pressure for entry as the calibration standard. See Section 5.1.3 for computation details on barometric pressure.

Notes:

- Calibration of DO mg/L also calibrates DO% Saturation.
- If there is a change in barometric pressure after calibration (for instance, if barometric pressure drops as you move the calibrated Transmitter to a higher elevation for deployment), the readings for DO %Saturation will not be correct. You must enter a new barometric pressure. However, the readings for DO mg/L will be correct regardless of changes in barometric pressure.

3.4.7 pH and ORP (Redox)

Cleaning and Preparation of pH

- If the pH sensor is obviously coated with oil, sediment, or biological growth, clean the glass with a very clean, soft, non-scratching cloth wet with rubbing alcohol (a cotton ball will do).
- Rinse with tap water.

Cleaning and Preparation of ORP

- If the platinum band at the tip of the ORP sensor gets dirty and/or discolored, polish it with a clean cloth and a very mild abrasive, such as toothpaste; or use a fine polishing strip.
- Rinse with water.
- Soak the sensor overnight in tap water to allow the platinum surface to restabilize.

Cleaning and Preparation of Standard Reference

- Gently pull the entire reference sleeve away from the Transmitter. The reference sleeve is the clear blue tube with a porous Teflon® Reference Junction attached.
- Discard the old electrolyte from the reference sleeve.
- Drop two KCl salt pellets (#005376) or two KCl salt rings (#005309) into the reference sleeve.
- Refill the sleeve to the top with reference electrolyte.
- With the Transmitter sensors pointed toward the floor, push the full reference sleeve back onto its mount until the sleeve has just covered the first o-ring located on the mount (just behind the silver electrode).
- Turn the Transmitter so that the sensors point toward the ceiling and push the sleeve the rest of the way onto its mount.
- Rinse with tap water.




Notes:

- **<u>The porous Teflon® Reference Junction is the most important part of the pH and ORP performance</u>**. Make sure it is clean and passes electrolyte readily. If not, replace it with the spare provided with the pH option. Replacement Reference Junctions are part #003883.
- When seating the reference sleeve, **trapped air and excess electrolyte is purged**. This **<u>purging flushes and cleans the porous Teflon® Reference Junction</u>**.
- The Standard Reference is designed for waters with specific conductances ≥ 0.2 mS/cm. For measurements in waters with specific conductances < 0.2 mS/cm, Hydrolab offers the LISRef as a factory installed option to improve measurements in very low-ionic strength waters.

<u>Cleaning and Preparation of Low-Ionic Strength Reference (LISRef)</u>

- **Remove the plastic LISRef soaking cap. <u>Save the cap!</u>**
- Inspect the LISRef sensor tip.
- If necessary, rinse with soapy water to remove visible contamination and rinse with tap water.
- If necessary, wipe with a cloth soaked in rubbing alcohol to remove oils and grease and rinse with tap water.
- Following cleaning, fill the plastic LISRef soaking cap with reference electrolyte, reinstall over the LISRef tip, and soak overnight.
- **Remove the plastic LISRef soaking cap before calibration or field use. <u>Save the cap!</u>**

Notes:

- **<u>The LISRef Reference is the most important part of the pH and ORP performance.</u>**
- **<u>Whenever the Quanta Transmitter is not in use, fill the plastic LISRef soaking cap with reference electrolyte and reinstall over the LISRef tip.</u>**
- The LISRef Reference is designed for low-ionic strength waters. During normal use, the LISRef Reference is consumed and cannot be rebuilt. Replacement LISRef tips are part #003333.
- For measurements in waters with specific conductances ≥ 0.2 mS/cm, the Standard Reference is preferred due to lower purchase and maintenance costs. Hydrolab offers the Standard Reference as a factory installed option.

Calibration Standard

- Pour the pH or ORP standard to within a centimeter of the top of the cup.

Notes:

- pH is a two-point calibration. A pH standard between 6.8 and 7.2 is treated as the "zero" and all other values are treated as the "slope". First calibrate "zero", then calibrate "slope".

3.4.8 Depth

Cleaning and Preparation

- Soap or rubbing alcohol may be used to remove grease, oil, or biological material.
- Rinse with water.

Calibration Standard

- Enter zero for the standard at the water's surface.

Notes:

- If the depth is known by another method, such as a carefully-marked cable, type the actual depth value as the standard when calibrating.
- The density of water varies with its specific conductance. Depth readings are corrected for specific conductance. See Section 5.3 for details.
- Recheck the 10m vented depth option for sensor drift with a precision pressure gauge at least once a month. A 'zero' drift is quickly corrected through calibration, but a 'slope' drift requires factory recalibration. Factory calibration includes characterization over temperature and pressure. Contact Hydrolab's Customer Service for the current recalibration price and scheduling of a factory recalibration.

3.4.9 Turbidity

Cleaning and Preparation

- Soap or rubbing alcohol may be used to remove grease, oil, or biological material.
- Use a non-abrasive, lint-free cloth to clean the quartz glass tube. Scratched glass reduces the sensor's accuracy.
- Rinse with water.

Calibration Standards

- Calibrate turbidity with primary standards ('turbid-free' water, Formazin, and/or polystyrene beads) and check with a secondary standard (Quick-Cal Cube™).
- Use 'turbid-free' water to calibrate the "zero".
- Use Formazin and/or polystyrene beads to calibrate the "slope".
- Primary standards must completely fill the optical area of the turbidity sensor plus ¼" (6 mm) of standard on both sides of the PVC body by filling the calibration cup to the top. Alternately, pour ≈1-¼" (32 mm) of standard into the storage cup and place the inverted sensors into the standard with bayonets disengaged.
- After calibration with primary standards, the value of the optional Quick-Cal Cube™ secondary standard, if used, must be determined and recorded for each individual instrument. The Quick-Cal Cube™ value is determined by removing the storage/calibration cups, wiping the optical areas, both sensor and cube, clean and dry with a non-abrasive, lint-

free cloth, and placing the ceramic glass cube into the turbidity sensor's optical area. Align the Quick-Cal Cube™'s pin with the turbidity sensor's recessed hole and, for optimum repeatability, rotate the Quick-Cal Cube™ clockwise to remove mechanical play in the pin/hole.

- To test for drift between primary calibrations, reinstall the Quick-Cal Cube™.



Notes:

- 'Turbid-free' water is available for purchase from chemical supply houses. However, it is far less expensive to make by passing reagent-grade water through a 0.1 µm or smaller filter.
- Formazin and polystyrene beads are primary standards as defined by the EPA. Quick-Cal Cubes™ are secondary standards, which must be rechecked, and value recorded, after each primary standard calibration with each instrument. However, Quick-Cal Cubes™ save resources, both time and money, by allowing inexpensive and frequent calibration checks between permit and/or standard operating procedure required primary calibrations.
- Formazin requires daily preparation.
- Polystyrene beads are instrumentation specific and beads formulated for one instrument design often read differently on a different instrument design. Hydrolab has polystyrene beads formulated for the Quanta Turbidity sensor. Please contact Customer Service or www.hydrolab.com for ordering information.
- When using liquid standards, insure no bubbles in the optical area. The optical properties of bubbles affect the turbidity calibration. Gentle agitation easily dislodges bubbles.
- When using Quick-Cal Cube™ standards, insure no water droplets in the optical area. The optical properties of water droplets affect the calibration check. Remove droplets with a non-abrasive, lint-free cloth.
- Turbidity is a two-point calibration. A turbidity standard of 0.0 is treated as the "zero" and all other values are treated as the "slope". First calibrate "zero", then calibrate "slope".

