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January 23, 2009

Mr. Joseph LeMay, P.E.
EPA Region 1
Office of Site Remediation and Restoration (OSRR)
MA Superfund Section
One Congress Street, Suite 1100
Mail Code HBO
Boston, MA 02114-2023

Subject: United States of America v. Bayer CropScience Inc. and Pharmacia Corporation, D. Ma. (Civ. Action No. 1:08-cv-10325)

Dear Mr. LeMay:

Pursuant to Paragraph 39(a) of the Consent Decree entered in the above-referenced matter, and also pursuant to Section V.A.3 and related portions of the Statement of Work (SOW) attached as Appendix D to the Consent Decree, enclosed please find five (5) copies and one electronic word processing file of the revised Surface Water Monitoring Plan (SWMP).

The Settling Defendants submitted a first draft of the SWMP to EPA on May 23, 2008. EPA issued its comments on the draft SWMP on November 20, 2008. In a letter dated December 16, 2008, EPA clarified the procedural status of the SWMP, and directed the Settling Defendants to submit a revised SWMP by January 15, 2009. In a phone conversation between the undersigned and Joseph LeMay on January 15, 2009, EPA extended the deadline for submitting the revised SWMP to January 23, 2009.

The SWMP has been revised in response to the following correspondence and discussions:

- "Industri-plex OU-2: EPA Comments on Draft SWMP," dated November 20, 2008
- "Industri-plex OU-2: EPA Comments on Draft SWMP," dated December 16, 2008

- Meeting between the undersigned, Settling Defendants' consultants, Joseph LeMay, and EPA consultants on January 9, 2009

- "Industri-plex OU-2: EPA responses to PRP 12-19-08 responses on Draft SWMP," dated January 14, 2009

- Conference call between the undersigned, Settling Defendants' consultants, Joseph LeMay and EPA Consultants on January 16, 2009

In connection with EPA's comments of November 20, 2008, the Settling Defendants have limited their revisions to the specific SWMP-related comments, and have not addressed EPA's stated concerns related to sampling or remedial program purposes or objectives, as these matters do not affect the implementation of the SWMP. We do this to promote your expeditious review and approval of this plan, and specifically reserve our rights to dispute these issues, including but not limited to your response to comments RC 1 and 17, at a later time and in the appropriate forum.

As reflected in the enclosed documents, the Settling Defendants have agreed to make the following modifications to the surface water monitoring program suggested by EPA:

- The SWMP will include the set-up of two auto-samplers, each fitted with a "rosette" of 24 1-liter containers at each monitoring station. One of the Isco units will serve as the primary sampler, while the secondary sampler will be used as a backup in case of sample failure in the primary unit. Please note the second set of 10 Isco units, the rosette samplers, and sample collection bags have been ordered, but based on our communication with Isco, delivery is not expected until February 8, 2009. Currently, each of sampling stations is set up with a single Isco unit, each with a single compositing vessel. The second units and rosettes will be installed as soon as possible.

- Storm sampling at each station will be "flow-paced." Intervals for each station and storm will be determined by dividing the projected station-specific total storm runoff by 40, such that 20 of the 24 sample containers in each rosette are filled over the course of the storm runoff event with two 400-milliliter aliquots each. Details of how this number of aliquots was determined are in the revised Field Sampling Plan. The remaining four containers (eight sample aliquots) will be reserved in case the storm is larger than expected. If necessary, we will be prepared to replace the sampling rosettes so that a significantly longer duration storm will be adequately monitored.

Please contact me at (860) 298-0541 if you have any questions.

Sincerely,

Bruce Thompson
Project Coordinator

Enclosures: Surface Water Monitoring Plan

cc: Jennifer McWeeney, MassDEP
Settling Defendants
Larry McTiernan, P.G. – Roux Associates

DRAFT

SURFACE WATER MONITORING PLAN

Industri-Plex Superfund Site Operable Unit 2
(including Operable Unit 3 of the Wells G&H Superfund Site)
Woburn, Massachusetts

Prepared by:

ROUX ASSOCIATES, INC.
67 South Bedford Street, Suite 101W
Burlington, Massachusetts 01803

January 23, 2009

ROUX

IPS1194.0001M007.100/RCv

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PLATE

1. GEMS Relational Database Model Flow Chart

Disclaimer – This document is a DRAFT document prepared by the Settling Defendants under a government Consent Decree. This document has not undergone formal review by the U.S. Environmental Protection Agency (EPA) or the Massachusetts Department of Environmental Protection (MassDEP). The opinions, findings, and conclusions expressed are those of the author and not those of the EPA or the MassDEP.

1.0 INTRODUCTION

Pursuant to the Consent Decree for Remedial Design/Remedial Action (Civil Action No. 1:08-cv-10325) and the Remedial Design/Remedial Action (RD/RA) Statement of Work (SOW) for Operable Unit 2 (OU 2) at the Industri-Plex Superfund Site (including Operable Unit 3 of the Wells G&H Superfund Site) in Woburn, Massachusetts (hereinafter, "Industri-Plex OU 2" or "Site"; see Figure 1), and on behalf of Pharmacia Corporation by its Attorney-in-Fact Monsanto Company and Stauffer Management Company LLC as litigation agent for Bayer CropScience Inc. (Settling Defendants), this Surface Water Monitoring Plan (SWMP) has been prepared to describe the surface water monitoring program to be conducted as part of the Initial Remedial Steps Phase of the Industri-Plex OU 2 RD. The objectives of this surface water monitoring program, as stated in the RD/RA SOW, are to develop data with which to monitor surface water trends and demonstrate compliance during implementation of the Industri-Plex OU 2 remedy. In accordance with the RD/RA SOW, the surface water monitoring program proposed in this SWMP will be conducted until a long-term monitoring program is implemented at Industri-Plex OU2 pursuant to a separate Final Environmental Monitoring Plan to be developed subsequently pursuant to Section VI.H of the RD/RA SOW.

The overall scope of the SWMP and the various work elements involved are described herein. Specific procedures to be followed when performing field, laboratory, and analysis work associated with the SWMP are detailed in the following site-specific plans prepared to support the SWMP:

- Site Management Plan (Appendix A)
- Sampling and Analysis Plan, comprising a Quality Assurance Project Plan (QAPP, Appendix B) and Field Sampling Plan (FSP, Appendix C)
- Health and Safety Plan (Appendix D)

Together, these plans constitute the Project Operations Plan for the SWMP.

2.0 SCOPE OF THE SWMP

In the RD/RA SOW (page 21), the SWMP is described as follows:

> *"The [SWMP] shall consist of monthly baseflow surface water sampling and quarterly storm flow sampling. The location and frequency of sampling shall be consistent with the monitoring conducted during the Remedial Investigation. The [SWMP] shall include all monitoring and analyses necessary to satisfy the surface water monitoring outlined in the [Record of Decision] and shall be generally consistent with the monitoring conducted during the [Remedial Investigation/Feasibility Study]. It shall continue until the implementation of the Operation & Maintenance Plan, which shall include Long-Term Environmental Monitoring (much of the surface water monitoring will continue under Operation and Maintenance). The data shall be utilized to monitor surface water trends and demonstrate compliance during implementation of the remedy."*

Accordingly, the SWMP as proposed herein will comprise monitoring at ten stations along Halls Brook and the Aberjona River at and downstream of Industri-Plex OU 2, with each station equipped for 1) the continuous monitoring of rainfall, stream depth and velocity, and six water chemistry parameters (water temperature, specific conductance, dissolved oxygen concentration, pH, oxidation-reduction potential [ORP], and turbidity) and 2) the automated collection of surface water samples during selected storm events (with "storm" defined as a precipitation event yielding at least one inch of generally continuous rainfall). The ten stations to be monitored under the SWMP include the eight Remedial Investigation/Feasibility Study (RI/FS) monitoring stations north of the Mystic Lakes (Stations 1 through 8, see Figure 2)[1] plus two additional stations located upstream of the Halls Brook Holding Area (HBHA) Pond, shown in Figure 3. The first of the two additional stations, designated SW-2-IP, is located in the Atlantic Avenue Drainway (AAD), at the same point monitored by Roux Associates during performance of the Final Groundwater and Surface Water Investigation Plan (GSIP) SOW.[2] The other,

[1] The RI/FS surface water monitoring stations were formally identified as SW-01-TT, etc; however, as was the convention adopted for the RI/FS report, the stations are herein identified as Station 1, etc.

[2] The designations given to Roux Associates' Final GSIP stations in the RI Report have been adopted herein to facilitate comparison of SWMP data with previous data.

designated SW-3-IP, is located in the ephemeral tributary stream draining the Boston Edison Company (BECO) right-of-way (ROW), just upstream of the location monitored by Roux Associates during performance of the Final GSIP SOW.[3]

In accordance with the RD/RA SOW, the SWMP will include sampling of surface water under both baseflow and storm conditions. Baseflow samples will be collected monthly while storm samples will be collected during four storms per year, on a roughly quarterly basis (i.e., separated to the extent possible to include each of the four seasons). In addition, to ensure that "large" storms (i.e., more than 2 inches of rainfall) are not missed, supplemental storm sampling may be conducted if a large storm occurs after the storm samples have already been collected for a given quarter.

All baseflow samples will be collected as discrete grab samples, while storm samples will be flow-weighted composites comprising multiple aliquots collected over the duration of a storm runoff event at a volume-based frequency (i.e., proportional to stream flow).[4] Stream flow at each station will be computed real-time using the automated sampling equipment and, for most stations, the station-specific rating curves established during the RI/FS. For new monitoring station SW-2-IP and any stations where the RI/FS rating curve is no longer valid because the stream profile has changed significantly since the RI/FS, new rating curves will be developed. In the interim (i.e., until new curves are developed), flow at these stations will be computed either using the old rating curves (with the understanding that computed stream flows may not be accurate) or using the area-velocity approach, wherein flow is computed by the automated sampling equipment based on level-to-area relationships established for the station (i.e., the respective cross-sectional areas of stream flow associated with incremental increases in stream stage [level]) and flow velocity. At station SW-3-IP, which is subject to backwater from the HBHA Pond during storms, flow will always be computed using the area-velocity approach since, once backwater enters the channel, flow is no longer proportional to stage in the same manner it is under free-flowing conditions.

[3] The Final GSIP SOW monitoring station for the BECO ROW tributary was subject to backflow from the HBHA Pond during storms; the station has been moved upstream to delay/minimize backflow effects.

[4] The frequency at which aliquots are collected will vary from station to station, but at all stations, aliquots will be collected most frequently when stream flow is highest (i.e., during the peak of the storm hydrograph).

All storm and baseflow samples will be analyzed for arsenic (total and dissolved), benzene, ammonia, nitrate, nitrite, total kjeldahl nitrogen (TKN), and total suspended solids (TSS). In addition, samples collected at the four stations surrounding the HBHA Pond (Station 1 [Halls Brook], SW-2-IP [AAD], SW-3-IP [BECO ROW], and Station 2 [HBHA Pond outlet]) will also be analyzed for total and dissolved (ferrous) iron.

3.0 SWMP WORK ELEMENTS

The SWMP surface water monitoring program includes the following five tasks:

- Task 1 – Monitoring Station Set-Up
- Task 2 – Preliminary Stage-Response Evaluation
- Task 3 – Water-Quality Monitoring
- Task 4 – Weekly Operations & Maintenance (O&M)
- Task 5 – Monthly O&M

Each task is described below. More detailed discussions of the analytical methodologies and QA/QC guidelines for implementation of the SWMP are discussed in Appendix B, while the associated field procedures are presented in the Field Sampling Plan (Appendix C).

3.1 Task 1 – Monitoring Station Set-Up

As was done during the RI/FS surface water monitoring program, each of the SWMP surface water monitoring stations will be equipped with two Isco Model 6712 automated water-quality samplers, each fitted with a "rosette" of 24 1-liter sample containers.[5] One of the Isco units will serve as the primary sampler, while the secondary sampler will be used as a backup in case of sample failure in the primary unit. The two units will be linked via a communication cable, and the backup Isco unit at each station will be programmed to function as a "slave" to the primary unit (i.e., to collect a sample whenever the primary unit collects a sample). The primary Isco sampler will be augmented with an Isco Model 750 area-velocity module to automatically compute flow based on rating curves or area-velocity measurements. The area-velocity module includes a low-profile water level and velocity sensor, which will be mounted on a steel plate or concrete block set onto (and partially into, to the extent possible) the stream bed in the deepest part of the stream channel.[6] Each station will also feature a dedicated In-Situ® MP Troll® 9500 multi-parameter water quality meter with probes to measure water temperature, specific conductance, dissolved oxygen concentration, pH, ORP, and turbidity. The In-Situ® MP Troll® 9500 will be mounted directly in the channel in close proximity to, but not directly upstream of, the flow sensor.

[5] To avoid the potential for cross-contamination, single-use, disposable Isco ProPak® sample bags will be used for sample collection. These bags are made of 3-mil-thick, low-density polyethylene (LDPE) and are inserted into re-usable bag holders that do not come into contact with the sample.

[6] Prior to installing any equipment in the stream channel, all vegetation, debris, and large stones will be removed to make the stream cross-section as uniform as possible.

As was done during the RI/FS surface water monitoring program, SWMP storm samples will be collected using an intake device designed to permit the collection of depth-integrated surface water samples (i.e., samples representative of the total water column). This intake device will consist of an appropriate length of 1.5-inch-diameter, slotted PVC pipe[7] mounted on a fence post driven into the stream bed as close as possible to the Isco Model 750 flow sensor. Quarter-inch intake slots will be cut on opposite sides of the pipe at half-inch intervals throughout the entire length of the pipe to minimize velocity-induced bias effects, and a "tee" will be attached to the base of the slotted pipe to prevent sediment accumulation within the pipe between sampling periods. Suction lines feeding the two Isco samplers at each station will be attached near the base of the intake device to minimize potential bias from bed load sediments during high discharge conditions and to preclude the suction of air during low-flow conditions. The desired aliquot volumes will be programmed into the Isco units during station set-up, and the Isco units will be calibrated to ensure that actual suction volumes match the desired aliquot volume.

A staff gage and, if necessary, piezometer will also be installed in the stream channel at each monitoring station to enable comparison of surface water and groundwater levels at each station during baseflow and, when practicable, storm conditions. Piezometers installed during the RI/FS will be used if still extant and in good condition. If necessary to install new piezometers, they will consist of a 2-foot-long section of 1.5-inch-diameter steel screen threaded to a 5-foot long section of blank steel pipe and will be driven 3 feet into the streambed using a hand-held vibratory hammer. The top of each piezometer and staff gage will be surveyed relative to an arbitrary benchmark established at the concrete pad for that station (= 100 feet). The cross-sectional stream profile at each monitoring station will also be surveyed relative to the station benchmark in order to establish the level-to-area relationships for that station and to provide a baseline for the elevation of the Model 750 level sensor.

The Isco 6712 units will be housed in a heavy-duty plastic shelter mounted on a concrete pad as close as possible to the flow-monitoring equipment and sample intake. The concrete pad will be surrounded by 6-foot-high, chain-link fencing with a locking gate.[8] An Isco Model 674 tipping-bucket rain gauge and a 40-watt solar panel will be mounted on extensions of the corner posts of

[7] The appropriate length of the pipe will be determined during Task 2 – Preliminary Stage-Response Evaluation.
[8] To the extent possible, the Settling Defendants will utilize the security enclosures used during the RI/FS or those built by Roux Associates during implementation of the Final GSIP SOW.

the security enclosures, and all nearby vegetation will be pruned as needed to preclude interference with the operation of the rain gauge. All cabling and sample tubing will be run in steel conduit to prevent vandalism or damage from rodents. The Isco 6712s will be programmed to measure stream level and velocity and the various water chemistry parameters at 5-minute intervals (with data recorded at 15-minute intervals), and precipitation (if any) continuously. Although the 6712's extended on-board memory is capable of storing these data for up to six months at the specified recording frequency, the stored data will be retrieved weekly using an Isco Model 581 rapid transfer device (RTD) or via remote telemetry, and the downloaded data will be reviewed after retrieval using Isco's Flowlink® software to monitor system performance.

3.2 Task 2 – Preliminary Stage Response Evaluation

Once the monitoring stations have been established, a preliminary stage-response evaluation will be conducted, during which hydrographs recorded during the RI/FS and Final GSIP SOW surface water monitoring programs will be reviewed to ascertain the range and rate of stage increases and the various runoff totals observed at each station. This information will be used to determine, respectively, the appropriate length of the sample intake at each station,[9] the range of flow-pacing intervals (i.e., the volume of runoff passing per sample aliquot) to be used for auto-sampling,[10] and appropriate stage-related sampling triggers.[11] In addition, the SWMP contractor will compare the cross-sectional stream profiles developed during Task 1 with those developed during the RI/FS. As discussed in Section 2.0, if the profiles are comparable, then the rating curves developed during the RI/FS will be deemed valid for the SWMP; alternatively, new rating curves will be developed.