3.5 Care of the Transmitter

In addition to normal sensor maintenance, clean the Transmitter with soap and water. **During storage or transportation, always use the calibration cup/cap or the storage cup filled with a ¼" of tap water to protect the sensors from damage and drying out.** Never deploy the

Transmitter without the guard protecting the sensors. Always rinse the Transmitter with clean water soon after returning from deployment.

3.6 Care of the Cable

Protect the cable from abrasion, unnecessary tension, repetitive flexure (fatigue), and bending over sharp corners (like the edge of the side of a boat). Excessive weight added to the Transmitter greatly increases the possibility of cable breakage.

When not in use, the cables should be clean, dry, and coiled at a 12" or greater diameter.

3.6.1 Dryer Assembly

With purchase of the optional Vented Depth, the Transmitter's cable upgrades to a vented cable with a dryer assembly. The dryer assembly uses a GORE-TEX® patch to reach equilibrium between the gases inside the dryer, vented cable, and Transmitter housing and the gases outside the dryer assembly. This equilibrium allows the vented depth sensor to remove measurement errors caused by changing barometric pressure.

The GORE-TEX® patch also prevents water from entering the dryer, vented cable, and housing. However, water vapor is also a gas and, if not removed, liquid water condensates within the dryer, vented cable, and housing. Water condensation prevents proper vent operation (inaccurate Vented Depth) and damages the Transmitter's internal circuitry (non-warranty).

To prevent water condensation, the dryer assembly includes desiccants to absorb water vapor. These desiccants have a limited capacity and require regular maintenance. An indicator is included inside the dryer and can be viewed through the clear dryer housing. If dark blue, the desiccants do not need to be replaced. However, if light pink or purple, the desiccants need to be replaced.

To replace desiccants:

- Unscrew dryer nut on the cable gland seal nearest the 4 pin connector.
- Unscrew the dryer cap and pull cap away from dryer housing. Take care not to stress wire connections to the terminal strip.
- Remove and properly discard spent desiccants.
- Install fresh desiccants.
- Reinstall dryer cap. Be sure to not pinch desiccants or wires or stress wire connections.
- Reinstall dryer nut.

3.7 Secchi Disk

The Secchi Disk is an option that can be added to the Transmitter. To install, simply thread the cable through the slot on the Secchi Disk, slide the Secchi Disk down to the top of the Transmitter, and thread onto the penetrator fitting.

3.8 FlowCell

For process or pump-through situations, the FlowCell is an option that can be added to the Transmitter so that the system does not have to be submerged in the water being studied.

To install, remove the storage cup and attach the FlowCell to the Transmitter. Connect ½" tubing to the inlet barb fitting (furthest from the Transmitter housing) and ½" tubing to the outlet barb

fitting (nearest to the Transmitter housing). Then connect the inlet and outlet as appropriate to the system being monitored. Filter debris from the inlet. Don't exceed a pumping rate of about 1.5 liters per minute. This maximum rate flushes the contents of the FlowCell about eight times per minute. If possible, lay the Transmitter on its side. Bubbles will tend to float away from the sensors and out the outlet on the side of the FlowCell.

Warning: **Do not pressurize the FlowCell or its feed line above 15 PSIG! Higher pressures could result in serious and/or fatal injury and/or damage to the FlowCell!** If pressures greater than 15 PSIG are possible, use an appropriate pressure regulator installed by qualified personnel.

Warning: **Remove pressure before disconnecting the Transmitter from the FlowCell!** Failure to do so could result in serious or fatal injury and/or damage to the Transmitter and/or FlowCell!

3.9 Additional Weight

The Transmitter has a negative buoyancy of approximately 1 pound. Some high flow conditions require additional weight to sink the Transmitter.

Three user methods to add weight are:

Location	Dimensions
Annular Ring around Cable/above Transmitter	1-¼" – 12UNF-2B thread or Internal ∅ > 1.25"
Fishing Line through main housing 'ears' (use 25 pound monofilament line)	Line ∅ < 0.1"
Baseball Bat Weight(s) (Slide down cable to top of Transmitter)	External ∅ < 3" Internal ∅ > 1.25"

Notes:

- **Do not add more than 10 pounds of weight** and use as small a weight as needed.
- Excessive and/or unnecessary tension on the cable will result in premature non-warranty cable failure.

4 DEPLOYMENT

4.1 Long-term

If using the Transmitter in open water, try to locate the Transmitter so that any available protection is utilized. For instance, in a swiftly flowing river, anchor the Transmitter to the downstream side of a bridge piling so that floating debris will strike the piling, not the Transmitter. Likewise, in a recreational lake deployment, use a marking buoy that will not attract the attention of vandals.

Try to fix the Transmitter in an upright or on-side position, and avoid areas that might see deep deposits of sand, gravel, or silt in the case of a heavy rainfall event. Being caught in water that is icing over can also cause the loss of the Transmitter.

Take similar precautions with the Cable to protect it from floating debris, navigation, and vandals.

Always make sure the sensors are protected with the Guard.

Some sensors cannot remain in calibration for long periods in certain situations. For instance, a DO sensor may become hopelessly fouled after just a few days in a warm, shallow, biologically-active lake. Likewise, a reference electrode's performance will begin to deteriorate quickly in a flowing stream of low ionic-strength water. On the other hand, if the only parameters being measured are temperature and conductivity, the Transmitter can be left for long periods. Deployment time can be judged by making periodic (i.e., daily) measurements of sensitive parameters with another instrument. The day on which the spot-measurements and the logged data begin to diverge significantly may be considered the maximum deployment time for that particular water and season.

The wrapping of the Guard with a fine mesh nylon material or fine copper mesh (.050") can prevent premature fouling of the sensors and should be tried on a case by case basis.

4.2 Short-term

Generally, short-term deployment implies hand-held operation. Just follow common sense; for instance, don't lower the Transmitter into the water without attaching a Guard. Watch out for hazards such as outboard motor propellers.

If necessary, add weight to the Transmitter for sinking in high flow situations. See Section 3.9 for more details.

4.3 Pressure Extremes

The Transmitter’s maximum depth depends on the depth sensor option purchased. The following table shows the maximum depths:

Depth Option	Maximum Depth
No Depth	100m (328 ft)
10m Vented	20m (65 ft)
25m	50m (164 ft)
100m	100m (328 ft)

The Display has a NEMA 6/IP 67 rating. Except during maintenance, keep the Lens and Battery Cap installed.

4.4 Temperature Extremes

The Quanta System's operating temperature range is -5°C to 50°C (23°F to 113°F) non-freezing. Exposure of the Transmitter or Display to temperatures outside of this range might result in mechanical damage or faulty electronic performance. The latter may be very subtle.