Once the existing data have been reviewed, the Isco 6712 samplers at the six stations located in or surrounding the HBHA Pond and Wetland (i.e., Stations 1 through 4, SW-2-IP, and SW-3-IP) will be programmed to 1) begin automated sampling upon the measurement, over a one-hour period of time, of 0.01 inch of rainfall and a station-specific stage increase[12] and 2) to continue sampling at station- and storm-specific flow-pacing intervals over the duration of the resulting

[9] The intake length will be based on maximum stage observed at each station.
[10] The flow-pacing intervals will be based on the range of total runoff volumes observed at each station.
[11] Commencement of sampling will be based, in part, on the rate at which stage typically increases at each station following onset of precipitation.
[12] If the stage increase trigger results in a portion of the rising limb being missed, use of the stage trigger will be reconsidered.

runoff event (i.e., during both the rising and falling limbs of the storm hydrograph).[13] Flow-pacing intervals for each station and storm will be determined by dividing the projected station-specific total storm runoff by 40, such that 20 of the 24 sample containers in each rosette are filled over the course of the storm runoff event with two 400-milliliter aliquots each (i.e., a total of 40 aliquots).[14] A composite sample will be considered acceptable if it contains at least 30 aliquots and no more than three consecutive aliquots are "missing" (see QAPP for procedure for determining whether aliquots are "missing"). Based on the analysis of site-specific dissolved arsenic data using EPA protocols,[15] this requirement will yield a concentration that is accurate within 20% of the true mean.

The primary Isco units at the six stations located in or surrounding the HBHA Pond and Wetland will also be programmed to notify the SWMP contractor via cellular telephone when sampling has been triggered, whereupon the contractor will remotely activate the auto-samplers at the four downstream stations (Stations 5 through 8), which will also have been programmed for continuous sampling at station- and storm-specific flow-pacing intervals over the duration of the runoff event.

3.3 Task 3 – Water-Quality Monitoring

As discussed in Section 2.0, surface water sampling under the SWMP will be conducted monthly under baseflow conditions and during four storms per year on a roughly quarterly basis, with additional sampling as needed for substantial storms. Baseflow sampling will commence following EPA approval of the SWMP, while storm sampling will commence following the completion of the preliminary stage-response evaluation (Task 2).

3.3.1 Baseflow Sampling

Baseflow samples will be collected as grab samples pursuant to the methodology described in the FSP (Appendix C), beginning at Station 8 and working upstream. Sampling will be scheduled for the first full week of each month whenever possible, but, as during the RI/FS, will not occur

[13] Actually, only the primary unit will be programmed as described since, as discussed in Section 3.1, the backup Isco units will function as "slaves" to the primary unit and, hence, will be programmed simply to collect a sample whenever the primary unit collects a sample.

[14] The extra four containers in each rosette will be kept in reserve in case storm runoff is slightly higher than projected.

[15] See EPA 821-B-02-001; EPA 600/2-79-161; WEF Manual of Practice No. 23 (1998); ASCE Manual and Report on Engineering Practice No. 87 (1998); Assessment of Efficient Sampling Designs for Urban Stormwater Monitoring (SCCWRP, 1999); and Caltrans Stormwater Monitoring Protocols 2003

within 3 to 5 days of precipitation events large enough to cause changes in stream stage. Prior to mobilization to the field for baseflow sampling, stream water levels will be evaluated using remote telemetry to ensure that water levels are generally stable (i.e., not still falling from a past storm event). Baseflow samples from all stations will be analyzed for arsenic (total and dissolved), benzene, ammonia, nitrate, nitrite, TKN, and TSS, with appropriate quality control (QC) sampling as described in the QAPP (Appendix B) and FSP (Appendix C). Samples from Stations 1 and 2, SW-2-IP, and SW-3-IP will also be analyzed for total and dissolved (ferrous) iron.

During the first year of sampling, manual measurements of stream flow will be made at the time of baseflow sampling to verify the Isco flow measurements and to develop additional data that may be used to refine the rating curves for each station, for example if the RI/FS rating curve lacks flow data for a particular stage. Manual measurement of flow will be conducted according to the U.S. Geological Survey's partial section method, described in the FSP (Appendix C). Depth-to-water measurements will also be made at all piezometers during monthly baseflow sampling, and stream stage will be read off the staff gages. These data will be used to determine the relative surface water and groundwater elevations at each station during each baseflow sampling event.

3.3.2 Storm Sampling

Storm samples will, for the most part, be collected using the Isco 6712 automated samplers, utilizing flow-pacing criteria selected during the preliminary stage-response evaluation. If storm-sampling is initiated, but it is later determined that less than the anticipated amount of rain fell during the storm, automated sampling will be remotely terminated and all samples will be discarded. For storms of sufficient magnitude, sampling will be terminated when stream flow has decreased to a rate roughly two times the flow rate prior to the storm, and the multiple aliquots collected at each station will be composited according to the procedure described in the FSP (Appendix C). In the event of a larger-than-anticipated storm, which will likely fill all of the sample containers before stream flow has returned to pre-storm levels, the automated sampling program will be interrupted after collection of the last aliquot (or shortly beforehand) and the rosette of full sample containers replaced with a rosette of empty containers. The program will then be re-started to collect samples over the remainder of the storm hydrograph,

with the process repeated as needed. Sample containers from any full rosettes will be stored on ice pending retrieval of later rosettes. All of the aliquots thus collected will be manually composited into a single sample prior to submittal to the laboratory.

Due to the potential for volatilization during sampling and compositing, all storm samples for benzene analysis will be collected as discrete grab samples rather than as flow-weighted composites. These samples will be collected during the rising limb of the storm hydrograph. However, since wading into the stream during the rising limb of the storm hydrograph may be hazardous, these grab samples will be collected by interrupting the automated sampling protocol on the primary Isco unit at each station and using that Isco unit's sample tubing and a portable, variable-speed peristaltic pump to fill the sample containers.[16] Upon collection of the grab samples, which will be stored on ice pending collection of the flow-paced composite storm samples, the sample tubing will be reconnected to the primary Isco unit and the automated sampling program re-started.

Following each precipitation event during which one or more auto-samplers are activated, all sample tubing at the activated stations will be replaced and suction volumes re-calibrated.[17] Following each sampled storm, the elevation of the Isco 750 level/velocity sensor at each station will be re-surveyed to determine if the elevation changed as a result of storm-related scouring. At any station where the elevation of an Isco 750 depth/velocity sensor has shifted significantly, the entire cross-sectional profile of the stream will be re-surveyed, and if the new profile differs significantly from the old profile, new level-to-area relationships and a new rating curve will be developed for that station.[18] In addition, at Station 6, where storm-related scouring and deposition were reportedly observed on a regular basis during the RI/FS, the entire cross-sectional profile of the stream will be re-surveyed after each sampled storm.

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[16] The Settling Defendants recognize that collection of samples for analysis of volatile compounds using a peristaltic pump is not ideal, as use of a peristaltic pump may result in the loss of volatile compounds through degassing. However, EPA Region I guidance (i.e., SOP #GW0001 - Region I Low Stress SOP) states that peristaltic pumps may be used with caution. To minimize potential loss of volatiles, the peristaltic pump will be operated at the lowest practicable setting (50-100 milliliters per minute). The Settling Defendants recognize that resulting data may be biased low.

[17] To avoid potential fouling with time, new tubing will be installed shortly before the next forecasted storm to be sampled rather than immediately following each storm.

[18] If a new rating curve has to be developed for any station, flow at that station will continue to be computed using the old rating curve until a new rating curve has been developed.

At some point during each storm runoff event, if and when safe to do so, depth-to-water measurements will be made at the piezometers. Stream stage will also be read off the staff gages, and the data used to determine the relative surface water and groundwater elevations at each station during storm events.

3.4 Task 4 – Weekly O&M

The SWMP monitoring stations will be visited weekly for routine O&M, including the following activities:

- inspection of instrumentation and tubing, if present
- clearing of debris
- cleaning of the sample intake and staff gage
- cleaning of the Isco 750 level/velocity and In-Situ® MP Troll® 9500 water quality sensors
- calibration check of the In-Situ® MP Troll® 9500 water quality meters using standard calibration solutions (i.e., with known values)
- collection of manual stage measurements (calibration check on the Isco 750 level sensors)
- calibration of the In-Situ® MP Troll® 9500 water quality and Isco 750 level/velocity sensors, if needed (based on calibration checks noted above)
- checking power levels (battery and solar panels)
- inspection and, if needed, cleaning of rain gauges

During the weekly O&M visits, the flow and water chemistry data stored in the Isco units will be downloaded, as discussed in Section 3.1.

3.5 Task 5 – Monthly O&M

In addition to the weekly O&M activities, the following O&M activities will occur on a monthly basis:

- calibration of the In-Situ® MP Troll® 9500 water quality meters, unless the need for more frequent calibration is demonstrated (see above)
- collection of manual velocity measurements (calibration check on the Isco 750 velocity sensors)
- cleaning of the solar panels

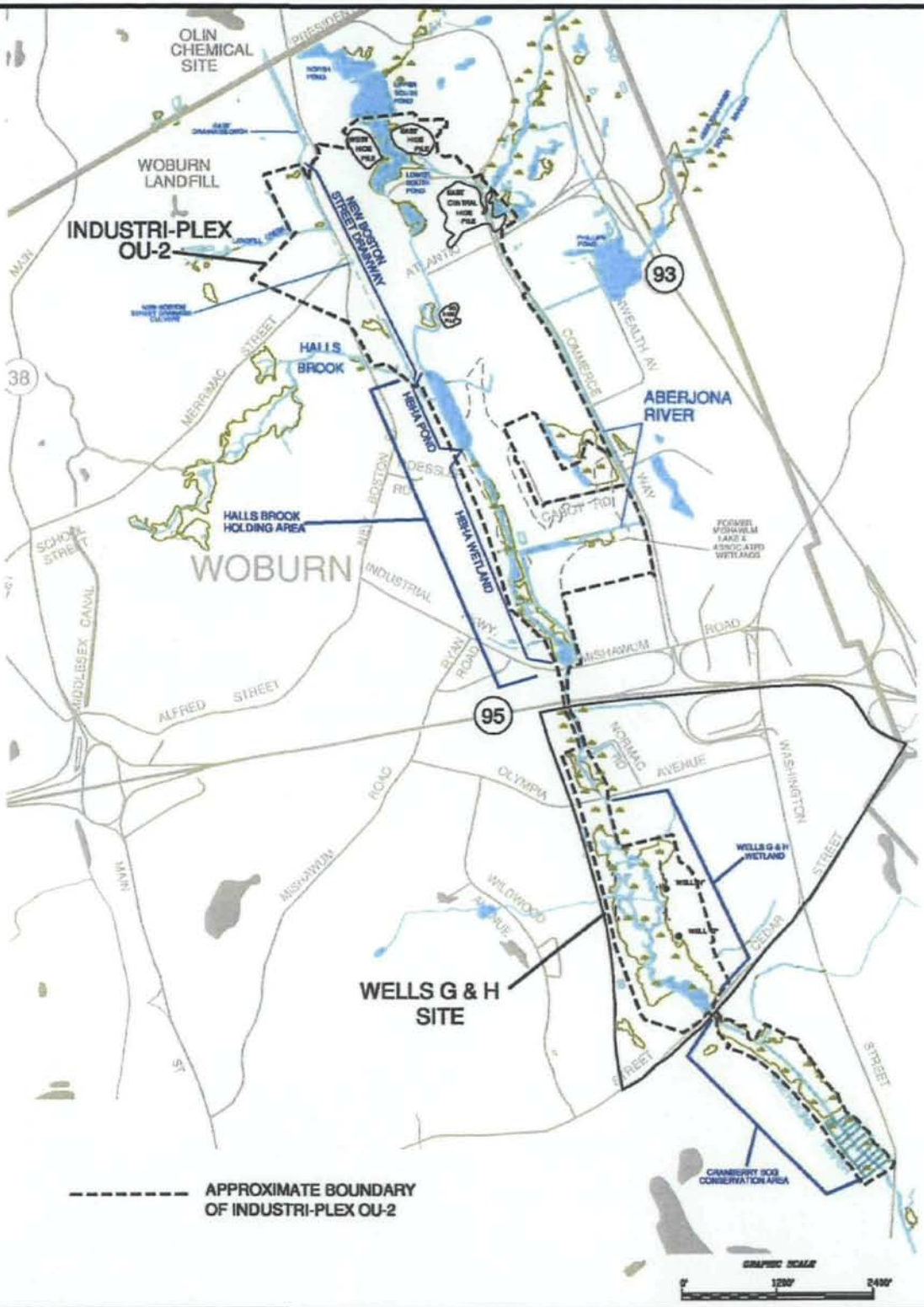
As discussed in Section 3.4, the In-Situ® MP Troll® 9500 water quality meters will be calibrated more frequently if needed based on the calibration checks performed as part of weekly O&M.

4.0 REPORTING

In accordance with the RD/RA SOW, Settling Defendants will submit monthly Baseflow Surface Water Monitoring Reports to EPA and MassDEP. Each monthly Baseflow Surface Water Monitoring Report will include 1) a narrative summarizing the surface water monitoring and maintenance activities performed during the reporting period (including any surveys and equipment repairs); 2) tabular summaries of the range of precipitation, flow, and water chemistry data recorded at each station during the reporting period, the flow and water chemistry readings at the time of monthly baseflow sampling, and the analytical results for the monthly baseflow samples; and 3) a brief discussion of the data (e.g., simple evaluation of trends). An electronic copy of the Flowlink®data for the reporting period will also be provided.

The RD/RA SOW also calls for quarterly Storm Flow Surface Water Monitoring Reports. These reports will be similar to the monthly Baseflow Surface Water Monitoring Reports, and will include 1) a narrative description of the storm event and related sampling activities; 2) tabular summaries of the storm/runoff statistics for each monitoring station (total precipitation, peak stage, peak velocity, and peak/total flow), the range of water chemistry readings measured during the storm, and the analytical results for the storm samples; 3) the Flowlink® hydrographs and data for the storm; and 4) a brief discussion of the data (e.g., simple evaluation of trends).

FIGURES



■ APPROXIMATE SITE LOCATION

SOURCE:
USEPA, 2006. Record of Decision
Industri-Plex Superfund Site
Operable Unit 2.

Title:

SITE LOCATION MAP
INDUSTRI-PLEX
OPERABLE UNIT 2

Prepared for:
INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES, INC. *Environmental Consulting & Management*	Compiled by: BH	Date: 3/21/08	FIGURE 1
	Prepared by: CRS	Scale: AS SHOWN	
	Project Mgr.: LM	Office: MA	
	File No.: IPS0110001	Project No.:119401M07	

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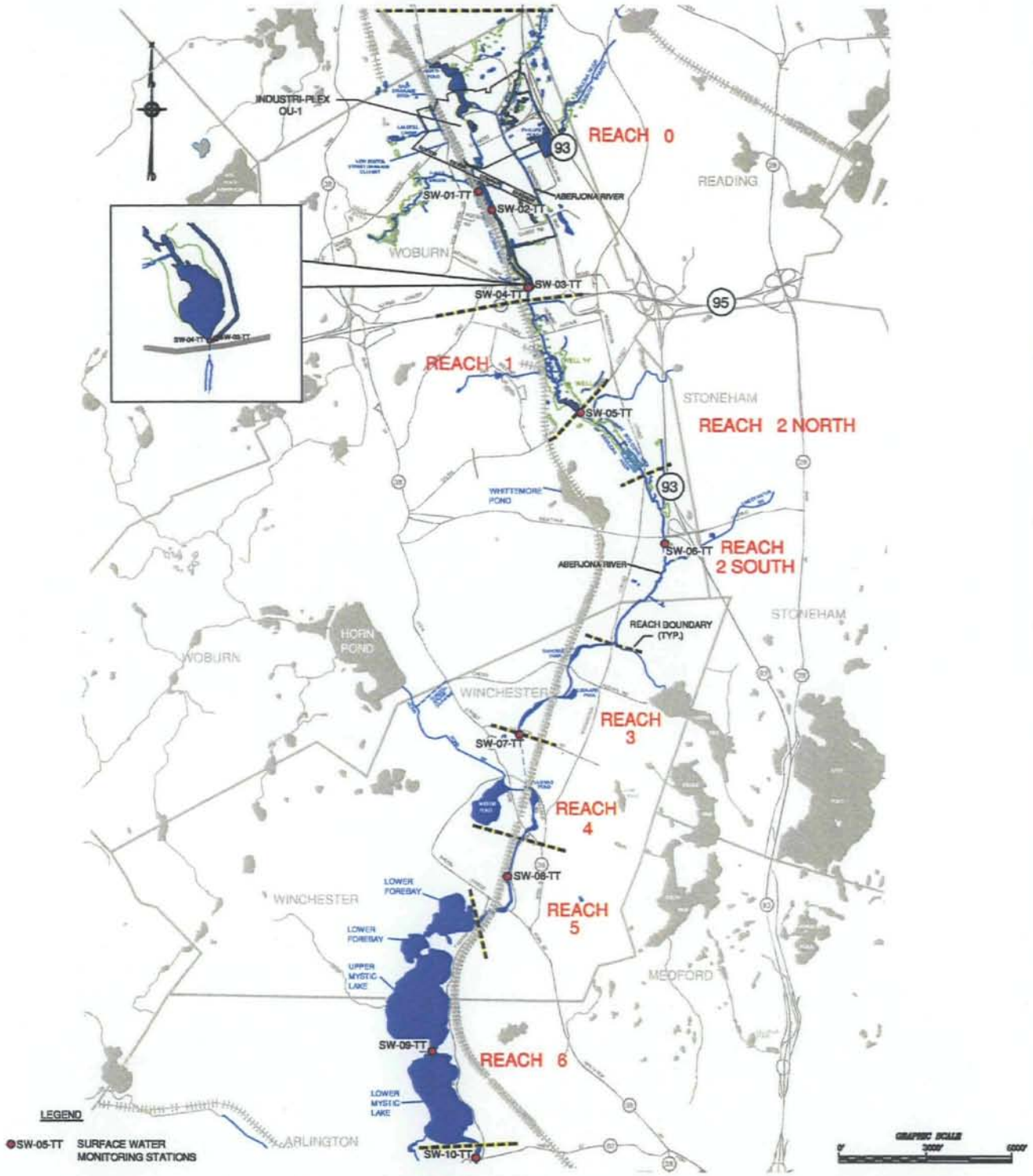

■ APPROXIMATE SITE LOCATION

SOURCE:
USEPA, 2006. Record of Decision
Industri-Plex Superfund Site
Operable Unit 2.