4.5 Data Transmission Lines

If you are adding transmission cable to your Transmitter Cable, the added cable must be large enough to carry the operating current and transmit data without distortion. For up to a total of 100m (328 ft) of cable, a pair of twisted shielded #26 AWG wires is suitable for data transmission and a pair of #18 AWG must be used for the power wires. The shield should be attached with the ground wire on pin 4.

The Transmitter cable pin-out is as follows:

Pin Number	Function	Internal Wire Colors
1	+12VDC	Brown
2	Ground	Red
3	SDI-12 Data	Orange
4	Ground	Yellow & Bare Wire

The Transmitter cable connector is Conxall part #3282-4PG-528. It mates to Conxall part #5282-4SG-5XX for cable-to-cable applications or Conxall part #4282-4SG-3XX for panel mount applications. Details on Conxall's Multi-Con-X® connectors can be found at *www.conxall.com*.

4.6 Quanta Display/PC Interface Cable

The Quanta Display/PC Interface cable is intended for indoor use only. The 4-pin male connector is Conxall part #3282-4PG-528 and the 9-pin 'D' female connector is compatible with RS232 industry standard 9-pin 'D' male connectors. The Quanta Display/PC Interface cable pin-out is as follows:

4-pin Male	9-pin Female	Function
Pin 1	-	Transmitter Power
Pin 2	Pin 5	Ground
Pin 3	Pin 2	RXD-
Pin 4	Shell	Shield
-	Pin 3	TXD-
-	Pins 1, 4, & 6 (tied together)	CD, DTR, & DSR
-	Pin 7 & 8 (tied together)	RTS & CTS
-	Pin 9	RI

5 TECHNICAL NOTES

5.1 Dissolved Oxygen

5.1.1 Oxygen Solubility in Water

The function used to calculate oxygen solubility is based on the oxygen solubility vs. temperature data from Table 4500-O found in the 19th Edition of *Standard Methods for the Examination of Water and Wastewater*.

5.1.2 Salinity Correction of DO mg/L

The function used to calculate oxygen solubility is based on the oxygen solubility vs. chlorinity data from Table 4500-O found in the 19th Edition of *Standard Methods for the Examination of Water and Wastewater*.

Note:

- DO %Saturation is not a function of solubility, and has no salinity or temperature correction.

5.1.3 Barometric Pressure Functions

Local barometric pressure, *BP*, in mmHg can be estimated using:

$$BP = 760 - 2.5(A_{ft}/100) \quad \underline{\text{or}} \quad BP = 760 - 2.5(A_m/30.5)$$

where 'A_{ft}' is the local altitude above sea level in feet and 'A_m' is the local altitude above sea level in meters.

If using the local weather bureau BP, remember these numbers are corrected to sea level. To calculate the uncorrected atmospheric pressure *BP'*, use one of the following functions:

$$BP' = BP - 2.5(A_{ft}/100) \quad \underline{\text{or}} \quad BP' = BP - 2.5(A_m/30.5)$$

Local barometric pressure in mbar (BP_{mbar}) can be converted to local barometric pressure in mmHg (BP_{mmHg}) using:

$$BP_{mmHg} = 0.75 \times BP_{mbar}$$

5.2 Specific Conductance, Salinity, and TDS

5.2.1 Specific Conductance Temperature Correction

Temperature correction of conductivity to produce specific conductance is based on the temperature correction formulas and factors of Table 3 in *ISO 7888-1985 Water Quality – Determination of Electrical Conductivity*. This temperature correction is normalized to 25°C

Because total dissolved solids (TDS) is calculated from the specific conductance reading, it also has the above correction.

5.2.2 Salinity Calculation

The method used to calculate salinity from conductivity is found in 2520B the 19th Edition of *Standard Methods for the Examination of Water and Wastewater*. This method is also commonly

referred to at the Practical Salinity Scale or UNESCO method. This method uses conductivity, not specific conductance, and includes its own temperature correction normalized to 15°C.

5.2.3 Total Dissolved Solids (TDS) Calculation

TDS is calculated from specific conductance as:

$$TDS = C \times \text{Scale Factor}$$

where TDS is total dissolved solids in g/L,
C is specific conductance in mS/cm,
and Scale Factor is user defined.

The default scale factor is 0.64 from Water Chemistry, by Snoeyink and Jenkins. If more site-specific information is available, then enter the site-specific TDS scale factor as per Section 3.4.

5.3 Depth Correction for Specific Conductance

The density of water, and hence its ability to "create" pressure, increases with specific conductance. Therefore, if a depth transducer is calibrated for fresh water, the depth reading must be reduced for measurements made in salt waters. The raw depth readings are multiplied by the following correction:

$$F(C) = 1 - 0.03(C/52)$$

where C is the measured specific conductance in mS/cm.

In effect, no correction is made at zero specific conductance, and depth readings are reduced by 3% at 52 mS/cm, the specific conductance of sea water.

5.4 CE Testing

The Quanta System has been tested and complies with CE requirements in effect at time of manufacture. A copy of the Quanta's current Certificate of Compliance is available on request.

5.5 Turbidity

Hydrolab's Quanta Turbidity option is compliant with GLI Method 2, an EPA approved method, and ISO 7027:1999(E). GLI Method 2 is recognized by EPA as an approved method in Section 141.74 of the Federal Register Vol. 59 No. 232 (December 5, 1994). Reprints of both the GLI Method 2 documentation and the Federal Register reference are available on request.

The Quanta's turbidity sensor, circuitry, software, and Quick-Cal Cubes™ were developed as a joint venture between Hydrolab Corporation and GLI International, Inc. and are protected by U.S. Patents #5,059,811 and #5,140,168. Other patents are pending.

6 SDI-12 INTERFACE

SDI-12 is an industry-originated, serial digital interface bus designed to allow an operator to connect a wide variety of transducers (meteorological, hydrological, water quality, etc.) to a single SDI-12 datalogger with a single cable bus.

The Quanta Transmitter is compatible with SDI-12 V1.3 approved by the SDI-12 Support Group in November 1999. A copy of the specification can be found at *www.sdi-12.org*.

The optional SDI-12 Interface Adapter is required to operate the Transmitter with an SDI-12 Datalogger.

6.1 SDI-12 Interface Adapter

A label on the SDI-12 Interface Adapter contains the pinout repeated in the following table:

Pin Number	Wire Color	SDI-12 Function
1	Brown	+12VDC
2	Red	Ground
3	Orange	SDI-12 Data
4	Yellow	Ground
Shield	Bare Wire	Ground

Consult the SDI-12 datalogger manual for information on how to connect the SDI-12 Interface Adapter.

Note:

- All five wires (three grounds) must be connected for correct SDI-12 operation.

6.2 SDI-12 Command Summary

The following table is a summary of the SDI-12 user commands supported by the Transmitter. For more details on correct use, consult the SDI-12 V1.3 specification or the appropriate section of this manual.

Command	Response	Description
a! *b*!	*a*<crlf> *b*<crlf>	Address Acknowledge
*a*I! *b*I!	*a*13HydrolabQuanta2.2-*serial number*<crlf> *a*13HydrolabQTTurb1.2<crlf>	Identify
*a*Ac! *b*A*d*!	*c*<crlf> *d*<crlf>	Change address from *a* to *c* or from *b* to *d*
*a*M! *b*M!	*adddn*<crlf> *bdddn*<crlf>	Measure: *n* values in *ddd* seconds.
*a*MC! *b*MC!	*adddn*<crlf> *bdddn*<crlf>	Measure: *n* values in *ddd* seconds. Report data with CRC.
*a*D*x*! *b*D*x*!	*aSvalueSvalue…CCC*<crlf> *bSvalueSvalue…CCC*<crlf>	Report data. CRC (CCC) added if MC or CC.

Command	Response	Description
*a*R*x*! *b*R*x*!	*a*S*value*S*value*…<crlf> *b*S*value*S*value*…<crlf>	Report continuous data.
*a*RC*x*! *b*RC*x*!	*a*S*value*S*value*…*CCC*<crlf> *b*S*value*S*value*…*CCC*<crlf>	Report continuous data with CRC.
*a*C! *b*C!	*adddnn*<crlf> *bdddnn*<crlf>	Concurrent Measure: *nn* values in *ddd* seconds.
*a*CC! *b*CC!	*adddnn*<crlf> *bdddnn*<crlf>	Concurrent Measure: *nn* values in *ddd* seconds. Report data with CRC.
*a*XT<C|F>!	*a*XT<C|F><crlf>	Change temperature units
*a*XT!	*a*<C|F><crlf>	Report temperature units
*a*XD<M|F>!	*a*XD<M|F><crlf>	Change depth units
*a*XD!	*a*<M|F><crlf>	Report depth units
*a*XST<S|T>!	*a*XST<S|T><crlf>	Set salinity or TDS
*a*XST!	*a*<S|T><crlf>	Report salinity or TDS
*a*XL! *b*XL!	*a*XL*ddd*<crlf> *b*XL*ddd*<crlf>	Report delay, *ddd* seconds
*a*XL*ddd*! *b*XL*ddd*!	*a*XL*ddd*<crlf> *b*XL*ddd*<crlf>	Change delay, *ddd* seconds
*a*X1! *b*X1!	*a*X1<crlf> *b*X1<crlf>	Sensors on
*a*X0! *b*X0!	*a*X0<crlf> *b*X0<crlf>	Sensors off
*a*XSS1!	*a*XSS1<crlf>	Circulator on
*a*XSS0!	*a*XSS0<crlf>	Circulator off
*a*XSS!	*a*<1|0><crlf>	Report circulator state
*a*XC<P|C|S|%|O|R|D|B|t>*Svalue*! *b*XCT*Svalue*!	*a*XC<P|C|S|%|O|R|D|B|t>*Svalue*<crlf> *b*XCT*Svalue*<crlf>	Calibrate parameter Calibrate turbidity
*a*XSN!	*aserialnumber*<crlf>	Report Transmitter serial number
*a*XSs!	*aserialnumber*<crlf>	Report depth serial number
*a*XSm!	*adate*<crlf>	Report date of manufacture (MMDDYY)
*a*XV! *b*XV!	*a+v+v+v+v+v+v+v+v+v+BP+ScaleFactor*<crlf> *b+v+v*<crlf>	Verify parameter: 0=OK, 1=Cal, 2=Ovr, 3=Udr, 4=ADC, 5=N/A

Notes:

- **<u>If equipped with the turbidity option, the Transmitter will occupy two SDI-12 addresses</u>**. All parameters except turbidity are on one SDI-12 address and turbidity is on another SDI-12 address.
- **<u>The Transmitter's factory default SDI-12 address is '0' for all parameters except turbidity and '1' for turbidity.</u>** In this manual, '*a*' refers to the SDI-12 address for all parameters except turbidity and '*b*' refers to the SDI-12 address for turbidity.
- **<u>Data Format for D and R commands on SDI-12 address '*a*' is temperature, pH, specific conductance, salinity or TDS, DO %Saturation, DO mg/L, ORP, depth, and battery.</u>**
- **<u>Data Format for D and R commands on SDI-12 address '*b*' is turbidity and battery.</u>**
- Previous measurements must be in the data buffer before running a parameter calibration.
- Total number of characters in a command must be less than 12.
- For calibrate command (XC) on SDI-12 address '*a*', P is pH, C is specific conductance, S is salinity or TDS, % is DO %Saturation, O is DO mg/L, R is ORP, D is depth, B is barometric pressure, and t is TDS scale factor.

7 TROUBLESHOOTING

7.1 The Display will not turn on.

- Are the batteries installed correctly? (See Section 2.1.4)
- Are the batteries good?

7.2 The Display will not show readings.

- Is the Transmitter connected?
- Is the contrast adjusted properly? (See Section 2.1.1)
- Are all connectors mated properly?

7.3 Measurements seem wrong.

- Are the sensors maintained and calibrated properly? (See Section 3.4.)
- Are the units (°C or °F, m or ft, Salinity or TDS) displayed correct? (See Section 3.2)

7.4 SDI-12 will not communicate.

- Recheck your connections. (See Section 6.1)
- Review the SDI-12 datalogger connection instructions.
- Is the SDI-12 address in the command correct? (See Section 6.2)
- Is the 12V battery good?

7.5 Water in the Transmitter

- Disassemble the Transmitter at an ESD workstation by removing the two flat blade retaining screws. As you remove the two retaining screws, be sure that the Bottom Cap is not pointed at anyone, since the internal pressure caused by the water leakage may blow the Bottom Cap out of the Transmitter body. Rinse the circuit board with distilled water and blow dry with a hair dryer. Clean and light grease o-rings before reassembly.
- Please contact Hydrolab Customer Service if you ever have a leakage problem, even if you are sure you have repaired the Transmitter.

7.6 Water in the Display

- Disassemble the Display at an ESD workstation by removing the Lens, Battery Cap, batteries, and four Phillips retaining screws above and below the LCD. Rinse the circuit board with distilled water and blow dry with a hair dryer. Clean and light grease o-rings before reassembly.
- Please contact Hydrolab Customer Service if you ever have a leakage problem, even if you are sure you have repaired the Display.