Title:

RI/FS SURFACE WATER MONITORING STATIONS

Prepared for:

INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: CRS	Date: 3/21/08	FIGURE
Prepared by: CRS	Scale: AS SHOWN	2
Project Mgr.: LM	Office: MA	
File No.: IPS0110002	Project No.:119401M07	

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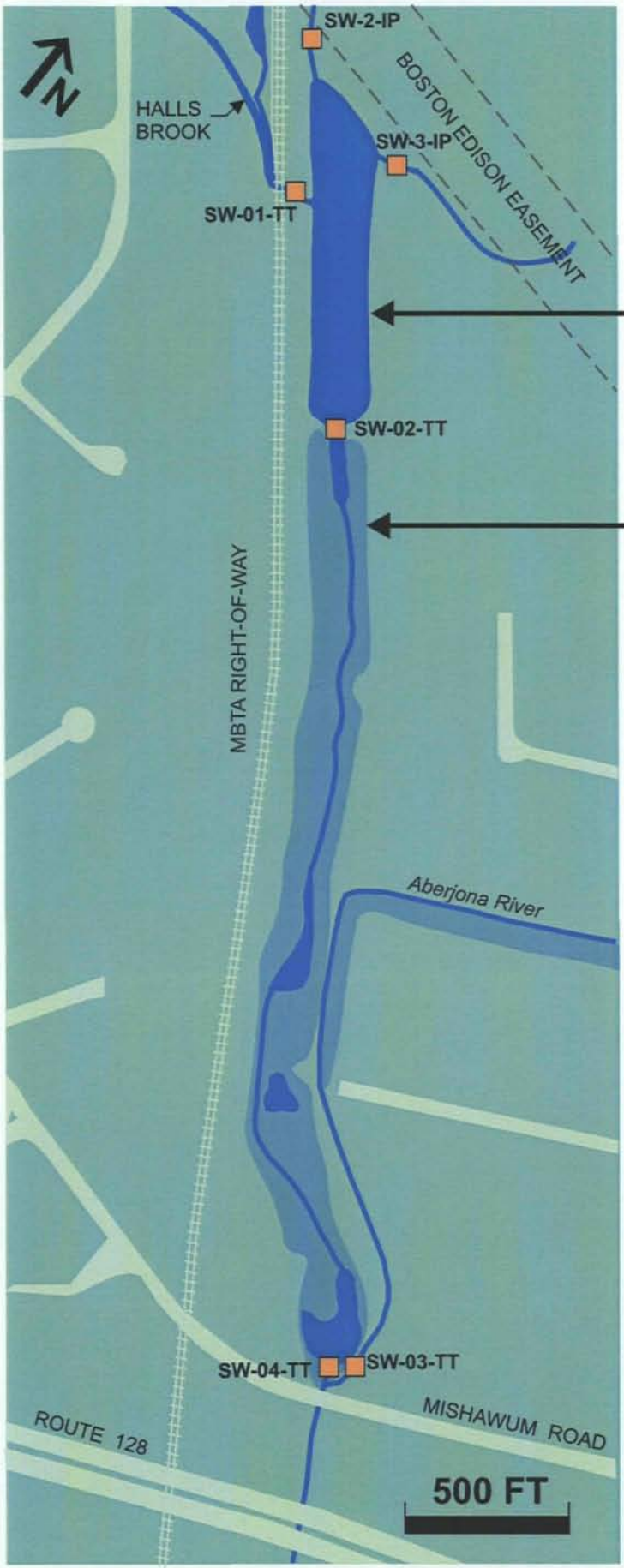


HBHA POND

HBHA WETLAND

LEGEND

SW-01-TT ■ APPROXIMATE LOCATION AND DESIGNATION OF SURFACE WATER MONITORING STATION

Title:

SURFACE WATER MONITORING STATIONS NORTH OF ROUTE 128

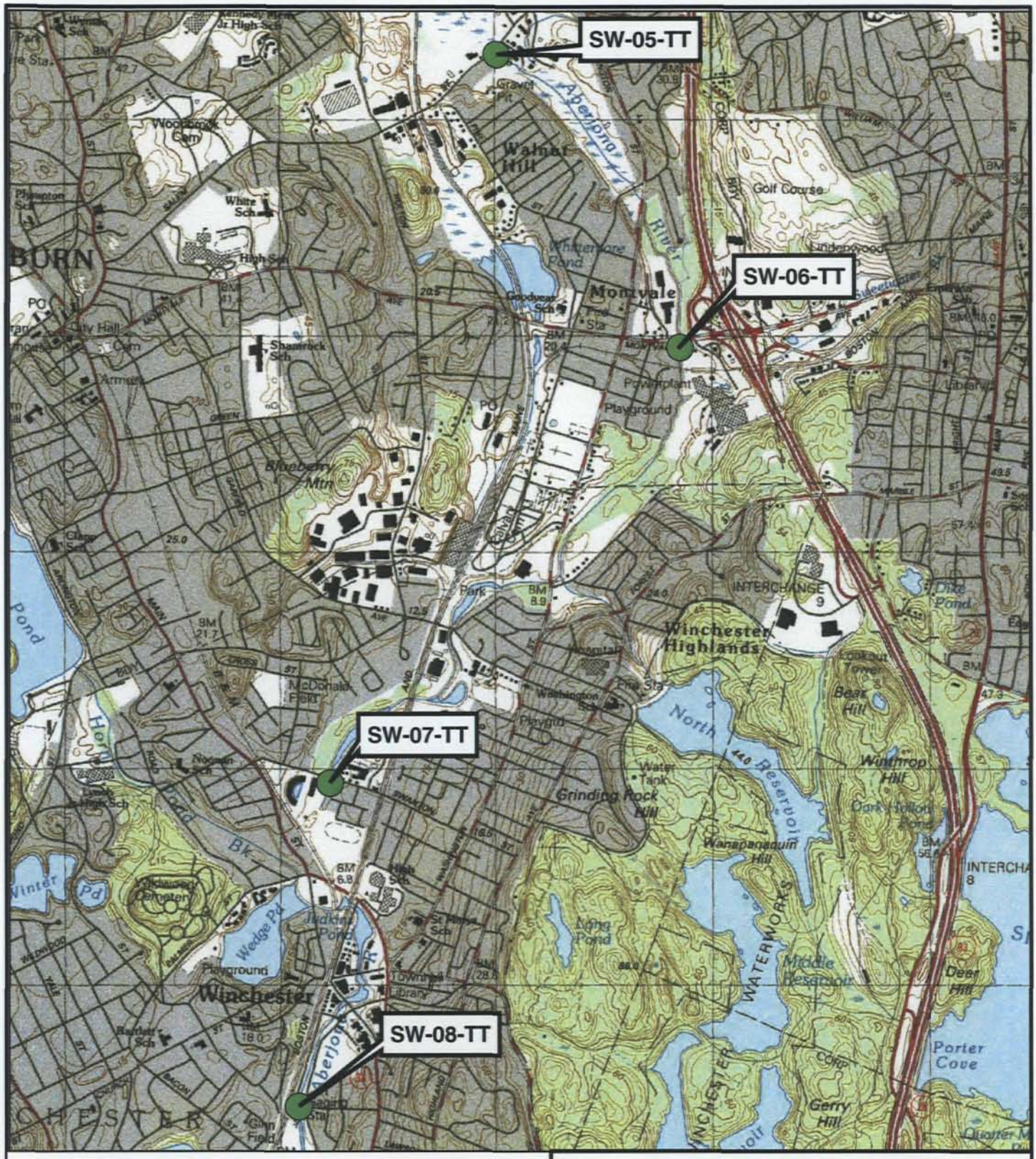
Prepared for:

INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES INC.
Environmental consulting & Management

Compiled by: LM	Date: 1/10/09	FIGURE	
Prepared by: CRS	Scale: AS SHOWN	3	
Project Mgr.: LM	Office: MA		
File No.: IPS0110006	Project No.: 119407M07		

N:\PROJECTS\I-PLEX\119401M07\100\IPS0110006.cdr



QUADRANGLE LOCATION

N

0 1,000 2,000 Feet

SOURCE:
USGS, 1987.
Reading (Massachusetts) Quadrangle
1:25,000–scale Topographic Map

Title:

SURFACE WATER MONITORING STATIONS SOUTH OF ROUTE 128

Prepared For:

INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled By: LM	Date: 1/13/09	FIGURE	4
Prepared By: CRS	Scale: AS SHOWN		
Project Mgr.: LM	Office: MA		
File No.: IPS0110005	Project: 119401M		

T:\GIS\I-PLEX\IPS0110005.mxd

APPENDIX A

Site Management Plan

DRAFT

SITE MANAGEMENT PLAN

Surface Water Monitoring
Industri-Plex Superfund Site Operable Unit 2
(including Operable Unit 3 of the Wells G&H Superfund Site)
Woburn, Massachusetts

Prepared by:

ROUX ASSOCIATES, INC.
67 South Bedford Street, Suite 101W
Burlington, Massachusetts 01803

January 23, 2009

ROUX

IPS1194.0001M007.100/SMPCv

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1.0 INTRODUCTION

Pursuant to the Remedial Design/Remedial Action (RD/RA) Statement of Work (SOW) for Operable Unit 2 (OU 2) at the Industri-Plex Superfund Site (including Operable Unit 3 of the Wells G&H Superfund Site) in Woburn, Massachusetts (hereinafter, "Industri-Plex OU 2"), and on behalf of Pharmacia Corporation by its Attorney-in-Fact Monsanto Company and Stauffer Management Company LLC as litigation agent for Bayer CropScience Inc. (Settling Defendants), this Site Management Plan (SMP) has been prepared to describe how the Settling Defendants will manage the implementation of the Surface Water Monitoring Plan (SWMP). More specifically, in accordance with Attachment A of the RD/RA SOW, this SMP provides the U.S. Environmental Protection Agency (EPA) and Massachusetts Department of Environmental Protection (MassDEP) with a written understanding of how various aspects of the SWMP implementation such as access, security, contingency procedures, management responsibilities, waste disposal, budgeting, and data handling will be managed by the Settling Defendants.

2.0 PROJECT OVERVIEW AND ORGANIZATION

The SWMP surface water monitoring program will comprise the monitoring of surface water at ten locations along Halls Brook and the Aberjona River at and downstream of Industri-Plex OU 2. The ten locations (surface water monitoring stations) are shown in Figures A-1 and A-2. Each station will be outfitted with equipment for the continuous monitoring of hydrological and water chemistry parameters and the automated collection of surface water samples during selected storm events. Surface water samples will also be collected manually during baseflow (i.e., non-storm) conditions, and a number of manual hydrologic measurements will also be made at each station on a periodic basis.

Project organization for the SWMP is shown in Figure A-3 and discussed in greater detail in the Quality Assurance Project Plan (QAPP, Appendix B of the SWMP). As shown in Figure A-3, Mr. Bruce Thompson of *de maximis, inc.* has been retained by the Settling Defendants to serve as Project Coordinator for the Industri-Plex OU 2 RD/RA and will oversee all aspects of the RD/RA, including implementation of the SWMP, on behalf of the Settling Defendants. Roux Associates has been retained by the Settling Defendants to prepare and implement the SWMP. Mr. Lawrence McTiernan will serve as the SWMP Project Manager on behalf of Roux Associates, providing overall management of the technical, financial, staffing, scheduling, and reporting aspects of the SWMP. Mr. Jim Dick of Roux Associates will serve as Field Manager, directing the activities of all technical staff in the field and those of the analytical laboratory and any other subcontractors.

Key subcontractors to be retained by Roux Associates include Alpha Analytical (laboratory services) and Bayside Engineering, Inc. (surveying). Haley & Aldrich, contracted directly by the Settling Defendants, will provide data validation services.

3.0 ACCESS REQUIREMENTS

All of the SWMP surface water monitoring stations are located on private property, so permission to access these properties will be required for implementation of the SWMP. In addition, for some of the stations, access to one or more abutting or nearby properties will also be required to facilitate station set-up and sampling. Table A-1 lists the various properties for which access will be required for each station, along with the name and address of the respective property owners and the reason(s) access is needed. The various properties are also shown in Figures A-4 through A-10. Access to all of these properties will be negotiated on behalf of the Settling Defendants by the Project Coordinator, Mr. Bruce Thompson of *de maximis, inc.* A copy of a typical access request letter for the SWMP is provided in Attachment A-1. In addition, it should be noted that arrangements for off-hours work will be made with each of the property owners.

Protection of private property will be held paramount at all times during implementation of the SWMP. This will be reflected in the agreements negotiated for the various properties to be accessed.

4.0 SITE CONTROL

As discussed in the Health and Safety Plan (Appendix D of the SWMP), since the potential for chemical exposures and the spread of contamination is expected to be minimal during implementation of the SWMP, air monitoring and the adoption of a three-zone approach to field operations (i.e., exclusion zone, contamination reduction zone, and support zone) will not be included as part of SWMP activities. Rather, during performance of field activities, a general "work zone" will be temporarily demarcated around each surface water monitoring station using cones or high-visibility flagging tape, to prevent unauthorized access. The low potential for chemical exposures notwithstanding, third-party access to work zones will be restricted due to the potential for physical hazards.

The former groundwater treatment building located at the southern boundary of Industri-Plex OU 1 and the thermal oxidation unit (TOU) building adjacent to the East Hide Pile will serve as field offices during implementation of the SWMP. The former groundwater treatment building will be used primarily for storage of equipment and will also be used as a staging area for drummed investigation-derived waste (IDW) such as used tubing and personal protective equipment (PPE). All IDW will be staged within the fenced enclosure adjacent to the former groundwater treatment building and will be consolidated, labeled, manifested, and disposed in accordance with applicable federal and state regulations under the direction of the Project Coordinator. Pursuant to the RD/RA SOW, the Settling Defendants will be identified as the generator of all IDW and other waste generated during implementation of the SWMP.

5.0 FINANCIAL AND DATA MANAGEMENT

Mr. Bruce Thompson of *de maximis, inc.*, Project Coordinator, will provide overall financial management for the Settling Defendants and, pursuant to the RD/RA SOW, will provide regular financial reports of the Settling Defendants' expenditures on RD/RA activities. *de maximis, inc.*, through its subsidiary *de maximis* Data Management Solutions, Inc. (*ddms*), will also perform overall data management for the RD/RA, including organizing, manipulating, and presenting the data generated through implementation of the SWMP. *ddms* will maintain a highly structured environmental database in conjunction with a geographic information system (GIS) and an internet communication platform to

- archive historic environmental data for the Industri-Plex Site (all media);
- normalize data from different sources (putting disjointed data in a common format so that they can be compared against one another);
- distribute the data to authorized personnel in a timely fashion;
- query that data in a fashion that allows a user to quickly obtain data based on sample locations, parameters, measurement value and date criteria;
- compare the data against environmental clean-up goals to quickly obtain samples with analytical values which exceed those drivers;
- trend the data temporally so that positive and negative relationships can be visualized between and among sample measurements;
- map and spatially analyze the data so that spatial relationships among the data might be realized.

The database platform is provided by the Geographic Environmental Management System (GEMS), an industry-tested environmental database platform developed by Summit Envirosolutions, Inc. GEMS is a Visual Basic for Applications (VBA) application written on Microsoft Access® 2003 and consists of two separate Access files, one used to house the graphical user interfaces (GUIs) and one dedicated to housing the environmental data, referred to as the "dataset." The environmental database is then accessed via the GUI database. The tables within the dataset are highly structured utilizing relational database concepts and practices (refer to the GEMS Relational Database Model flow chart in Plate 1 of the SWMP for a schematic of tables and columns and relationships among them). Generally speaking, these tables were constructed to represent the characteristics and resulting data associated with any environmental sampling efforts including, but not limited to

- **Sample Locations** – physical attributes describing the physical location that the sample was collected (e.g., well name, construction, screen elevation, boring drill method, install date, elevations, coordinates)
- **Field Sample Properties** – attributes associated with the actual sample collected from the Sample Location (e.g., sample name, collected by, sample date, weather conditions at the time of sampling)
- **Sample Measurements, Results or Description** – actual physical or analytical numeric results generated by various measuring techniques depending on the parameter values desired (e.g., depth to water, chemical concentration, soil type, measurement method, measurement method detection limits, entity that did the measurement)

The database consists of tables designed to store these data and also tables associated with providing list of valid values acceptable for use in describing these data. These valid value tables are crucial in that they are utilized to standardize or normalize the data so that queries can be performed with confidence that they are returning all the results associated with the question that the user has asked.

The GEMS user interface was designed to enforce referential database integrity and approved valid values. Without this enforcement, a database query for all trichloroethene, for example, may not truly return all data it has that matches those criteria because some of the data is stored as trichloroethylene (a known synonym) thereby producing an incomplete representation of the dataset.

The GEMS user interface contains a QA/QC interface that one can run to identify parameter and location names that exist in the dataset but which are not in the approved set of valid values. Users are then provided the option to either add that parameter or sample location name as a new approved value or change it to that of an existing respective value from the list of values.

Historical data imported to the Industri-Plex OU2 database at the time of this writing include historic analytical data provided by the EPA and previous surface water data measured through the use of Isco samplers. Forthcoming data will be imported into the database through the use of the EDD vehicle. The GEMS v6 EDD format has been provided to the laboratory so that their forthcoming deliverables can be imported directly into the database, quality checked, and distributed in a timely fashion.

Third-party data validation reports will be used to then update any result values and qualifiers which the validator has changed. The original result, original qualifier, validation date and validator's name are then recorded and stored in the actual table row which received a validator's update.

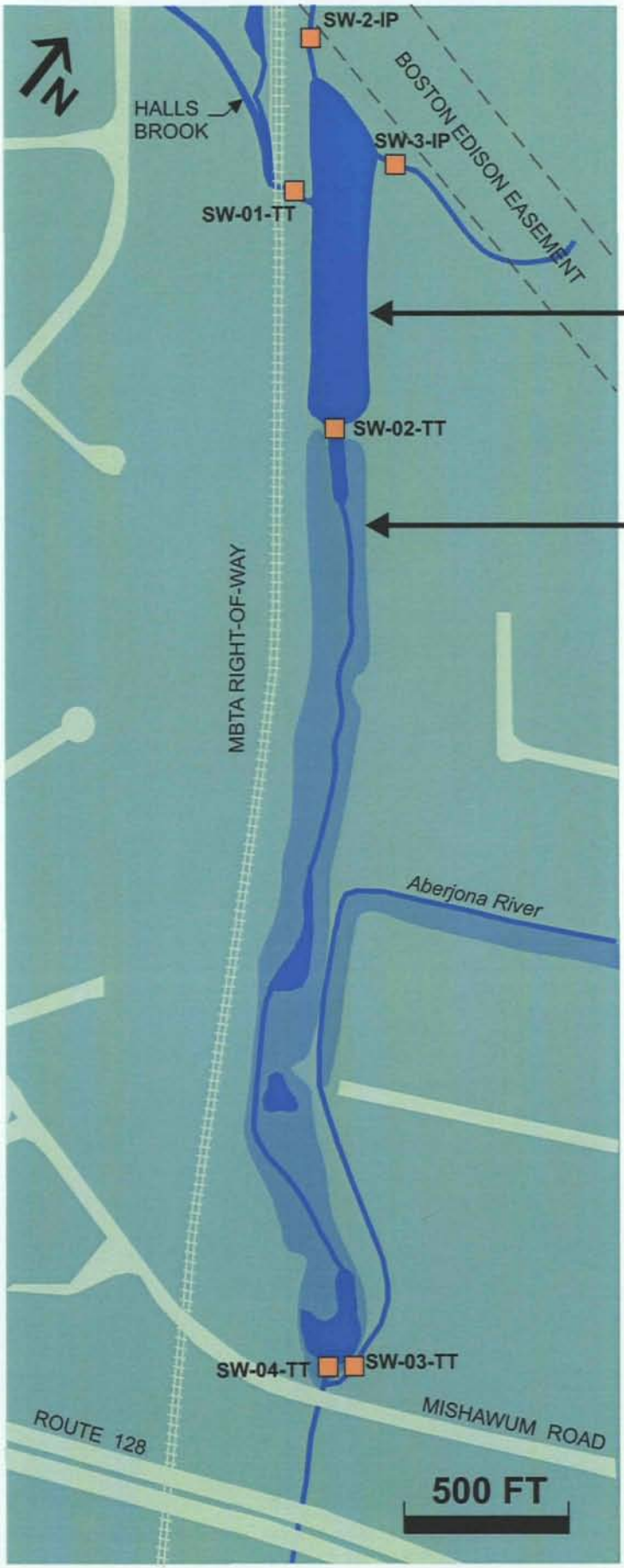
Once a GEMS dataset has been updated with a new set of data from a recent field sampling event, it will be imported into the Project Portal™ web application for distribution to the collective project team. Project Portal is a .NET™ web application designed to centralize and distribute documents, schedules, environmental data and maps to large environmental project teams in a highly efficient manner. Project Portal employs a rigorous rights management system to enforce which users are permitted to perform individual operations. Project Portal consists of the following modules, all available for use by the Industri-Plex OU2 project team:

- Document Management System
- Project Calendar Sharing and Collaboration
- Query-able Environmental Database Access
- Interactive and embedded On-line GIS
- Custom Project Tables (database) which users can use to create tables for distributing tabular data of any nature

Environmental data uploaded into Project Portal's Environmental Database Module is stored in a MySQL® server-grade relational database backend. The Environmental Database module allows authorized users to query the Industri-Plex OU2 environmental dataset through an intuitive interface that allows them to query data based from their custom sample location, sample parameter (e.g., analyte), sample date, and exceedances filter setting selections. The user may then either simply view, graph, map or export the subsequent query results to various formats including Microsoft Excel®, a comma-separate value (.csv) file, Environmental System Research Institute (ESRI)® shapefile, or a Google Earth® (.kml) file.

If the user chooses to map the query results, those values will be plotted to the interactive GIS Module utilizing the coordinates stored in the database. The result value will be posted next to each sample location.

Table A-1. Surface Water Monitoring Property Access Requirements				Station Location	Through-Access
Station No.	**Property Address**	**Owner Name**	**Mailing Address**		
SW-01-TT, SW-2-IP, and SW-3-IP	36 Cabot Road	DEK Portfolio LLC, c/o Great Point Investors	98 North Washington Street, 5th Floor Boston, MA 02114	x	
SW-02-TT	36 Cabot Road	See Above		x	
	32 Cabot Road	DEK Portfolio LLC, c/o Great Point	See above		x
	Halls Brook Holding Area	Mark-Philip Trust, c/o Resources for Responsible Site Management, Inc.	131 Mount Auburn Street Cambridge, MA 02138		x
	280 Mishawum Road	Thomas F. Derro	148 Stoney Gate Way Carlisle, MA 01741		x
SW-03-TT and SW-04-TT	Halls Brook Holding Area	See Above		x	
	280 Mishawum Road	See Above			x
SW-05-TT	Abandoned Property @ Salem Street	City of Woburn	10 Common Street Woburn, MA 01801	x	
SW-06-TT	331 Montvale Avenue	Aberjona Realty Trust	331 Montvale Avenue Woburn, MA 01801	x	
SW-07-TT	166-168 Swanton Street	Paul N and Jacalyn Masi	166-168 Swanton Street Winchester, MA 01890	x	
SW-08-TT	Aberjona River at USGS on Mystic Valley Parkway across from Mystic Avenue	Massachusetts Department of Conservation & Recreation	251 Causeway Street, Suite 600 Boston, MA 02114	x	



LEGEND

SW-01-TT — APPROXIMATE LOCATION AND DESIGNATION OF SURFACE WATER MONITORING STATION

Title:

SURFACE WATER MONITORING STATIONS NORTH OF ROUTE 128

Prepared for:

INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES INC.
Environmental consulting & Management

Compiled by: LM		Date: 1/10/09	FIGURE
Prepared by: CRS		Scale: AS SHOWN	A-1
Project Mgr.: LM		Office: MA	
File No.: FIGUREA-1		Project No.: 119407M07	

N:\PROJECTS\I-PLEX\119401M07\100\NEW\FIGURES5-15-08\A FIGURES\FIGUREA-1.cdr

■ QUADRANGLE LOCATION

N

SOURCE:
USGS, 1987.
Reading (Massachusetts) Quadrangle
1:25,000-scale Topographic Map

0 1,000 2,000 Feet

Title:

SURFACE WATER MONITORING STATIONS SOUTH OF ROUTE 128

Prepared For:

INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled By: LM	Date: 1/13/09	FIGURE
Prepared By: CRS	Scale: AS SHOWN	A-2
Project Mgr.: LM	Office: MA	
File No.: FIGUREA-2	Project: 119401M	

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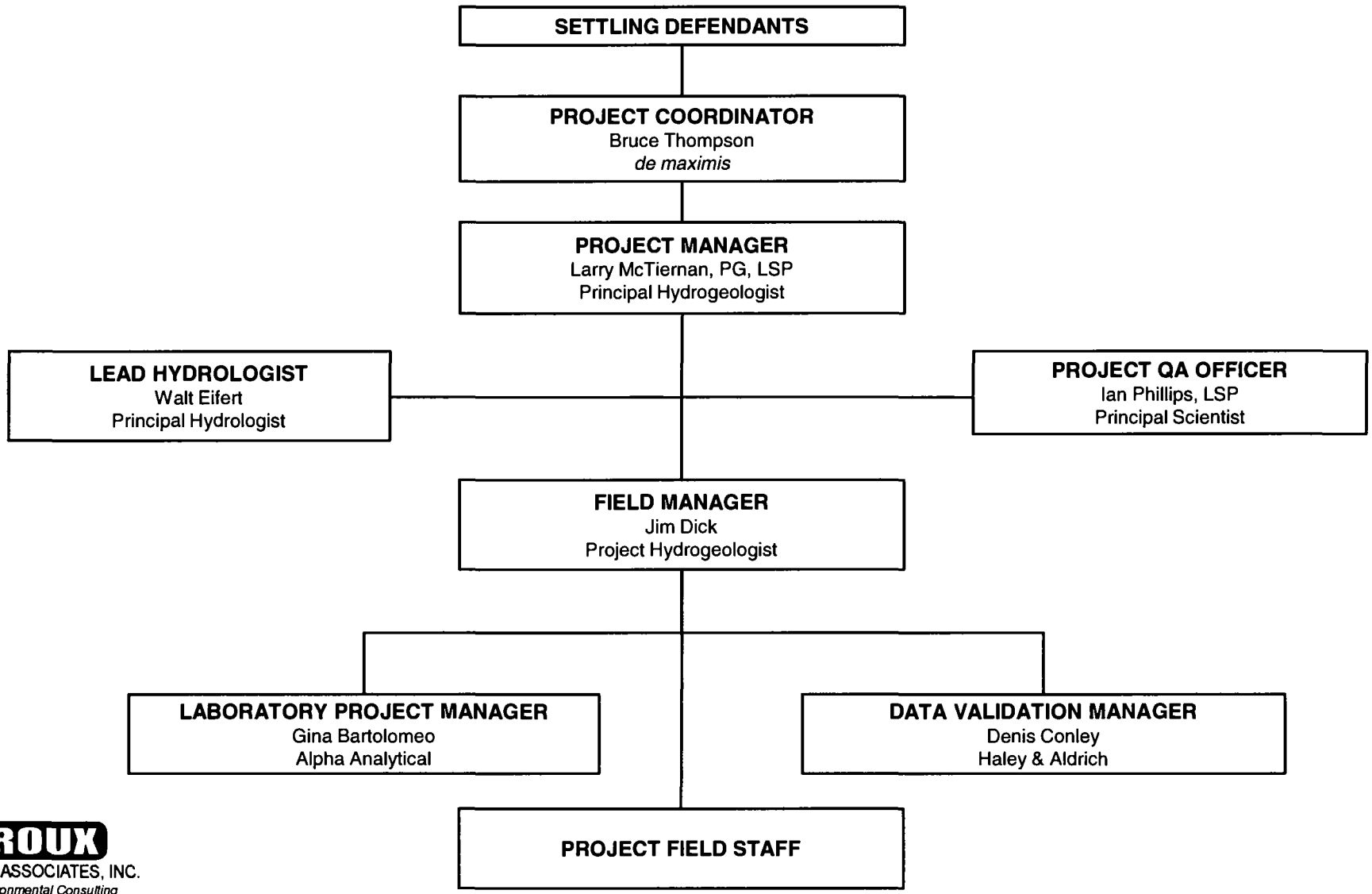
Figure A-3

PROJECT ORGANIZATION CHART

Surface Water Monitoring Plan
Industri-Plex Superfund Site Operable Unit 2
Woburn, Massachusetts



ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

IPS1194.0001M007.100/SMP.Fig3

LEGEND

- Surface Water Monitoring Station
- Parcels
- Property Boundary

Projection: Lambert Conformal Conic
Coordinate System: MA State Plane (Mainland)
FIPS Zone: 2001
Units: US Feet
Datum: North American Datum (NAD) 83

N

ACCESS REQUEST FOR SW-01-TT, SW-2-IP & SW-3-IP

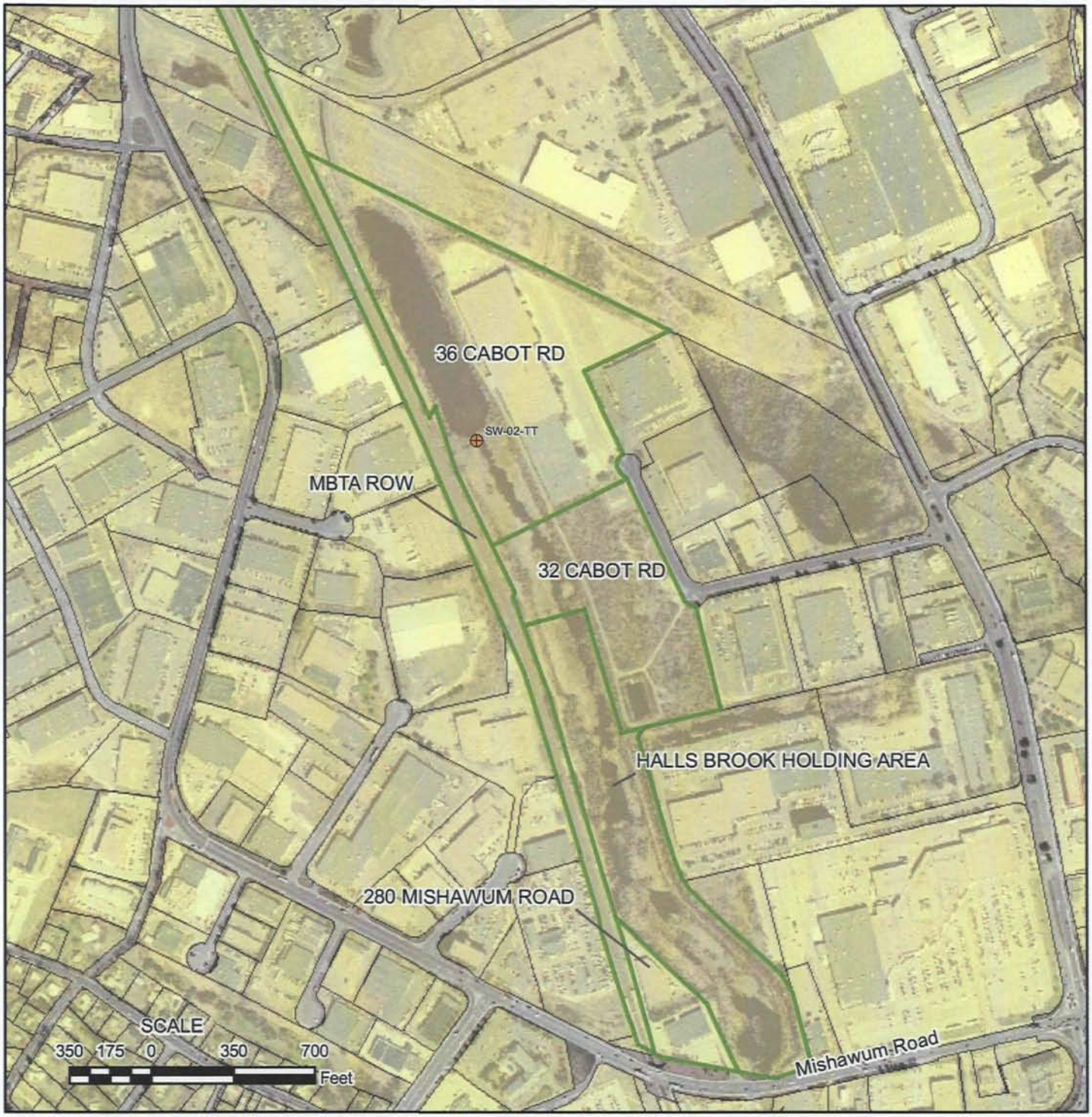
MXD: Figure_A-4.mxd
Project No.: 3204
Plot Date: 13 JAN 2009
Arc Operator: JJK
Reviewed by: TM

Figure A-4

de maximis Data ddms
Management Solutions Inc.
1217 Bandana Boulevard North
Saint Paul, Minnesota 55108
Main Phone: (651) 842-4224
www.ddmsinc.com

R:\Projects\DEF\demax-1547\3204-Industri-PlexOU2\DataAnalysis\MXDs

Map adapted from a 2005 aerial photograph and City of Woburn GIS Data



LEGEND

- Surface Water Monitoring Point
- Parcels
- Property Boundary

Projection: Lambert Conformal Conic
Coordinate System: MA State Plane (Mainland)
FIPS Zone: 2001
Units: US Feet
Datum: North American Datum (NAD) 83