8 BILLS OF MATERIAL/EXPLODED DIAGRAMS

8.1 Quanta Display

ITEM #	QTY	PART #	DESCRIPTION
1	1	004489	Case Subassembly, Quanta Display
2	1	004497	Battery Cap Subassembly, Quanta Display (was 04490)
3	1	003894	Spring, Battery Cap, Quanta Display
4	1	003991	O-ring, 1-911, Silicone, 50 Durometer (was 003978, 0.118 x 0.866 Buna-N)
5	1	006316	Board Assembly, Quanta Display
6	1	004488	Panel/Label Subassembly, Quanta Display
7	4	003971	Screw, #6 x 5/8, Panhead, Sheetmetal
8	1	003968	O-ring, 3.984 x .156, Buna-N, 70 Durometer
9	1	003884	Lens, Quanta Display
10	3	000679	"C" Cell Battery
11	1	003906	Harness, Quanta Display
12	1	003873	Connector Cap, Quanta Display
OPTIONAL FEATURES			
OF1a	1	006320	Board Assembly, Quanta Display RTC (not shown)
OF1b	1	014230	Cable, Quanta Display/PC Interface (not shown)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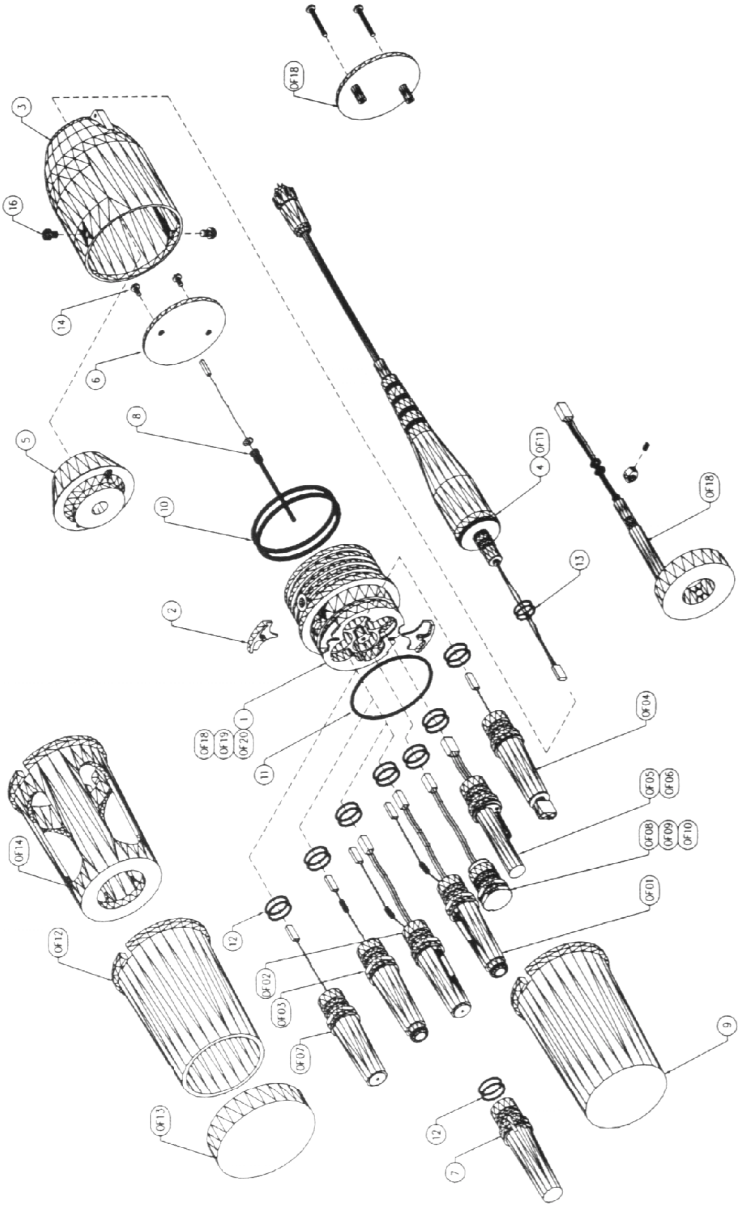
8.2 Quanta Transmitter

ITEM #	QTY	PART #	DESCRIPTION
1	1	003963	Bottom Cap, Quanta Transmitter, Metric (was 003791, small bayonet&#10-32)
2	2	003793	Retainer, Probe, Quanta Transmitter
3	1	003788	Housing, Quanta Transmitter
4	1	018XXX	Penetrator, Non-Vented, Quanta Transmitter
5	1	003877	Nut/Weight, Quanta Transmitter
6	1	006310	Board Assembly, Quanta Transmitter
7	1	003880	Probe Plug, Quanta Transmitter
8	1	004165	Probe Assembly, Temperature
9	1	005200	Storage Cup, Quanta Transmitter (was 003795, small bayonet)
10	2	003860	O-ring, -230, Buna-N, 70 Durometer
11	1	000335	O-ring, -141, Buna-N, 70 Durometer
12	8	000085	O-ring, -016, Buna-N, 70 Durometer (was 003947, 77-614)
13	2	000467	O-ring, -013
14	2	003971	Screw, #6 x 5/8, Panhead, Sheetmetal (was 003988, #4-40 or 000078, #6-32)
15	2	-	- (was 000080, lockwasher)
16	2	003964	Screw, M4 x 0.7 x 7mm, 316SS (was 003878, #10-32)
17	1	003099	Quanta Manual (Not Shown)
18	1	002497	MSDS Packet (Not Shown)
19	1	014720	Quanta Basic Maintenance Kit (Not Shown)
20	1	003879	Box, Quanta (Not Shown)

ITEM #	QTY	PART #	DESCRIPTION
OPTIONAL FEATURES			
OF01	1	004484	Probe Assembly, Conductivity/DO, Quanta Transmitter
OF02	1	004451	Probe Assembly, Conductivity/pH Return, Quanta Transmitter
OF03	1	004486	Probe Assembly, Dissolved Oxygen Only, Quanta Transmitter
OF04	1	004508	Probe Assembly, Circulator, Quanta Transmitter (was 004450)
OF05	1	004453	Probe Assembly, pH/ORP/Reference, Quanta Transmitter
OF06	1	004452	Probe Assembly, pH/Reference, Quanta Transmitter
OF07	1	004487	Probe Assembly, pH Return, Quanta Transmitter
OF08	1	003901	Transducer, 10 Meter, Vented, Quanta Transmitter
OF09	1	003902	Transducer, 25 Meter, Quanta Transmitter
OF10	1	003903	Transducer, 100 Meter, Quanta Transmitter
OF11	1	019XXX	Penetrator, Vented, Quanta Transmitter
OF12	1	005202	Calibration Cup, Quanta Transmitter (was 003796, small bayonet)
OF13	1	000465	Calibration Cup Cap
OF14	1	005201	Sensor Guard, Quanta Transmitter (was 003885, small bayonet)
OF15	1	014740	Quanta Basic/DO/pH Maintenance Kit (Not Shown)
OF16	1	014750	Quanta Basic/pH Maintenance Kit (Not Shown)
OF17	1	014730	Quanta Basic/DO Maintenance Kit (Not Shown)
OF18	2	002295	O-ring, -009, Buna-N, 70 Durometer
	1	002935	Set Screw, #6-32 x 3/16, 18-8 SS
	1	004507	PA, Quanta Turbidity
	1	005272	Conn, 8PF, 2x4 Housing
	2	005292	Screw, #6 x 1, Self-tap, 18-8 SS
	1	005295	Bottom Cap, Mod Turb, Quanta
	1	005316	Retainer, Turbidity, Quanta
	1	006319	Board Assembly, Quanta Turbidity
OF19	1	006501	PA, Quanta LISRef (Not Shown)
			(Replacement LISRef sensor tip is 003333)
	1	006503	Bottom Cap, Mod LISRef, Quanta
OF19a	1	002896	Transducer, 25m, Quanta LISRef (Not Shown)
OF19b	1	002897	Transducer, 100m, Quanta LISRef (Not Shown)
OF19c	1	002899	Transducer, 10m, Vented, Quanta LISRef (Not Shown)
OF20	1	005296	Bottom Cap, Mod Turb/LISRef, Quanta (Not Shown)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OF14

SERVICE and LIMITED 3-YEAR WARRANTY

THIS WARRANTY IS EXPRESSLY MADE BY HYDROLAB CORPORATION AND ACCEPTED BY PURCHASER IN LIEU OF ALL OTHER WARRANTIES, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHETHER WRITTEN OR ORAL, EXPRESS OR IMPLIED, OR STATUTORY. HYDROLAB DOES NOT ASSUME ANY OTHER LIABILITIES IN CONNECTION WITH ANY PRODUCT.