N

ACCESS REQUEST FOR SW-02-TT

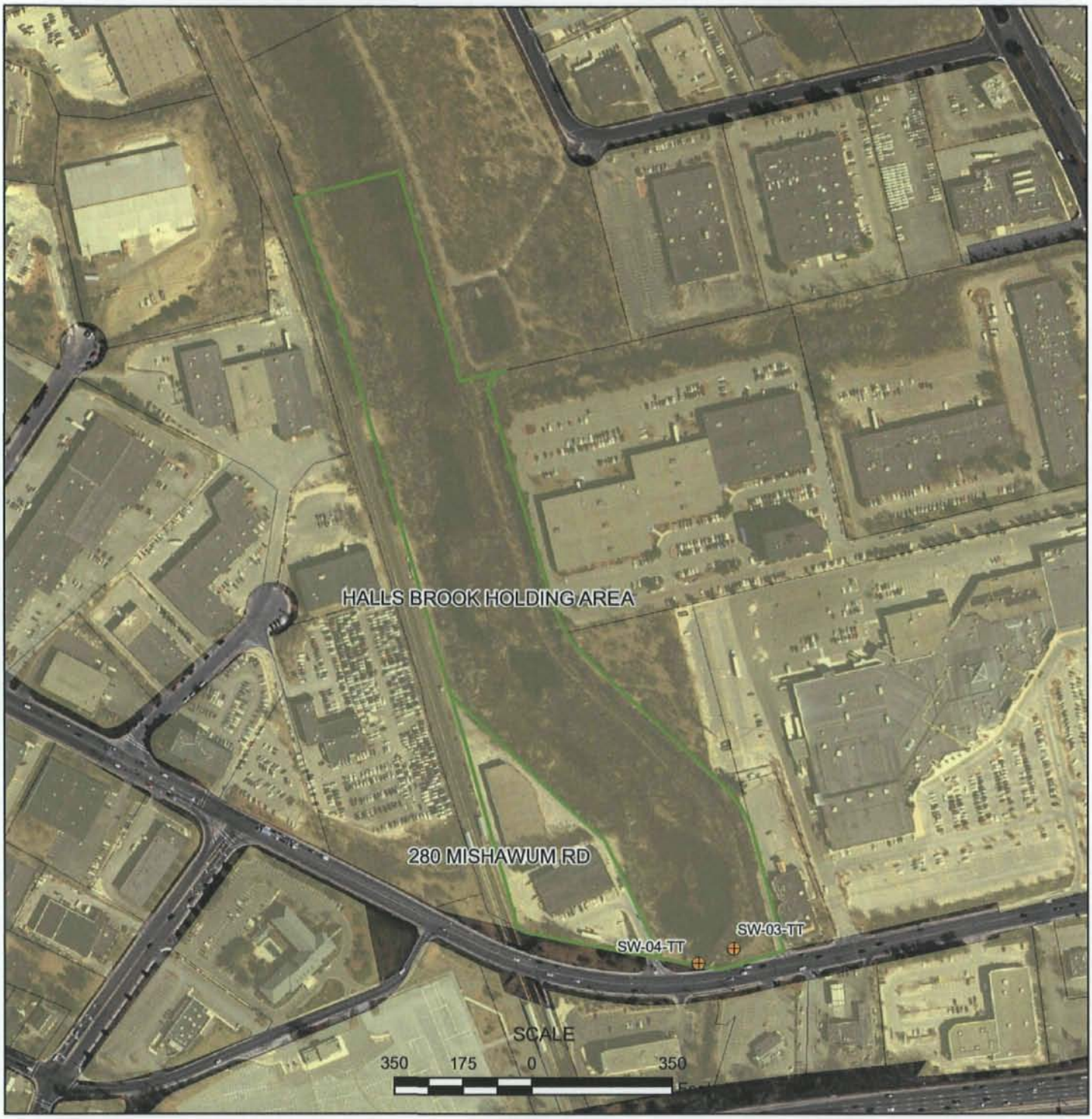
MXD: Figure_A-5.mxd
Project No.: 3204
Plot Date: 13 JAN 2009
Arc Operator: JJK
Reviewed by: TM

Figure A-5

de maximis Data ddms Management Solutions Inc.
1217 Bandana Boulevard North
Saint Paul, Minnesota 55108
Main Phone: (651) 842-4224
www.ddmsinc.com

R:\Projects\DEF\demax-1547\3204-Industri-PlexOU2\DataAnalysis\MXDs

Map adapted from a 2005 aerial photograph and City of Woburn GIS Data



LEGEND

- Surface Water Monitoring Station
- Parcels
- Property Boundary

Projection: Lambert Conformal Conic
Coordinate System: MA State Plane (Mainland)
FIPS Zone: 2001
Units: US Feet
Datum: North American Datum (NAD) 83

N

ACCESS REQUEST FOR SW-03-TT and SW-04-TT

MXD: Figure_A-6.mxd
Project No.: 3204
Plot Date: 21 MAY 2008
Arc Operator: JJK
Reviewed by: TM

Figure A-6

de maximis Data ddms
Management Solutions Inc.
1217 Bandana Boulevard North
Saint Paul, Minnesota 55108
Main Phone: (651) 842-4224
www.ddmsinc.com

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Map adapted from a 2005 aerial photograph and City of Woburn GIS Data

LEGEND

- Surface Water Monitoring Station
- Parcels
- Property Boundary

Projection: Lambert Conformal Conic
Coordinate System: MA State Plane (Mainland)
FIPS Zone: 2001
Units: US Feet
Datum: North American Datum (NAD) 83

N

ACCESS REQUEST FOR SW-05-TT

MXD: Figure_A-7.mxd
Project No.: 3204
Plot Date: 21 MAY 2008
Arc Operator: JJK
Reviewed by: TM

Figure A-7

de maximis Data ddms Management Solutions Inc.
1217 Bandana Boulevard North
Saint Paul, Minnesota 55108
Main Phone: (651) 842-4224
www.ddmsinc.com

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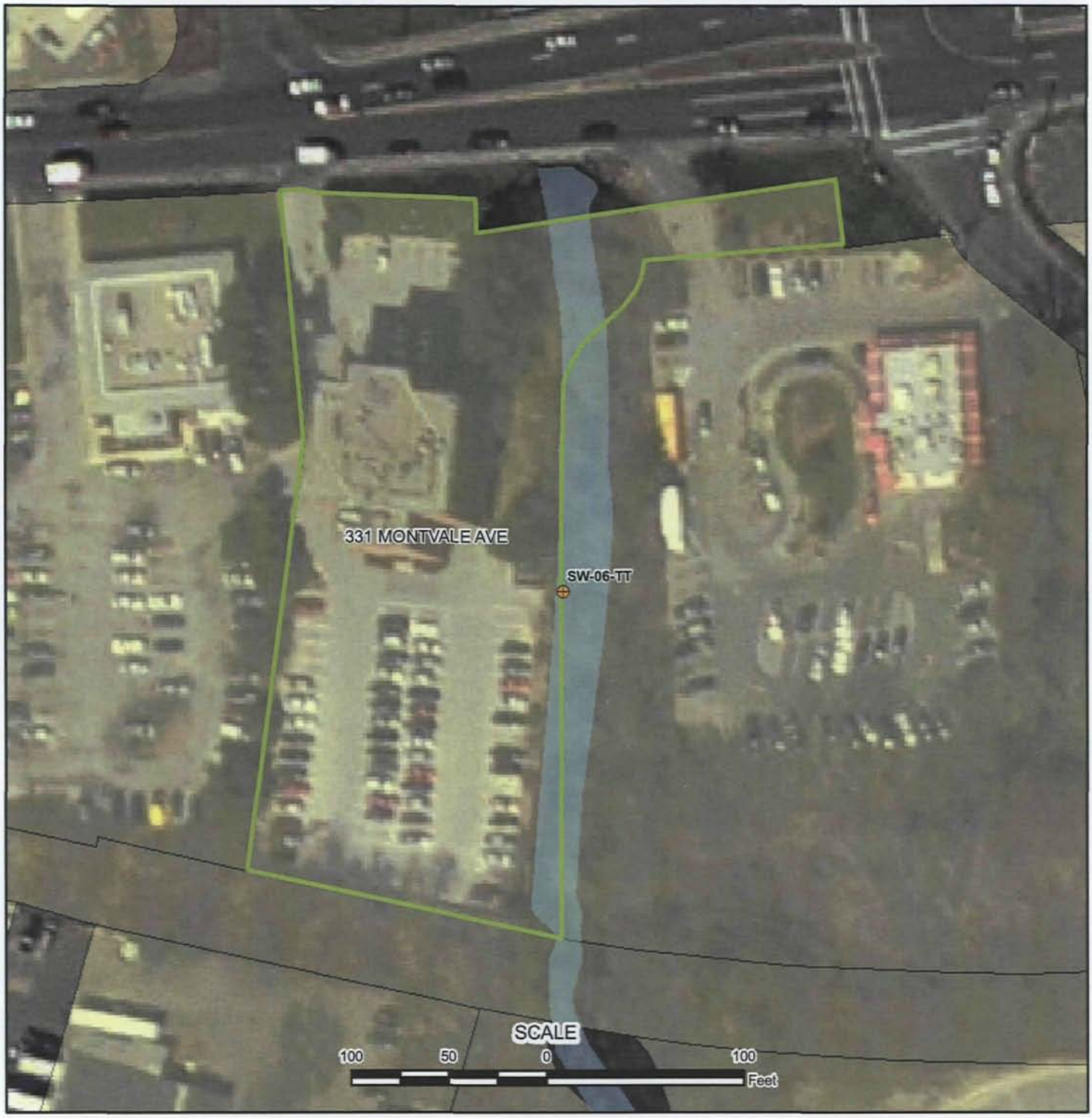
Map adapted from a 2005 aerial photograph and City of Woburn GIS Data



LEGEND

- Surface Water Monitoring Location
- Parcels
- Property Boundary

Projection: Lambert Conformal Conic
Coordinate System: MA State Plane (Mainland)
FIPS Zone: 2001
Units: US Feet
Datum: North American Datum (NAD) 83

N

ACCESS REQUEST FOR SW-06-TT

MXD: AR-331MontvaleAvenue.mxd
Project No.: 3204
Plot Date: 13 JAN 2009
Arc Operator: JJK
Reviewed by: JH

Figure A-8

de maximis Data ddms Management Solutions Inc.
1217 Bandana Boulevard North
Saint Paul, Minnesota 55108
Main Phone: (651) 842-4224
www.ddmsinc.com

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Map adapted from a 2005 aerial photograph and City of Woburn GIS Data

LEGEND

- Surface Water Monitoring Station
- Parcels
- Property Boundary

Projection: Lambert Conformal Conic
Coordinate System: MA State Plane (Mainland)
FIPS Zone: 2001
Units: US Feet
Datum: North American Datum (NAD) 83

N

ACCESS REQUEST FOR SW-07-TT

MXD: Figure_A-9.mxd
Project No.: 3204
Plot Date: 13 JAN 2009
Arc Operator: JJK
Reviewed by: TM

Figure A-9

de maximis Data ddms Management Solutions Inc.
1217 Bandana Boulevard North
Saint Paul, Minnesota 55108
Main Phone: (651) 842-4224
www.ddmsinc.com

R:\Projects\DEF\demax-1547\3204-Industri-PlexOU2\DataAnalysis\MXDs

Map adapted from a 2005 aerial photograph and City of Woburn GIS Data

LEGEND

- Surface Water Monitoring Station
- Parcels
- Aberjona River
- Property Boundary

Projection: Lambert Conformal Conic
Coordinate System: MA State Plane (Mainland)
FIPS Zone: 2001
Units: US Feet
Datum: North American Datum (NAD) 83

N

ACCESS REQUEST ABERJONA RIVER AT USGS

Winchester, Massachusetts

MXD: AR-AberjonaRiverAtUSGS.mxd
Project No.: 3204
Plot Date: 13 JAN 2009
Arc Operator: JJK
Reviewed by: JH

Figure A-10

de maximis Data ddms
Management Solutions Inc.
1217 Bandana Boulevard North
Saint Paul, Minnesota 55108
Main Phone: (651) 842-4224
www.ddmsinc.com

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Map adapted from a 2005 aerial photograph and City of Woburn GIS Data

ATTACHMENT A-1

Sample Access Request Letter

Date

{Property Owner Name}
{Property Owner Address}
{Property Owner Town/City}

Subject: Access to Property at {Property Address/Town}

Dear Sir/Madame or Mr. / Ms.:

This letter requests access to your property located at {Property Owner Address} to conduct certain investigations in support of the Remedial Design / Remedial Action (RD/RA) at the Industri-Plex Operable Unit Two (OU-2) Superfund Site (the "Site") in Woburn, MA. The City of {Property Owner Town/City} public records indicate that the property is defined as {Property Parcel ID}.

de maximis inc. has been selected by Pharmacia Corporation by its Attorney-in-Fact Monsanto Company and Stauffer Management Company LLC as litigation agent for Bayer CropScience Inc. (the "Companies") to serve as Project Coordinator and Supervising Contractor for the RD/RA activities at the Site.

The Companies have entered into a Consent Decree (CD) with the United States Environmental Protection Agency ("EPA") pursuant to which remedial response actions at the Site will be designed and implemented. The CD became effective on February 27, 2008. RD related activities are anticipated to take at least two years.

Information on the history of the Site can be found at
http://www.epa.gov/region1/superfund/sites/industriplex

Pursuant to Paragraph 26 of the CD, if access to any property is necessary to perform investigation or response actions, an access agreement must be obtained that grants access to the Companies, their authorized representatives (meaning contractors retained by the Companies, which include ***de maximis, inc.***, Roux Associates, Haley and Aldrich, Inc., and Geosyntec Consultants), EPA and the Commonwealth of Massachusetts, as well as their officers, employees, agents, contractors, consultants, and other authorized representatives for purposes of implementing and overseeing the implementation of the work to be performed under the CD. The specific work will be detailed in project work plans that will be reviewed and approved by EPA and the Massachusetts Department of Environmental Protection (MassDEP). The purpose of the RD is to collect samples from various media for laboratory analysis, to support the design process.

de maximis currently anticipates that completing the RD will require the following activities on your property:

- land survey;
- installation of surface water monitoring stations:

The RD process will proceed in a phased manner, starting with the activities detailed below. The need for remedial action activities on your property will be determined based on the results of the RD process. We will contact you again at the conclusion of the RD process to discuss whether the RD process has identified specific remedial activities needed on your property.

{Property Owner}, as the property owner you should know that at times during RD activities, a representative from de maximis, one or several of the contractor firms named above or EPA may be on-site to observe these activities.

At this time, we are requesting permission to access your property to conduct the following activities:

Land Survey

Land survey is a necessary, ancillary task to provide survey control and a base map for design development. The land survey task will involve the following major elements:

- Locate visible Site features, including, roadways, paths, drainages, culverts, fence, and other features
- Subsurface utility information will be compiled from field observations/measurements and available record information.

This activity will be completed by one, 2-person team, a vehicle and the necessary field instruments to conduct the land survey. The team will be wearing regular work clothes with high visibility vest. This activity will take up to one to two days to complete.

Surface Water Monitoring Station Sampling

Your property currently contains a surface water monitoring station structure (i.e., concrete pad, a security-housing unit for the surface water monitoring equipment, and a chain-link security cage). We require access to this structure in order to re-install surface water monitoring equipment and to collect surface water samples for analysis. The collection of surface water samples is consistent with previous work performed by the EPA at this location. This activity will be completed by a 2-person team.

Surface water sampling equipment will consist of one vehicle, coolers containing sample bottles, and field instruments. The team will be wearing regular work clothes, hip waders (if necessary) and protective gloves. The sampling activity will take two to four hours and will be performed once per month. In addition to the sampling, weekly operation & maintenance will be conducted on the surface water monitoring station. This activity will take one to two hours per visit. We anticipate collecting surface water samples at this station for a period of two years.

General Assumptions

- Working hours are from 7am to 5pm Monday through Friday.
- de maximis will provide Aberjona Realty Trust one week notice prior to start of any activity on-site.

de maximis and other contractors retained by the Companies will be responsible for the health and safety of their workers while on your property, and will provide you with certificates of insurance at the time we notify you of our intent to start work. In addition, de maximis will maintain the work areas in an appropriate manner, and will coordinate with you or your representative to address any necessary restoration of our work locations.

With respect to the results of any testing performed at your property, de maximis will provide you with the sampling results after EPA review and we will make ourselves available to discuss with you the results of tests conducted on your property. Attached please find a draft agreement for your review and execution, and a figure showing the location of work to be done on or in the vicinity of your property.

Thank you in advance for your cooperation in helping ***de maximis, inc.*** with this program at the Site. A representative of de maximis will contact you in the next week to discuss any questions you may have regarding this work. In the meantime, if you have any questions in connection with this matter, please contact me at (860) 298-0541.

Sincerely,

Bruce Thompson
de maximis, inc.
Project Coordinator

CONSENT FOR ACCESS TO PROPERTIES

In signing this agreement, {Property Owner} hereby licenses and authorizes the Companies, their contractors, United States Environmental Protection Agency (EPA) and the Commonwealth of Massachusetts, to access portions of the property (excluding buildings) located at {Property Owner Address} in {Property Owner's Town} for purposes relating to the Consent Decree (CD) with the EPA pursuant to which remedial response actions at the Site will be designed and implemented. The CD became effective on February 27, 2008.

Name: _____

Address of Properties:
City:
State:

I Consent that officers, employees, contractors, and authorized representatives of the EPA, the Commonwealth of Massachusetts, and the Companies, may enter upon and have continued access to my property for the purposes of conducting certain work under the terms and as described in the attached letter to me from Bruce Thompson dated {date of letter}.

I realize that these actions are undertaken pursuant to response and enforcement responsibilities under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA).

This written permission is given by me voluntarily and with knowledge of my right to refuse.

Name: _____

Title: _____

Firm: _____

Date Authorized: _____

APPENDIX B

Quality Assurance Project Plan

DRAFT

Title and Approval Page

Document Title: Quality Assurance Project Plan

Project Name: Surface Water Monitoring Plan
Industri-Plex Superfund Site Operable Unit 2
(including Operable Unit 3 of the Wells G&H Superfund Site)
Woburn, Massachusetts

Lead Organization: Pharmacia Corporation f/k/a Monsanto Company
by its Attorney-in-Fact Monsanto Company
and
Stauffer Management Company LLC
as Litigation Agent for Bayer CropScience Inc.

Project Coordinator: Mr. Bruce Thompson, *de maximis, inc.*

Approval Signature/Date: 23 JAN 09

SWMP Project Manager: Mr. Lawrence McTiernan, Roux Associates, Inc.

Approval Signature/Date: 1/23/09

SWMP Quality Assurance Manager: Mr. Ian Phillips, Roux Associates, Inc.

Approval Signature/Date: 1/23/09

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B-2. Laboratory SOPs for Analytical Methods

B-3. Equipment Manuals

Distribution

Organization	Recipient	Title	Copies
U.S. EPA[1]	Joseph LeMay	Remedial Project Manager	5
MassDEP[2]	Jen McWeeney	Project Manager	2
de maximis, inc.	Bruce Thompson	Project Coordinator	1
Roux Associates	Lawrence McTiernan	Project Manager	1
	Ian Phillips	Project Quality Assurance Manager	1
	James Dick	Field Manager	1
Alpha Analytical	Gina Bartolomeo	Laboratory Project Manager	1
Haley & Aldrich	Denis Conley	Data Validation Manager	1

1 – U.S. Environmental Protection Agency
2 – Massachusetts Department of Environmental Protection

1.0 INTRODUCTION

Pursuant to the Remedial Design/Remedial Action (RD/RA) Statement of Work (SOW) for Operable Unit 2 (OU 2) at the Industri-Plex Superfund Site (including Operable Unit 3 of the Wells G&H Superfund Site) in Woburn, Massachusetts (hereinafter, "Industri-Plex OU 2"), and on behalf of Pharmacia Corporation by its Attorney-in-Fact Monsanto Company and Stauffer Management Company LLC as litigation agent for Bayer CropScience Inc. (Settling Defendants), this Quality Assurance Project Plan (QAPP) has been prepared to describe the policy, organization, functional activities, and quality assurance (QA) and quality control (QC) protocols necessary to achieve the data quality objectives (DQOs) of the Surface Water Monitoring Plan (SWMP). The QAPP constitutes the first part of the Sampling and Analysis Plan (SAP) for the SWMP and was prepared in general accordance with Attachment A of the RD/RA SOW and the U.S. Environmental Protection Agency (EPA) guidance document titled "Guidance for Quality Assurance Project Plans" (EPA QA/G-5, December 2002).

The aforementioned EPA guidance lists 24 standard elements, divided into four basic element groups, that pertain to various aspects of a project and which must be addressed in the project QAPP. Accordingly, this QAPP contains four principal sections, in addition to this introduction. Each section covers one of the four basic element groups: A) Project Management; B) Data Generation and Acquisition; C) Assessment and Oversight; and D) Data Validation and Usability. Each section is divided into subsections discussing the individual elements applicable to the SWMP.

2.0 GROUP A – PROJECT MANAGEMENT

This element group, comprising nine elements, addresses project administrative functions and project concerns, goals, and approaches to be followed. The first three elements (Title and Approval Sheet, Table of Contents, and Distribution List) have already been provided. The remaining six elements are addressed below.

2.1 Element A4 – Project/Task Organization

Project organization for the SWMP is shown in Figure B-1. The project responsibilities of the various key project team members shown in Figure B-1 are discussed below.

Project Coordinator

Mr. Bruce Thompson of *de maximis inc.* has been retained by the Settling Defendants to serve as Project Coordinator for the Industri-Plex OU 2 RD/RA. Pursuant to the RD/RA Consent Decree, Mr. Thompson's responsibility is to oversee all aspects of the RD/RA, including implementation of the SWMP, on behalf of the Settling Defendants. Mr. Thompson will also serve as liaison between the Settling Defendants and the regulatory agencies (EPA and MassDEP) and between the Settling Defendants and the contractors retained to implement the RD/RA SOW.

SWMP Project Manager

Roux Associates has been retained by the Settling Defendants to prepare and implement the SWMP. Mr. Lawrence McTiernan of Roux Associates will serve as the SWMP Project Manager and, as such, will bear ultimate responsibility for the successful implementation of the SWMP. Accordingly, Mr. McTiernan will provide overall management of the technical, financial, staffing, scheduling, and reporting aspects of the SWMP and will critique all critical project decisions and deliverables. Mr. McTiernan will direct the activities of the SWMP Field Manager and other project staff, and will be supported by the Project QA Officer in the implementation of this QAPP. The approved version of the QAPP will be maintained by Mr. McTiernan, and all recommended changes to the QAPP will be made through Mr. McTiernan.

SWMP Field Manager

Mr. James Dick of Roux Associates will serve as the Field Manager for implementation of the SWMP and, as such, will bear responsibility for the successful execution of the scope of work outlined in the SWMP. Accordingly, Mr. Dick will direct the activities of all technical staff in the

field and those of the analytical laboratory and any other subcontractors. Mr. Dick will also ensure compliance with QA/QC protocols specified in this QAPP (with assistance from the Project QA Officer), as well as the sampling and health-and-safety protocols specified in the Field Sampling Plan (FSP) and Health and Safety Plan (HASP). He will also be responsible for data management and reporting.

Project QA Officer

Mr. Ian Phillips of Roux Associates will serve as the Project QA Officer. Mr. Phillips reviewed and critiqued this QAPP and will assist the SWMP Project and Field Managers as needed in ensuring compliance with this QAPP and the sampling protocols in the FSP. This will be accomplished through reviews, inspections, and audits to ensure that data collection is conducted in accordance with the FSP and QAPP and through coordination with the analytical laboratory and data validation subcontractors.

Laboratory Project Manager

The Laboratory Project Manager, Ms. Gina Bartolomeo of Alpha Analytical, will be responsible for sample container preparation, sample custody in the laboratory, and completion of the required analysis through oversight of the laboratory staff. She will ensure that all QA/QC protocols specified in this QAPP are followed and that an acceptable laboratory report is prepared and submitted. She will report to Roux Associates' Field Manager and/or Project QA Officer and will also communicate directly, as needed, with the Data Validation Manager.

Data Validation Manager

The Data Validation Manager, Mr. Denis Conley of Haley & Aldrich, is responsible for performing/overseeing all data review, verification, and validation for the SWMP. Mr. Conley will likewise report to Roux Associates' Field Manager and/or Project QA Officer and will also communicate directly, as needed, with the Laboratory Project Manager.

2.2 Element A5 – Problem Definition/Background

This element discusses the basis for the SWMP (problem to be solved), provides pertinent background information, and discusses the intended uses of the information to be developed during implementation of the SWMP.

2.2.1 Basis for the SWMP

Although contaminated soils at the Industri-Plex Site have been capped as part of OU 1 remedial actions, they continue to impact groundwater and result in the discharge of contaminated groundwater into Halls Brook Holding Area (HBHA) Pond, located immediately south (downgradient) of OU 1. As depicted in Figure B-2, arsenic, benzene, and ammonia are the principal contaminants migrating via groundwater to the HBHA Pond and impacting surface water and sediments in the pond. In the deeper portions of the HBHA Pond, these contaminants are present in surface water at levels exceeding National Recommended Water Quality Criteria (NRWQCs) and are, therefore, considered by EPA to represent a threat to ecological receptors. Arsenic concentrations in sediment in the HBHA Pond are also considered by EPA to represent a threat to ecological receptors, while arsenic concentrations in sediment in downstream areas including the HBHA Wetland, Wells G&H Wetland, and the Cranberry Bog Conservation Area are considered to represent a current or future human health risk.

In January 2006, EPA issued a Record of Decision (ROD) for Industri-Plex OU 2, which comprises Industri-Plex OU 1 and the aforementioned downstream areas (Figure B-3). The selected remedy is intended, in large part, to manage the downstream migration of arsenic, benzene, and ammonia in HBHA Pond surface water and sediment through engineering controls. On February 27, 2008, a Consent Decree was lodged requiring the Settling Defendants to implement the remedy selected by EPA in the OU 2 ROD. Appendix D to the Consent Decree (the RD/RA SOW) defined the response activities that the Settling Defendants are obligated to perform under the Consent Decree. Among the activities required pursuant to the RD/RA SOW is the submittal and implementation of the SWMP, which is to include all monitoring and analyses necessary to satisfy the surface water monitoring outlined in the ROD. Monitoring under the SWMP is intended to be an interim monitoring program, to be conducted until commencement of long-term monitoring upon approval of the Environmental Monitoring Plan submitted as part of the Remedial Design.

2.2.2 Background Information

As mentioned above, arsenic, benzene, and ammonia concentrations in surface water in the deeper portions of the HBHA Pond exceed NRWQCs, largely as a result of contaminated groundwater discharging to the pond. However, these elevated concentrations are generally restricted to the deeper portions of the pond by a chemocline that is present at about the mid-water depth of the pond. The chemocline is the result of the difference in density between oxic surface water entering

the pond via Halls Brook and other tributaries and the anoxic contaminated groundwater discharging into the pond from below. The relative position of the chemocline fluctuates throughout the year due to seasonal variations in temperature and surface water flow. Below the chemocline, elevated concentrations of dissolved arsenic (up to 5,043 micrograms per liter [µg/L]), benzene (up to 2,530 µg/L), and ammonia (up to 1,762 milligrams per liter [mg/L]) are present. Above the chemocline, maximum arsenic and ammonia concentrations detected are only 27.4 µg/L and 31.1 mg/L, respectively, while benzene was not detected at all in shallow surface water in the HBHA Pond. However, sudden increases in flows, as seen during storm conditions, may mix the water column and destabilize the chemocline, potentially allowing contaminants to be flushed downstream. In addition, ammonia from upstream sources has also been detected in surface water entering the HBHA Pond, primarily via Halls Brook, contributing to the ammonia concentrations in shallow surface water of the pond.

According to the Industri-Plex OU 2 ROD, surface water is a transport mechanism facilitating the migration of arsenic downstream of Industri-Plex OU 1. This conclusion was based on the data collected during an 18-month study of surface water quality conducted on behalf of EPA at and downstream of the HBHA Pond. These data indicate that arsenic concentrations in surface water are highest within Industri-Plex OU 2 and steadily decrease as the Aberjona River flows south to the Mystic Lakes. This study also concluded that, although arsenic concentrations were below NRWQCs at all stations during both storm and baseflow conditions, both particulate and dissolved phases of arsenic represent a mass flux to downstream depositional areas.

2.2.3 Intended Use of the Information

In accordance with the RD/RA SOW, the data developed during implementation of the SWMP will be utilized to monitor surface water trends and demonstrate compliance during implementation of the Industri-Plex OU2 remedy.

2.3 Element A6 – Project/Task Description

Pursuant to the RD/RA SOW, the surface water monitoring program outlined in the SWMP is to be generally consistent with the surface water monitoring conducted during the RI/FS. Accordingly, the SWMP surface water monitoring program will include monitoring of surface water at ten stations along Halls Brook and the Aberjona River at and downstream of Industri-Plex OU 2, shown in Figures B-4 and B-5. The various RI/FS surface water sampling locations will be outfitted with equipment for the continuous monitoring of rainfall, stream depth and velocity, and

six water chemistry parameters (water temperature, specific conductance, dissolved oxygen concentration, pH, oxidation-reduction potential [ORP], and turbidity) and for the automated collection of surface water samples during selected storm events.[1] Baseflow samples will be conducted manually on a monthly basis, while storm samples will be collected roughly quarterly. SWMP monitoring and analysis will include total and dissolved arsenic, total and dissolved iron, benzene, ammonia, nitrate, nitrite, total kjeldahl nitrogen (TKN), and total suspended solids (TSS).

A more detailed discussion of field and sampling techniques and protocols to be employed during implementation of the SWMP is provided in the FSP.

2.4 Element A7 – Quality Objectives and Criteria for Measurement Data

EPA guidance (e.g., "Guidance for Quality Assurance Project Plans" [EPA QA/G-5, December 2002]) requires that a systematic planning process (e.g., Data Quality Objectives Process) be used to plan and design the study that is the subject of a QAPP and that the results of the systematic planning process be discussed within this element. However, since the scope and objectives of the SWMP were largely prescribed by EPA in the RD/RA SOW, a systematic process was not used by the Settling Defendants to plan and design the SWMP, particularly with regard to the type and quantity of data to be developed. Nevertheless, consistent with the aforementioned guidance, to obtain data of adequate quality for their intended uses (i.e., to monitor surface water trends and demonstrate compliance during implementation of the Industri-Plex OU 2 remedy), the Settling Defendants have established the following quality objectives for SWMP data:

1. The data must be comparable with previous datasets for Industri-Plex OU2.
2. The data must be representative of actual conditions.
3. The data must meet the measurement performance criteria (MPCs) established herein for other Data Quality Indicators (DQIs), including precision, accuracy, sensitivity, and completeness.

The use of standard operating procedures (SOPs) for sample collection, accepted analytical methods, and EPA-selected sampling locations will promote comparability of the data, while adherence to SOPs and the use of dedicated or decontaminated sampling equipment will promote the generation of representative data. With regard to the third quality objective identified above, the following are the MPCs that must be achieved to ensure the reliability of SWMP data:

[1] Storms are herein defined as generally continuous rain events during which more than 1 inch of rain falls.

MPCs for Arsenic and Iron Analyses			
DQI	**Assessment Tool**	**Error Type(s)***	**MPC**
Accuracy	Matrix Spike (MS)	A/M	75-125% recovery
	Laboratory Control Sample (LCS)	A	80-120% recovery
Precision	Field Duplicate	S	RPD** ≤ 30%
	Lab Duplicate	A	RPD ≤ 20%***
	LCS Duplicate	A	RPD ≤ 20%
Sensitivity	Method Blank	A	Analyte < reporting limit
	Reporting Limit		3 µg/L
Completeness			85%

*S = sampling error, A = analytical error; M = matrix effect
**RPD = relative percent difference
***If sample result is greater than 5x the reporting limit; if less than 5x the reporting limit, difference between sample and duplicate results must be less than the reporting limit.

MPCs for Benzene Analyses			
DQI	**Assessment Tool**	**Error Type(s)**	**MPC**
Accuracy	MS	A/M	70-130% recovery
	Surrogates	A	70-130% recovery
	LCS	A	70-130% recovery
Precision	Field Duplicate	S	RPD ≤ 30%
	LCS Duplicate	A	RPD ≤ 25%
	MS Duplicate	A	RPD ≤ 30%
Sensitivity	Trip Blank	S/A	Compound < reporting limit
	Method Blank	A	Compound < reporting limit
	Reporting Limit		0.5 µg/L
Completeness			85%

MPCs for Ammonia Analyses			
DQI	**Assessment Tool**	**Error Type(s)**	**MPC**
Accuracy	MS	A/M	80-120% recovery
	LCS	A	80-120% recovery
Precision	Field Duplicate	S	RPD ≤ 30%
	Lab Duplicate	A	RPD ≤ 20%
Sensitivity	Method Blank	A	Compound < reporting limit
	Reporting Limit		0.075 mg/L
Completeness			85%

MPCs for Nitrate Analyses			
DQI	**Assessment Tool**	**Error Type(s)**	**MPC**
Accuracy	MS	A/M	83-120% recovery
	LCS	A	90-110% recovery
Precision	Field Duplicate	S	RPD ≤ 30%
	Lab Duplicate	A	RPD ≤ 6%
Sensitivity	Method Blank	A	Compound < reporting limit
	Reporting Limit		0.1 mg/L
Completeness			85%

MPCs for Nitrite Analyses			
DQI	**Assessment Tool**	**Error Type(s)**	**MPC**
Accuracy	MS	A/M	80-120% recovery
	LCS	A	90-110% recovery
Precision	Field Duplicate	S	RPD ≤ 30%
	Lab Duplicate	A	RPD ≤ 20%
Sensitivity	Method Blank	A	Compound < reporting limit
	Reporting Limit		0.05 mg/L
Completeness			85%

MPCs for TKN Analyses			
DQI	**Assessment Tool**	**Error Type(s)**	**MPC**
Accuracy	MS	A/M	76-111% recovery
	LCS	A	85-110% recovery
Precision	Field Duplicate	S	RPD ≤ 30%
	Lab Duplicate	A	RPD ≤ 24%
Sensitivity	Method Blank	A	Compound < reporting limit
	Reporting Limit		0.3 mg/L
Completeness			85%

MPCs for TSS Analyses			
DQI	**Assessment Tool**	**Error Type(s)**	**MPC**
Precision	Field Duplicate	S	RPD ≤ 30%
	Lab Duplicate	A	RPD ≤ 20%
Sensitivity	Method Blank	A	Analyte < reporting limit
	Reporting Limit		5 mg/L
Completeness			85%

2.5 Element A8 – Special Training Requirements/Certifications

There are no special training requirements associated with the technical aspects of the SWMP, either for field personnel, the analytical laboratory, or other subcontractors. The Field Manager will ensure that all Roux Associates field team members have received at least 24 hours of prior, on-the-job training with respect to the various field sampling tasks.

2.6 Element A9 – Documentation and Records

The Project Manager will be the custodian of all project records, including this QAPP. If any changes are made to this QAPP,[2] including the SOPs contained herein, the Project Manager will communicate this information to the project team and make sure that the revised QAPP is distributed to all parties listed in the Distribution List.