WHAT IS COVERED

This warranty statement applies to the Quanta Transmitter and Quanta Display.

All new Hydrolab Quanta Transmitters and Quanta Displays are warranted by Hydrolab against defects in materials and workmanship for 3 years from date of invoice. Our obligation to repair or to replace products, including dissolved oxygen sensors, does not apply to those that have been consumed through normal use.

WHAT IS NOT COVERED

This warranty does not apply to products or parts thereof which may be used or connected to Hydrolab equipment but which are not manufactured by Hydrolab. This warranty specifically excludes batteries of any type and all other items, such as calibration solutions, which carry shelf lives.

This warranty does not apply to products or parts thereof which have been altered or repaired outside of a Hydrolab factory or other authorized service center, or products damaged by improper installation or application, or subjected to misused, abuse, neglect or accident.

WHAT WE WILL DO

During the warranty period, we will repair or, at our option, replace at no charge a product that proves to be defective provided that you return the product, shipping prepaid, to Hydrolab. Hydrolab's liability and obligations in connection with any defects in materials and workmanship are expressly limited to repair or replacement, and your sole and exclusive remedy in the event of such defects shall be repair or replacement.

Hydrolab's obligations under this warranty are conditional upon it receiving prompt written notice of claimed defects within the warranty period and its obligations are expressly limited to repair or replacement as stated above.

WHAT WILL WE NOT DO

Hydrolab shall not be liable for any contingent, incidental, or consequential damage or expense incurred by you or others due to partial or complete inoperability of its products for any reason whatsoever or due to any inaccurate information generated by its products. Hydrolab's obligations and your remedies are limited as described above.

Products are sold on the basis of specifications applicable at the time of sale. Hydrolab Corporation shall have no obligation to modify or update products once sold.

WARRANTY AND SERVICE INFORMATION

If you have any questions concerning this warranty, please call Hydrolab by telephone, fax, letter, or e-mail, at Hydrolab Corporation 8700 Cameron Road, Suite 100, Austin, Texas, 78754, USA; telephone: 800-949-3766 or 512-832-8832; fax: 512-832-8839; e-mail: techsupport@hydrolab.com.

Should you be advised by Hydrolab to return an item, a returned materials authorization number (RMA Number) will be issued. The RMA number must be shown on the Service Memorandum, the address label of each shipping carton, and any correspondence related to the equipment returned for repair.

Please carefully pack your equipment in its original shipping case (or other protective package) to avoid in-transit damage. Such damage is not covered by warranty, so we suggest that you insure the shipment. We also recommend that the entire instrument, including the battery pack and charger (when applicable), be returned unless a particular faulty component has been clearly isolated.

Send the instrument and a complete Service Memorandum to Hydrolab, using the address shown on the Service Memorandum.

Whether or not the unit is under warranty, it is your responsibility to pay shipping charges for delivery to Hydrolab.

APPENDIX F

LAMOTTE DO KIT MANUAL

DISSOLVED OXYGEN TEST KIT

CODE 5860

For determining the dissolved oxygen content of water, this test kit uses the azide modification of the Winkler Method and employs a LaMotte Direct Reading Titrator in the final titration.

QUANTITY	CONTENTS	CODE
30 mL	*Manganous Sulfate Solution	*4167-G
30 mL	*Alkaline Potassium Iodide Azide	*7166-G
30 mL	*Sulfuric Acid, 1:1	*6141WT-G
60 mL	*Sodium Thiosulfate, 0.025N	*4169-H
30 mL	Starch Indicator Solution	4170WT-G
1	Direct Reading Titrator, 0 - 10	0377
1	Titration Tube, 20 mL, w/cap	0299
1	Bottle, Water Sampling, 60 mL, glass	0688-DO

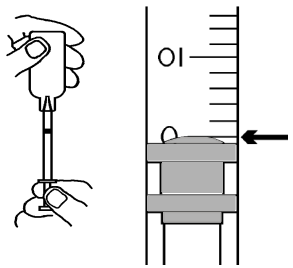
***WARNING:** Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

To order individual reagents or test kit components, use the specified code number.

NOTE: A Check Standard is needed to perform an "EPA Accepted" test.

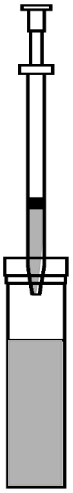
DIRECT READING TITRATOR INSTRUCTIONS

1. Fill the titration tube to 20 mL line with sample water.
2. Add the reagents as specified in the test procedure. Cap the tube with the special titration tube cap. Mix by swirling gently.
3. Depress the plunger of the Titrator to expel air.
4. Insert the Titrator into the plastic fitting of the titrating solution bottle.



5. To fill the Titrator invert the bottle and slowly withdraw the plunger until the bottom of the plunger is opposite the zero mark on the scale.

NOTE: A small air bubble may appear in the Titrator barrel. Expel the bubble by partially filling the barrel and pumping the titrating solution back into the inverted reagent container. Repeat this pumping action until the bubble disappears.



6. Turn the bottle right-side-up and remove the Titrator.

7. Insert the tip of the Titrator into the opening of the titrator tube cap. Slowly depress the plunger to dispense the titrating solution. Gently swirl tube to mix. A slight rotating or twisting motion may permit the plunger to move more smoothly.

8. Continue adding the titrating solution until the specified color change occurs. If no color change occurs by the time the plunger tip reaches the bottom of the scale, refill the Titrator to the zero mark. Continue the titration. Include both titration amounts in the final test result.

9. Read the test result directly from the scale opposite the bottom of the plunger tip.

10. If no additional tests are to be made, discard the titrating solution in the Titrator. Thoroughly rinse the Titrator and the titration tube.

NOTE: The plunger tip should periodically be coated with silicon grease.

COLLECTION & TREATMENT OF THE WATER SAMPLE

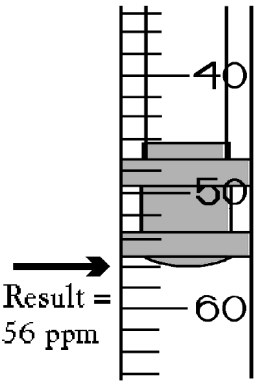
Step 1 through 4 below describe proper sampling technique in shallow water. For sample collection at depths beyond arm's reach, special water sampling apparatus is required (e.g., the LaMotte Water Sampling Chamber, Code 1060; Model JT-1 Water Sampler, Code 1077; Water Sampling Outfit, Code 3103; or Code 3-0026 Water Sampling Bottle).