Pursuant to the RD/RA SOW, the Settling Defendants will submit monthly Baseflow Surface Water Monitoring Reports and periodic Storm Flow Surface Water Monitoring Reports. The monthly Baseflow Surface Water Monitoring Reports will include 1) a narrative summarizing the surface water monitoring and maintenance activities performed during the reporting period (including any surveys and equipment repairs); 2) tabular summaries of the range of precipitation, flow, and water chemistry data recorded at each station during the reporting period, the flow and water chemistry readings at the time of monthly baseflow sampling, and the analytical results for the monthly baseflow samples; and 3) a brief discussion of the data (e.g., simple evaluation of trends). An electronic copy of the Flowlink®data for the reporting period will also be provided.

Storm Flow Surface Water Monitoring Reports will also be produced following storm events during which samples were collected and analyzed. These reports will be similar to the monthly Baseflow Surface Water Monitoring Reports, and will include 1) a narrative description of the storm event and related sampling activities; 2) tabular summaries of the storm/runoff statistics for each monitoring station (total precipitation, peak stage, peak velocity, and peak/total flow), the range of water chemistry readings measured during the storm, and the analytical results for the storm samples; 3) the Flowlink® hydrographs and data for the storm; and 4) a brief discussion of the data (e.g., simple evaluation of trends).

[2] All proposed changes to the QAPP must first be reviewed and approved by EPA and MassDEP.

Field logbooks will be used to document on-site conditions during monitoring activities, to record any deviations from established protocols, and to provide a means for identifying field QC samples (which, as described further in Section 3.3, will be designated such that the laboratory cannot determine their origin). This field documentation will not be included in the monthly and periodic reports described above, but will be maintained in Roux Associates' project files. Field forms used to record field data, if any, will be included in the various reports, and will also be stored in the project files.

Project files (including hard copies of reports) will be maintained at Roux Associates' offices in Burlington, Massachusetts or at a secure, off-site storage facility (e.g., Iron Mountain) for up to ten years, or longer if requested by EPA. Reports will also be stored electronically in Roux Associates' local area network, which is password-protected and backed up weekly, as well as on a project portal maintained by the Project Coordinator.

3.0 GROUP B – DATA GENERATION AND ACQUISITION

This element group, comprising ten elements, addresses data generation and data acquisition and management activities.

3.1 Element B1 – Sampling Process Design

As discussed above in Section 2.4, the scope and objectives of the SWMP were largely prescribed by EPA in the RD/RA SOW. Therefore, this element does not include a detailed discussion of the sampling process (experimental) design, such as the scale of representativeness of each particular sample or the class of sampling design (i.e., probability based versus judgmental). Nevertheless, it is recognized that the experimental design for the SWMP selected by EPA was designed to ensure that the data generated during implementation of the SWMP are comparable to those generated during the RI/FS and that the data are representative of different surface water flow regimes (i.e., baseflow versus storm flow) and seasons. Accordingly, the SWMP will include monitoring at eight of the ten RI/FS monitoring locations, as well as at two new stations (all shown in Figures B-4 and B-5), with monthly baseflow sampling and storm sampling on a roughly quarterly basis. At least 160 field samples are anticipated to be collected each year, with analysis for total and dissolved arsenic and iron, benzene, ammonia, nitrate, nitrite, TKN, and TSS. Field QC samples to be collected include field duplicates for all target analytes (one per sampling event), trip blanks (one per sampling event, for benzene only), matrix spikes (one per quarter, for all analytes except TSS), and matrix spike or laboratory duplicates (also one per quarter, for all analytes except TSS).

Baseflow samples will be collected manually as discrete grab samples, while storm samples will be collected automatically as flow-weighted composites comprising multiple aliquots collected over the duration of a storm runoff event at a volume-based frequency (i.e., proportional to stream flow). In order to minimize the likelihood of sampling error, and therefore maximize the likelihood of obtaining representative storm samples (consistent with the data quality objective of developing data that are representative of actual conditions [Section 2.4]), a target of 40 400-milliliter (mL) aliquots divided among 20 individual sample containers has been selected for each storm, with acceptance criteria of no fewer than 30 aliquots and no more than three consecutive "missing" aliquots. Based on the analysis of site-specific dissolved arsenic data using EPA protocols,[3] these criteria will yield a concentration that is accurate within 20% of the true mean. For the purposes of

[3] See EPA 821-B-02-001; EPA 600/2-79-161; WEF Manual of Practice No. 23 (1998); ASCE Manual and Report on Engineering Practice No. 87 (1998); Assessment of Efficient Sampling Designs for Urban Stormwater Monitoring (SCCWRP, 1999); and Caltrans Stormwater Monitoring Protocols 2003

determining the number of aliquots collected, each sample container with a sample volume of 600 mL or greater shall be considered to indicate successful collection of two aliquots. A volume between 250 mL and 600 mL shall be considered to indicate collection of one aliquot, and a volume less than 250 mL will be assumed to indicate that no aliquot was collected. Therefore, two adjacent sample containers containing less than 250 mL of sample would be considered to indicate three consecutive missed aliquots. There will be, of course, exceptions to this general rule; for example, if all 20 sample bottles contained 500 mL of sample, that would indicate collection of only 20 aliquots according to the procedure described above. Although that might otherwise be cause for questioning the representativeness of the entire sample, since the 30-aliquot minimum for sample acceptance would not be achieved, it could be argued that the sample is, in fact, representative, since all 20 sample containers contained the same volume (i.e., the composite sample would still be evenly weighed.),

3.2 Element B2 – Sampling Methods

Baseflow surface water samples will be collected as discrete grab samples, while storm samples will be collected as flow-weighted composites using Isco Model 6712 auto-samplers. Details regarding field sampling procedures and equipment are presented in the FSP. As mentioned in Section 2.4 of this QAPP, the use of and adherence to the SOPs contained in the FSP will promote comparability of the data and the generation of representative data.

At all surface water monitoring stations, continuous measurements of rainfall, stream level and velocity, and six water chemistry parameters (water temperature, specific conductance, dissolved oxygen concentration, pH, ORP, and turbidity) will be obtained using a variety of instruments. In-Situ® MP Troll® 9500 multi-parameter water quality meters will be used to measure water temperature, specific conductance, dissolved oxygen concentration, pH, ORP, and turbidity every five minutes, with the data recorded in the linked Isco Model 6712 automated samplers' data loggers every 15 minutes. Stream stage (level) and velocity will be measured and recorded at the same frequencies using Isco Model 750 area velocity modules linked to the Isco Model 6712s' data loggers. When rain is falling, cumulative rainfall will be measured continuously using Isco Model 674 tipping-bucket rain gauges, with the data also stored in the Model 6712s' data loggers. All equipment will be inspected and downloaded weekly using an Isco Model 581 rapid transfer device (RTD) or via remote telemetry. The downloaded data will be reviewed back at the office using Isco's Flowlink® software to monitor system performance.

For automated monitoring and sampling, system performance will be monitored periodically using remote telemetry to ensure that the system is operating properly. In the event of power failure or other sampling malfunction, staff will be mobilized as soon as possible to the effected monitoring station to assess and rectify the situation.

3.3 Element B3 – Sample Handling And Custody

This element describes the management approaches that will be implemented to ensure that field samples retain their original physical form and chemical composition through collection to final disposal. Management approaches discussed below include sample designation, handling, and custody. For remote sensing data (i.e., rainfall, stream flow, water-chemistry parameters), data will be downloaded weekly to preclude loss or corruption.

3.3.1 Sample Designation

The sample designation system to be used during implementation of the SWMP surface water monitoring program is presented in the FSP. In summary, each field sample will receive a unique identifier containing the sample location and the sampling date. Trip blanks and field duplicates will also be given unique identifiers indicating the type of sample and the sample date, but the analytical laboratory will be kept "blind" as to the location of field duplicate pairs to avoid introducing any bias to the analytical process. Matrix spikes and matrix spike or laboratory duplicates will not specifically be identified as such; rather, field staff will simply collect triple the normal volume of sample required and will label each sample container as a single field sample according to the convention described in the FSP. The laboratory is to be instructed that the extra volume is for the matrix spike and matrix spike or laboratory duplicate by indicating such in the comments column of the chain-of-custody form.

3.3.2 Sample Handling

As described earlier in Section 3.1, all samples will be preserved (as required) and placed in iced coolers immediately upon collection or field processing (for storm samples) to maintain representativeness. The table below, which also appears in the FSP, lists container types and sizes, preservation, and holding times for the various analyses to be performed.

Analyte	Container	Preservation	Holding Time
Arsenic and iron (total)	1 x 250-milliliter (mL) plastic container	Nitric acid to pH<2, 4° C	6 months
Arsenic and iron (dissolved)	1 x 250-mL plastic container	Nitric acid to pH<2, 4° C	6 months
Benzene	2 x 40-mL amber glass vials with Teflon septa	Hydrochloric acid to pH<2, zero headspace, 4° C	14 days
Ammonia and TKN	1 x 500-mL plastic container	Sulfuric acid to pH<2, 4° C	28 days
Nitrate and Nitrite	1 x 500-mL plastic container	4° C	48 hours
TSS	1 x 1000-mL plastic container	4° C	7 days

All samples must be placed in chilled coolers immediately upon collection and delivered to the analytical laboratory within 24 hours of collection, due to the short holding time for the analysis nitrate and nitrite. Other sample handling protocols are described in Roux Associates' SOP for Sample Handling, provided in the FSP.

3.3.3 Sample Custody

The possession and proper transfer of samples must be traceable from the time the samples are collected until the samples are accepted for analysis (and storage/final disposal of unused portions of sample, if any). The FSP informs field personnel that each individual collecting samples is personally responsible for the care and custody of those samples until custody of the samples is formally transferred to another party, such as a sample custodian in the field or office or a laboratory courier. The FSP also provides instructions on documenting custody and custody transfers with a properly completed chain-of-custody form.

Laboratory custody procedures for sample receiving and log-in, sample storage, tracking during sample preparation and analysis, and storage of data are described in detail in Alpha Analytical's Quality Manual, provided as Attachment B-1.

3.4 Element B4 – Analytical Methods

All field and laboratory analytical methods to be employed during implementation of the SWMP were chosen based on one or more of the following criteria:

- the ability to meet the quality objectives for the project

- the validity and reproducibility of the methods
- conformance of the methods to industry-standard or EPA-published methods and practices

3.4.1 Field Analyses

Water chemistry parameters (i.e., water temperature, specific conductance, dissolved oxygen concentration, pH, ORP, and turbidity) will be measured in the field using commonly used, calibrated field probes operated according to the manufacturer's instructions, copies of which have been provided in Attachment B-3. Probes will be calibrated monthly at a minimum, but more frequently if needed based on weekly calibration checks using standard calibration solutions (i.e., with known values).

3.4.2 Laboratory Analyses

For the laboratory analysis of SWMP surface water samples, the laboratory (Alpha Analytical of Westborough, Massachusetts) will use the following methods detailed in the MassDEP's Compendium of Analytical Methods (CAM)/*Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, EPA SW-846, Update III (December 1996) and *Standard Methods for the Examination of Water and Wastewater*, APHA-AWWA-WPCF, 18th Edition (1992):

Analyte	Method	Reporting Limit	SOP
Arsenic (total and dissolved)	CAM/SW-846 Method 6010B with digestion by SW-846 Method 3005A	3 µg/L	06-01/05-05
Iron (total and dissolved)	CAM/SW-846 Method 6010B with digestion by SW-846 Method 3005A	50 µg/L	06-01/05-05
Benzene	CAM/SW-846 Method 8260B	0.5 µg/L	03-03
Ammonia	SM4500NH_3-BH	0.075 mg/L	07-14
Nitrate	SM4500NO_3-F	0.1 mg/L	07-26
Nitrite	SM4500NO_2-B	0.05 mg/L	07-26
TKN	SM4500N-C	0.3 mg/L	07-15
TSS	SM2540D	5 mg/L	07-29

The laboratory's SOPs for the methods cited above (including CAM supplements for Methods 6010B and 8260B) are provided in Attachment B-2. These SOPs specify equipment, method-specific performance criteria, and corrective actions; where QC requirements differ between the SOP and CAM supplements, those specified in the CAM supplements will take precedence.

(Method performance criteria are also summarized in Section 2.4.) Turnaround time on the laboratory analyses is anticipated to be ten business days. The laboratory reports will be presented in a CAM format and will indicate whether the data meet the requirements for attaining "Presumptive Certainty" pursuant to the CAM.

3.5 Element B5 – Quality Control

Overall data usability is influenced by variability (error) introduced into and/or inherent with both field (sampling) and laboratory (analytical) processes. QC checks are tools with which to measure or estimate the overall effect of this variability on a sample collection effort. During implementation of the SWMP, a variety of QC checks will be performed by both field and laboratory staff to assess compliance with project MPCs (see Section 2.4) and the SOPs for the various analytical methods (see Attachment B-2). These QC checks are discussed below.

3.5.1 Field QC Checks

As discussed in Section 3.1, field QC samples to be collected during implementation of the SWMP include field duplicates, trip blanks, and matrix spikes. Equipment blanks will not be collected since primarily dedicated (i.e., disposable) sampling equipment will be used.

Field Duplicates

Field duplicates are used to estimate the overall precision (reproducibility) of a sample collection process. Specifically, if there is a significant difference in the results for a field duplicate pair, it suggests sampling design or process error. Duplicates may be collected as replicates or collocated samples. Replicates are samples from the same sampling point that have been divided into two portions (containers) at some step in the measurement process after sample collection. Collocated samples are independent samples collected in close proximity to one another such that they are essentially an equal representation of the parameter(s) of interest at a given point in space and time. For the SWMP, since much of the sampling will require decanting of samples from sampling devices or unpreserved containers into preserved containers, field duplicates will be collected as replicates by collecting a larger-than-needed volume of sample and alternately filling separate sampling containers.

Field duplicate samples will be collected at a rate of 10%, which equates to one duplicate sample per sampling event.

Trip Blanks

Trip blanks are used to assess the potential for bias (inaccuracy) through the introduction of volatile contaminants into the sample or sample containers during transport, handling, and/or storage. Trip blanks are prepared at the laboratory by filling a sample container with analyte-free water prior to the sampling event. The trip blanks are then transported to the field and are kept with the investigative samples throughout the sampling event, but are not exposed to the sampling process. They are then packaged with the other samples for shipment to the laboratory for analysis. At no time after their preparation are trip blank containers opened before they reach the laboratory.

One trip blank should be included in each sample shipping cooler containing samples for volatile organic compound (VOC) analyses. Therefore, to minimize costs, all samples for VOC analysis should be placed in the same cooler whenever practicable. Given that only nine field samples and one field duplicate will be collected per sampling event, it is anticipated that only one trip blank will be required for each sampling event during which samples are collected for benzene analysis (i.e., baseflow sampling events).

Matrix Spikes

Matrix spikes are used to determine if the sample matrix has any adverse effect on the ability of the laboratory to accurately quantify constituent concentrations in the sample. Designated field samples (typically samples known to have low concentrations of target analytes) are spiked by the laboratory with known concentrations of one or more analytes, and then the spiked samples are analyzed with the sample batch. The extent to which the laboratory can recover the spiked concentration is an indicator of potential matrix effect. The method SOP details the corrective actions necessary when matrix spike recoveries are poor, since the poor recoveries can also be attributable to other laboratory error or even field error.

Since the only medium being sampled during implementation of the SWMP is surface water, significant matrix effects are not anticipated. Therefore, matrix spikes samples will be requested only quarterly during baseflow sampling.

Matrix Spike Duplicates

Matrix spike duplicates will be requested quarterly to further evaluate potential matrix effects, but also to assess laboratory precision (see next section).

3.5.2 Laboratory QC Checks

The laboratory analytical methods selected for the SWMP surface water monitoring program (see Section 3.4.2) include specific QC activities, acceptance criteria, and corrective actions to ensure that data produced by the analytical laboratory are usable for project objectives. All laboratory QC activities are specified in the method SOPs provided in Attachment B-2. In general, laboratory QC checks include, but are not limited to, the following:

- calibration checks for verifying instrument sensitivity and accuracy
- method blanks to ensure representativeness of the results
- laboratory control samples (LCSs) to measure instrument accuracy
- LCS duplicates and laboratory duplicates to assess laboratory precision
- surrogates (organics only) for assessing potential matrix effects

MPCs for some of these laboratory QC checks are identified in Section 2.4.

3.6 Element B6 – Instrument/Equipment Testing, Inspection and Maintenance

As described in Section 2.3, the SWMP surface water monitoring stations will be outfitted with equipment for the continuous monitoring of rainfall, stream flow, and water chemistry parameters and the automated sampling of surface water during selected storm events. To ensure that this equipment will work property when needed, the various monitoring stations will be visited weekly for routine O&M, including the following activities:

- inspection of instrumentation and tubing, if present
- clearing of flotsam and other debris
- cleaning of sample intakes and staff gages
- cleaning of the Isco 750 level/velocity and In-Situ® MP Troll® 9500 water quality sensors
- checking power levels (battery and solar panels)
- inspection and, if needed, cleaning of rain gauges

In addition to these weekly O&M activities, the solar panels powering the monitoring equipment will be cleaned on a monthly basis. All inspection and maintenance activities will be performed in accordance with manufacturers' specifications, which are contained in the respective equipment manuals, copies of which are provided in Attachment B-3. All equipment O&M activities, including anomalies noted and corrective actions taken, will be documented in field logbooks or O&M log forms.

Laboratory equipment will be regularly inspected and maintained in accordance with the laboratory's Quality Manual (Attachment B-1).