1. To avoid contamination, thoroughly rinse the Water Sampling Bottle (0688-DO) with sample water.

2. Tightly cap the bottle and submerge to the desired depth. Remove cap and allow the bottle to fill.

3. Tap the side of the submerged bottle to dislodge any air bubbles clinging to the inside. Replace cap while the bottle is still submerged.

4. Retrieve bottle and examine it carefully to make sure that no air bubbles are trapped inside. Once a satisfactory sample has been collected, proceed immediately with Steps 5 & 6 to "fix" the sample.



NOTE: Be careful not to introduce air into the sample while adding the reagents in Steps 5 & 6. Simply drop the reagents into sample. Cap carefully, and mix gently.

5. Add 8 drops of *Manganous Sulfate Solution (4167) and 8 drops of *Alkaline Potassium Iodide Azide (7166). Cap and mix by inverting several times. A precipitate will form. Allow the precipitate to settle below the shoulder of the bottle before proceeding.

6. Add 8 drops of *Sulfuric Acid, 1:1 (6141WT). Cap and gently mix until the precipitate has dissolved. A clear-yellow to brown-orange color will develop, depending on the oxygen content of the sample.

NOTE: Following the completion of Step 6, contact between the water sample and the atmosphere will not affect the test result. Once the sample has been "fixed" in this manner, it is not necessary to perform the actual test procedure immediately. Thus, several samples can be collected and "fixed" in the field, and then carried back to a testing station or laboratory where the test procedure is to be performed.

TEST PROCEDURE

1. Fill the titration tube (0299) to the 20 mL line with the "fixed" sample and cap.
2. Fill the Direct Reading Titrator (0377) with *Sodium Thiosulfate, 0.025N (4169). Insert the Titrator into the center hole of the titration tube cap. While gently swirling the tube, slowly press the plunger to titrate until the yellow-brown color is reduced to a very faint yellow.

   NOTE: If the color of the "fixed" sample is already a very faint yellow, skip to Step 3.
3. Remove the Titrator and cap. Be careful not to disturb the Titrator plunger, as the titration begun in Step 2 will be continued in Step 4. Add 8 drops of Starch Indicator Solution (4170WT). Sample should turn blue.
4. Replace the cap and Titrator. Continue titrating until the blue color just disappears. Read the test result where the plunger tip meets the scale. Record as ppm dissolved oxygen.

   NOTE: Each minor division on the Titrator scale equals 0.2 ppm.

   NOTE: If the plunger tip reaches the bottom line on the Titrator scale (10 ppm) before the endpoint color change occurs, refill the Titrator and continue the titration. When recording the test result, be sure to include the value of the original amount of reagent dispensed (10 ppm).

LaMOTTE COMPANY

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APPENDIX G

FIELD DATA SHEET

Friends OF THE Bay
Working to keep the oyster in Oyster Bay

FUSS & O'NEILL
Disciplines to Deliver

Stream and Outfall Field Data Sheet

Location ID:	Lat: Long:
Location Name:	Precipitation in previous 72 Hours: _____
Sample ID:	Start Date/Time of Precipitation: _____/_____
Date: Time: Sampler:	Total Storm Event Precipitation: _____

Location Sketch:

Wet or Dry Event:

Description of Flow (circle one or estimate):

Dry Stagnant Trickle Moderate Heavy Est. Rate: _____CFS

Est. Method (circle or name): Area-Rate Volume/Time Other:

Indicator	Check if Present	Description	1 = slight to 3 = severe
Odor	☐		
Color	☐		
Turbidity	☐		
Floatables	☐		

Appearance:

Comments:

Container	Quantity	Preservative

Field Parameters:

Parameter	Instrument	Result	QA/QC Performed?	Method	Result	Note
DO						
Specific Conductance						
pH						
Temperature						

Comments:

APPENDIX H

ELECTRONIC DATA FORMAT

FUSS & O'NEILL

Friends of the Bay Stream and Outfall Water Quality Monitoring Results

GENERAL							QUALITATIVE				FIELD PARAMETERS					BACTERIA		NUTRIENTS				PHYSICAL				METALS							QA/QC		HARDNESS - DEPENDENT STANDARD						NOTE
Sample ID	Location Description	Sampling Round	Wet or Dry Weather Event	Event Precipitation	Sample Collection Date	Sample Collection Time (Field Data Sheet)	Odor (0-3)	Color (0-3)	Particulate (0-3)	Floatables (0-3)	D.O., mg/L	Spec. Cond. (mS/cm)	pH	Temperature, °C	Estimated Flow Rate (cfs)	E. Coli, /100 mls.	Fecal Coliform, /100 mls.	Ammonia as N, mg/L	Nitrate as N, mg/L	TKN, mg/L	Phosphorus as P, mg/L	BOD, mg/L	COD, mg/L	TSS, mg/L	Turbidity, NTU	Hardness as CaCO3, mg/L	Lead, mg/L	Copper, mg/L	Zinc, mg/L	Magnesium, mg/L	Calcium, mg/L	Alkalinity as CaCO3, mg/L	D.O., mg/L	D.O. RPD (%)	Lead, mg/L EPA CMC (acute)	Lead, mg/L EPA CCC (chronic)	Copper, mg/L EPA CMC (acute)	Copper, mg/L EPA CCC (chronic)	Zinc, mg/L EPA CMC (acute)	Zinc, mg/L EPA CCC (chronic)	
Standard 6 NYCRR 703											4	780	6.5 - 8.5	32.2	-	-	-	TABLE	10 mg/L	mg/L - Nitr	-	-	-	-	-	-	CALC	CALC	CALC	-	-	-								
Sample											8															30.00							6.5	20.7	0.0256	0.0010	0.0043	0.0032	0.0422	0.0297	
OBS-1																																	n/a							
OBS-2																																	n/a							
OBS-3																																	n/a							
OBS-4																																	n/a							
OBS-5																																	n/a							
OBS-6																																	n/a							
OBS-7																																	n/a							
OBS-8																																	n/a							
OBS-9																																	n/a							
OBS-10																																	n/a							
Field Duplicate																																	n/a							
Reporting Limit																																	n/a							
Standard Reported																																	n/a							

Ammonia					
Classes A, A-S, AA, AA-S, B, C without the (T) or (TS)					
pH	**0°C**	**5°C**	**10°C**	**15°C**	**20-30°C**
6.5	0.7	0.9	1.3	1.9	2.6
6.75	1.2	1.7	2.3	3.3	4.7
7	2.1	2.9	4.2	5.9	8.3
7.25	3.7	5.2	7.4	11	15
7.5	6.6	9.3	13	19	26
7.75	11	15	22	31	43
8.0-9.0	13	18	25	35	50

APPENDIX I

OUTFALL INVENTORY FORM

Friends OF THE Bay
Working to keep the oyster in Oyster Bay

FUSS & O'NEILL
Disciplines to Deliver

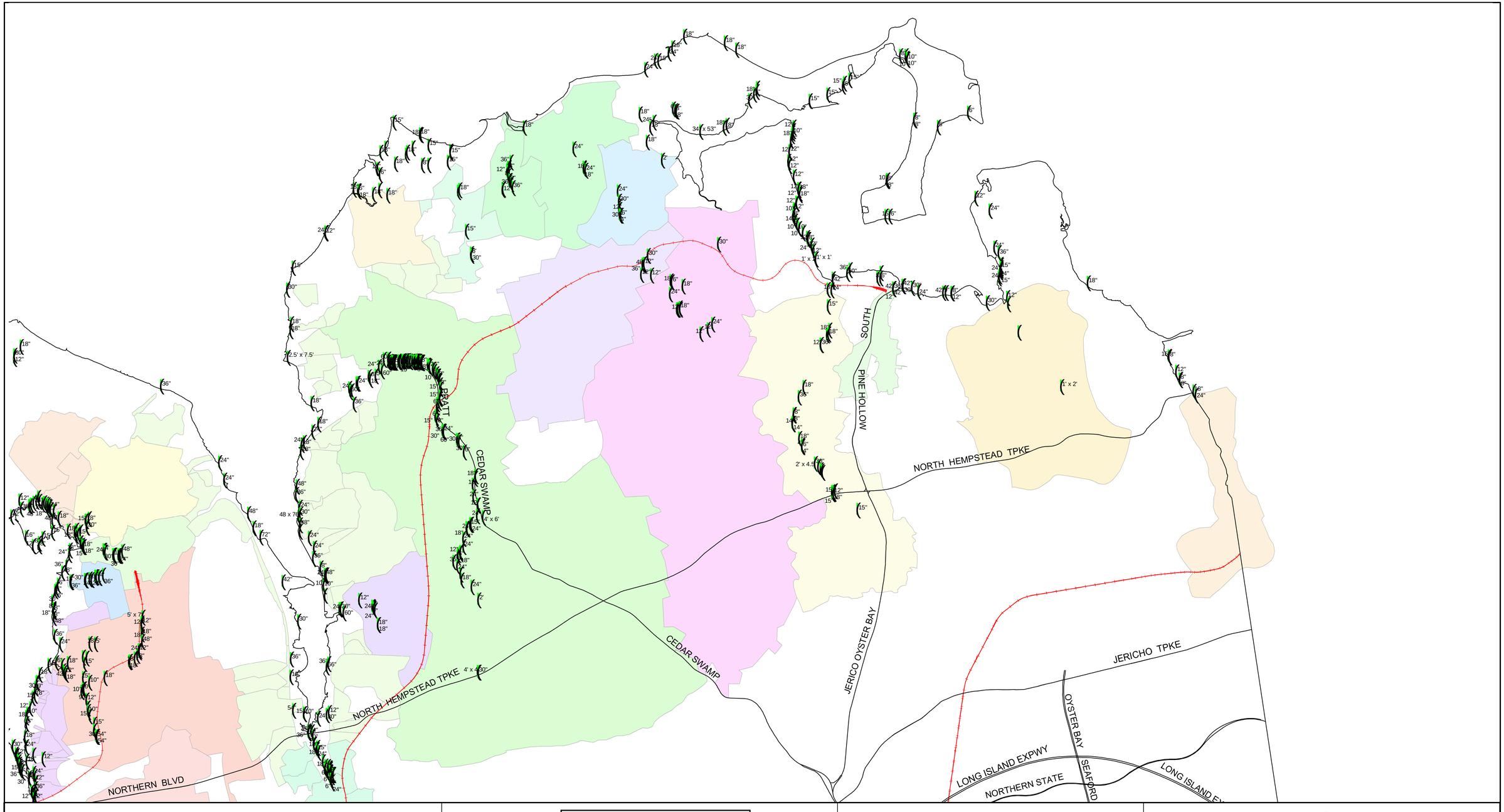
Outfall Inventory Form

Complete one row of the table below per outfall. Perform the calculation in the "RESULT" column. If a result is zero (e.g. no flow was observe) revisit the outfall during a rain event and re-evaluate. Select the highest-ranked outfall as the next rotating outfall for the stream and monitoring program.

				A	B	C	D	E	F	G	RESULT
Outfall ID	GPS Coords	Type (pipe, swale, etc)	Dimensions	Flow Observed	Has it rained in the previous 24 hours?	Flow Rate	Color	Suspended Material	Odor	Floatables (grease, foam, trash)	Perform the following operations and place result in this column AxBx(C+D+E+F+G)
	(Lat/Long)		(inches)	0 = no 1 = yes	1 = yes 2 = no	0= no flow 5 = flowing full	0 = none 5 = dark	0 = clear 5 = opaque	0 = none 5 = strong	0 = none 5 = surface obscured	

APPENDIX J

NASSAU COUNTY OUTFALL MAP



Legend

Drainage Outfall
Railroad

Drainage Areas

- BAILEY ARBORTUM
- BALDWIN DRAIN
- BAXTER BROOK
- BEDELL CREEK
- BELLMORE CREEK
- CAMMANS CREEK
- CARMANS CREEK
- CEDAR CREEK
- CEDAR SWAMP CREEK
- CHRISTOPHER MORLEY PARK
- CLEAR STREAM
- CLEMENTS BROOK
- COLD SPRING HARBOR
- CUTTER MILL BROOK
- DOSORIS
- DOXEY BROOK
- EAST MEADOWBROOK
- ELMONT DRAIN
- FORTESQUE CREEK
- FOSTERS BROOK
- FRANCIS POND
- FREEPORT BROOK
- FROST CREEK
- GRAND CANAL
- GRANT POND
- HEMPSTEAD HARBOR
- HOOK CREEK
- HORSE BROOK
- KENTUCK BROOK
- KINGS POINT
- LAKE SUCCESS
- LEEDS POND
- LITTLE NECK BAY
- MACY CHANNEL
- MANHASSET BAY
- MANHASSET VALLEY PARK
- MASSAPEQUA CREEK
- MILBURN CREEK
- MILL CREEK
- MILL NECK CREEK
- MILL POND
- MITCHELLS CREEK
- MOTT CREEK
- NARRASKATUCK CREEK
- NEWBRIDGE CREEK
- PARSONAGE CREEK
- PINES BROOK
- POWELLS CREEK
- RANDALLS BAY
- ROSLYN POND
- SCUDDERS POND
- SEAFORD CREEK
- SEAMANS CREEK
- SHEETS CREEK EAST
- STANNARDS BROOK
- THIXTON CREEK
- TIFFANY BROOK
- UDALLS MILL POND
- UNQUA CREEK
- VALLEY STREAM
- WELWYN
- WEST BRANCH UNQUA
- WEST END CANAL
- WHITE'S CREEK
- WHITNEY POND
- WILLOW POND
- WOODCLIFF BASIN
- WOODMERE CHANNEL
- YORKSHIRE BROOK

Map Location

OYSTER BAY HARBOR AND VICINITY

Prepared By: - NCDPW - Water/Wastewater Engineering Unit

Not to Scale

Nassau County

Geographic Information System

Date: 11/29/2004