3.7 Element B7 – Instrument/Equipment Calibration and Frequency

Roux Associates will calibrate the surface water monitoring equipment on a regular basis as part of routine O&M. Weekly O&M activities will include the collection of manual stage measurements as calibration checks on the Isco 750 level sensors, as well as calibration checks on the In-Situ® MP Troll® 9500 water quality meters using standard calibration solutions (i.e., with known values). Monthly O&M will include calibration of the In-Situ® MP Troll® 9500 water quality meters and calibration of the Isco 750 velocity sensors through manual measurement of velocity. If any significant anomalies are noted during either weekly or monthly O&M, the equipment will be recalibrated or removed from service.

Laboratory equipment will be calibrated in accordance with the laboratory's Quality Manual (Attachment B-1) and method-specific SOPs/CAM requirements (Attachment B-2). Calibration records will be maintained by the laboratory in accordance with the laboratory's Quality Manual.

3.8 Element B8 – Inspection/Acceptance of Supplies and Consumables

Certain supplies and consumables associated with the SWMP surface water monitoring program are considered "critical," i.e., which may directly or indirectly affect the quality of the results. These include sample containers, tubing, and filters. The Field Manager will be responsible for ensuring that an adequate supply of the critical supplies and consumables is available and that consumables are certified clean. Sample containers will be provided by the laboratory, pre-cleaned and with appropriate preservative added. The laboratory has a control procedure in place to ensure cleanliness of sample containers, as described in its Quality Manual (Attachment B-1). In addition, there are other laboratory-related critical consumables such as reagent water and reference standards. The adequacy of these materials will be ensured and documented in accordance with the laboratory's Quality Manual (Attachment B-1) and method-specific SOPs (Attachment B-2).

3.9 Element B9 – Non-Direct Measurements

This element in intended to address data obtained from existing sources rather than directly measured or generated during the SWMP. The only such data which will be used during implementation of the SWMP will be storm hydrographs recorded during the RI/FS and Final GSIP SOW surface water monitoring programs. These hydrographs will used, along with new information developed during the preliminary stage-response evaluation phase of the SWMP, to

determine stream response at each SWMP monitoring station to a range of storms/runoff events. This information will, in turn, be used to determine the appropriate length of the sample intake at each station, the type (i.e., local vs. remote) and timing of sampler activation, and the flow intervals and aliquot volumes to be used in flow-paced sampling.

The RI/FS hydrographs, produced by EPA's contractor, were published in the Final RI/FS Report and are therefore considered acceptable for their intended use. Similarly, the Final GSIP SOW hydrographs are considered acceptable for their intended use since they were published in the Final GSIP SOW Downgradient Transport (Surface Water and Sediments) Report, which is part of the Industri-Plex OU2 Administrative Record.

3.10 Element B10 – Data Management

A variety of data will be generated during the SWMP surface water monitoring program, including manual field measurements, data collected and logged automatically by field instruments, and results of chemical analyses. Management of these data will vary from type to type, as discussed below. Regardless of data type, however, all hard-copy and electronic data will be stored consistent with Roux Associates' document retention policy, as described in Section 2.6.

Manual Field Measurements

Manual field measurements will be recorded in field logbooks or activity-specific forms. Entries in the field logbooks will be photocopied as soon as practicable following each site visit to ensure that a backup copy of the field measurements exists in the event the field logbook is lost, stolen, or destroyed. Photocopies of field logbooks will be kept in the project file. Field forms will also be returned to the office as soon as practicable following each site visit and stored in the project file.

Automatic Field Measurements

Semi-continuous measurements of rainfall, stream flow, and water-chemistry parameters obtained by the various automated monitoring equipment to be employed during implementation of the SWMP will be stored in the Isco Model 6712 datalogger. Although the Model 6712's extended on-board memory is capable of storing these data for up to six months at the recording frequency to be used, the data will be retrieved weekly to minimize the potential for data loss due to power failure or corruption. Roux Associates will upload all data into Roux Associates' Flowlink® project database, which will in turn be uploaded to a site-specific project portal maintained by the Project Coordinator (discussed below).

Laboratory Results

For each SWMP sampling event, the analytical laboratory will provide a CAM-compliant summary report, electronic data files, and a CLP-like Level IV data package. A Level IV data package will permit validation in accordance with EPA Region 1 Tier III requirements, if desired. Level IV data packages will include the following:

- sample results
- forms summarizing all QC measurement parameters specified in the method
- all associated raw data generated in support of the reported results

Forms summarizing all QC measurement parameters specified in the method include:

- instrument tuning summary and associated sample summary
- initial and continuing calibration data summaries
- internal standard response and retention time summaries
- laboratory control sample (LCS) data summaries
- MS results
- surrogate standard results
- laboratory duplicate summaries.

Raw data will include copies of all associated instrument printouts and laboratory notebook records that were generated during sample preparation and analysis.

Laboratory electronic data deliverables (EDDs) delivered to Roux Associates will be uploaded into Roux Associates' Microsoft Access project database. EDDs will also be provided to the Project Coordinator for uploading into the Site database. Laboratory protocols for data reduction are described in the laboratory's Quality Manual (Attachment B-1).

Site Database

The Project Coordinator will maintain a highly structured environmental database in conjunction with a geographic information system (GIS) and an internet communication platform to

- archive historic environmental data for the Industri-Plex Site (all media);
- normalize data from different sources (putting disjointed data in a common format so that they can be compared against one another);
- distribute the data to authorized personnel in a timely fashion;

- query that data in a fashion that allows a user to quickly obtain data based on sample locations, parameters, measurement value and date criteria;
- compare the data against environmental clean-up goals to quickly obtain samples with analytical values which exceed those drivers;
- trend the data temporally so that positive and negative relationships can be visualized between and among sample measurements;
- map and spatially analyze the data so that spatial relationships among the data might be realized.

The database platform is provided by the Geographic Environmental Management System (GEMS), an industry-tested environmental database platform developed by Summit Envirosolutions, Inc. GEMS is a Visual Basic for Applications (VBA) application written on Microsoft Access® 2003 and consists of two separate Access files, one used to house the graphical user interfaces (GUIs) and one dedicated to housing the environmental data, referred to as the "dataset." The environmental database is then accessed via the GUI database. The tables within the dataset are highly structured utilizing relational database concepts and practices (refer to the GEMS Relational Database Model flow chart in Plate 1 of the SWMP for a schematic of tables and columns and relationships among them). Generally speaking, these tables were constructed to represent the characteristics and resulting data associated with any environmental sampling efforts including, but not limited to

- **Sample Locations** – physical attributes describing the physical location that the sample was collected (e.g., well name, construction, screen elevation, boring drill method, install date, elevations, coordinates)
- **Field Sample Properties** – attributes associated with the actual sample collected from the Sample Location (e.g., sample name, collected by, sample date, weather conditions at the time of sampling)
- **Sample Measurements, Results or Description** – actual physical or analytical numeric results generated by various measuring techniques depending on the parameter values desired (e.g., depth to water, chemical concentration, soil type, measurement method, measurement method detection limits, entity that did the measurement)

The database consists of tables designed to store these data and also tables associated with providing list of valid values acceptable for use in describing these data. These valid value tables are crucial in that they are utilized to standardize or normalize the data so that queries can be performed with confidence that they are returning all the results associated with the question that the user has asked.

The GEMS user interface was designed to enforce referential database integrity and approved valid values. Without this enforcement, a database query for all trichloroethene, for example, may not truly return all data it has that matches those criteria because some of the data is stored as trichloroethylene (a known synonym) thereby producing an incomplete representation of the dataset.

The GEMS user interface contains a QA/QC interface that one can run to identify parameter and location names that exist in the dataset but which are not in the approved set of valid values. Users are then provided the option to either add that parameter or sample location name as a new approved value or change it to that of an existing respective value from the list of values.

Historical data imported to the Industri-Plex OU2 database at the time of this writing include historic analytical data provided by the EPA and previous surface water data measured through the use of Isco samplers. Forthcoming data will be imported into the database through the use of the EDD vehicle. The GEMS v6 EDD format has been provided to the laboratory so that their forthcoming deliverables can be imported directly into the database, quality checked, and distributed in a timely fashion.

Third-party data validation reports will be used to then update any result values and qualifiers which the validator has changed. The original result, original qualifier, validation date and validator's name are then recorded and stored in the actual table row which received a validator's update.

Once a GEMS dataset has been updated with a new set of data from a recent field sampling event, it will be imported into the Project Portal™ web application for distribution to the collective project team. Project Portal is a .NET™ web application designed to centralize and distribute documents, schedules, environmental data and maps to large environmental project teams in a highly efficient manner. Project Portal employs a rigorous rights management system to enforce which users are permitted to perform individual operations. Project Portal consists of the following modules, all available for use by the Industri-Plex OU2 project team:

- Document Management System
- Project Calendar Sharing and Collaboration
- Query-able Environmental Database Access
- Interactive and embedded On-line GIS

- Custom Project Tables (database) which users can use to create tables for distributing tabular data of any nature

Environmental data uploaded into Project Portal's Environmental Database Module is stored in a MySQL® server-grade relational database backend. The Environmental Database module allows authorized users to query the Industri-Plex OU2 environmental dataset through an intuitive interface that allows them to query data based from their custom sample location, sample parameter (e.g., analyte), sample date, and exceedances filter setting selections. The user may then either simply view, graph, map or export the subsequent query results to various formats including Microsoft Excel®, a comma-separate value (.csv) file, Environmental System Research Institute (ESRI)® shapefile, or a Google Earth® (.kml) file.

If the user chooses to map the query results, those values will be plotted to the interactive GIS Module utilizing the coordinates stored in the database. The result value will be posted next to each sample location.

4.0 GROUP C – ASSESSMENT AND OVERSIGHT

The two elements in this group detail the assessments and evaluations that will occur during implementation of the SWMP to determine whether this QAPP is being implemented as approved, to increase confidence in the information obtained, and ultimately to determine whether the information may be used for its intended purpose.

4.1 Element C1 – Assessments and Response Actions

Given the interim and low-profile nature of the SWMP surface water monitoring program and its consistency with the RI/FS monitoring program, only one internal audit will be performed during implementation of the SWMP. This audit, a field audit, will be led by Mr. Walt Eifert, Principal Hydrologist with Roux Associates, and will be conducted relatively early in the program to allow for timely corrective action, if needed, prior to the generation of a significant amount of data. The audit will focus mainly on measurement and sampling procedures, to ensure that representative data are being generated.

The analytical laboratory will perform internal audits in accordance with its Quality Manual (Attachment B-1).

4.2 Element C2 – Reports To Management

The scope and findings of Roux Associates' internal field audit will be provided in the applicable monthly Baseflow Surface Water Monitoring Report, along with a scope and schedule for corrective action.

5.0 GROUP D – DATA VALIDATION AND USABILITY

The three elements in this group address the final project checks to determine whether the data developed conform to the stated objectives of the project and to estimate the effect of any deviations.

5.1 Element D1 – Data Review, Verification, and Validation

In accordance with EPA guidance, this element identifies the criteria for deciding to accept, reject, or qualify project information. Such decisions will be based on the data review, verification, and validation procedures described below in Section 5.2, which will determine whether the data meet project quality objectives. As discussed in Section 2.4, the following quality objectives have been established for SWMP data:

1. The data must be comparable.
2. The data must be representative of actual conditions.
3. The data must meet the MPCs established herein for other DQIs, including precision, accuracy, sensitivity, and completeness.

The MPCs for the DQIs of precision, accuracy, sensitivity and completeness were presented in Section 2.4. Data meeting the MPCs for these DQIs, and not otherwise determined to be unrepresentative or unreliable, will be considered acceptable for meeting project objectives. Data which do not meet one or more MPCs may still be acceptable for project use, although some degree of qualification may be required. Data grossly failing to meet one or more MPCs will be rejected, unless substantial other evidence supports use with qualification.

5.2 Element D2 – Verification and Validation Methods

All laboratory data generated during the course of the project will be validated using Region I EPA – New England Data Validation Functional Guidelines for Evaluating Environmental Analyses (Revised December 1996) or similar procedures modified for non-CLP analyses.

Tier II data validation comprising evaluation of the following will be performed on 100% of the laboratory data generated during the SWMP surface water monitoring program:

- data completeness
- holding times
- GC/MS tuning (organics)
- calibration

- blanks
- surrogate recovery (organics)
- ICP interference check samples (inorganics)
- matrix spike analysis
- matrix spike duplicate analysis (organics)
- lab duplicate analysis (inorganics)
- field duplicates
- laboratory control sample analysis
- internal standards performance (organics)
- ICP serial dilution analysis (inorganics)
- Sample result verification
- Detection limits
- System performance (organics)
- Overall assessment of data

Tier III validation, including the evaluation of the analytical raw data and mass spectra to verify sample results, will be completed on approximately 10 percent of the data (i.e., two sampling events [one baseflow, one storm] per year). Any qualification of the data recommended as a result of either Tier II or Tier III data validation will be communicated to EPA in the Baseflow and Storm Flow Surface Water Monitoring Reports, and copies of the validation reports will be provided to EPA upon request. Data qualifiers will also be added to the project database as necessary.

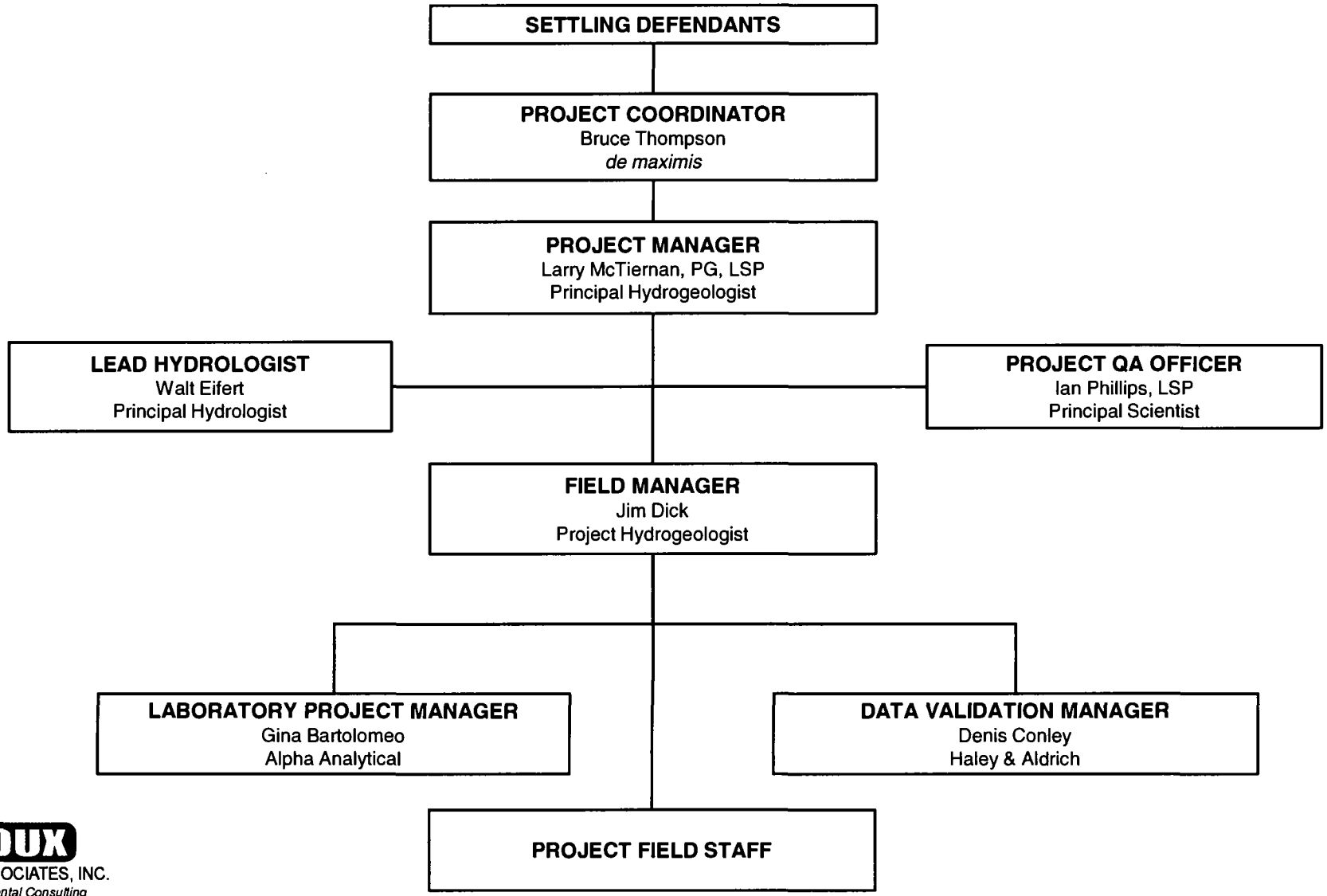
5.3 Element D3 – Reconciliation With User Requirements

This final element of the QAPP describes how validated data are evaluated to determine if they are of adequate quality to be used for the stated objectives of the project. As described in Section 2.2.3, the data developed during implementation of the SWMP are to be utilized to monitor surface water trends and demonstrate compliance during implementation of the Industri-Plex OU2 remedy. If the data are accepted (see Section 5.1), they are of adequate quality to be used for the stated objectives of the project. Conversely, if the data are rejected, they cannot be used for the stated objectives of the project. In between are the data that do not meet all MPCs and are therefore usable but qualified. The significance of the qualification will be determined by the end user of the data, and may necessitate additional data collection.

Figure B-1

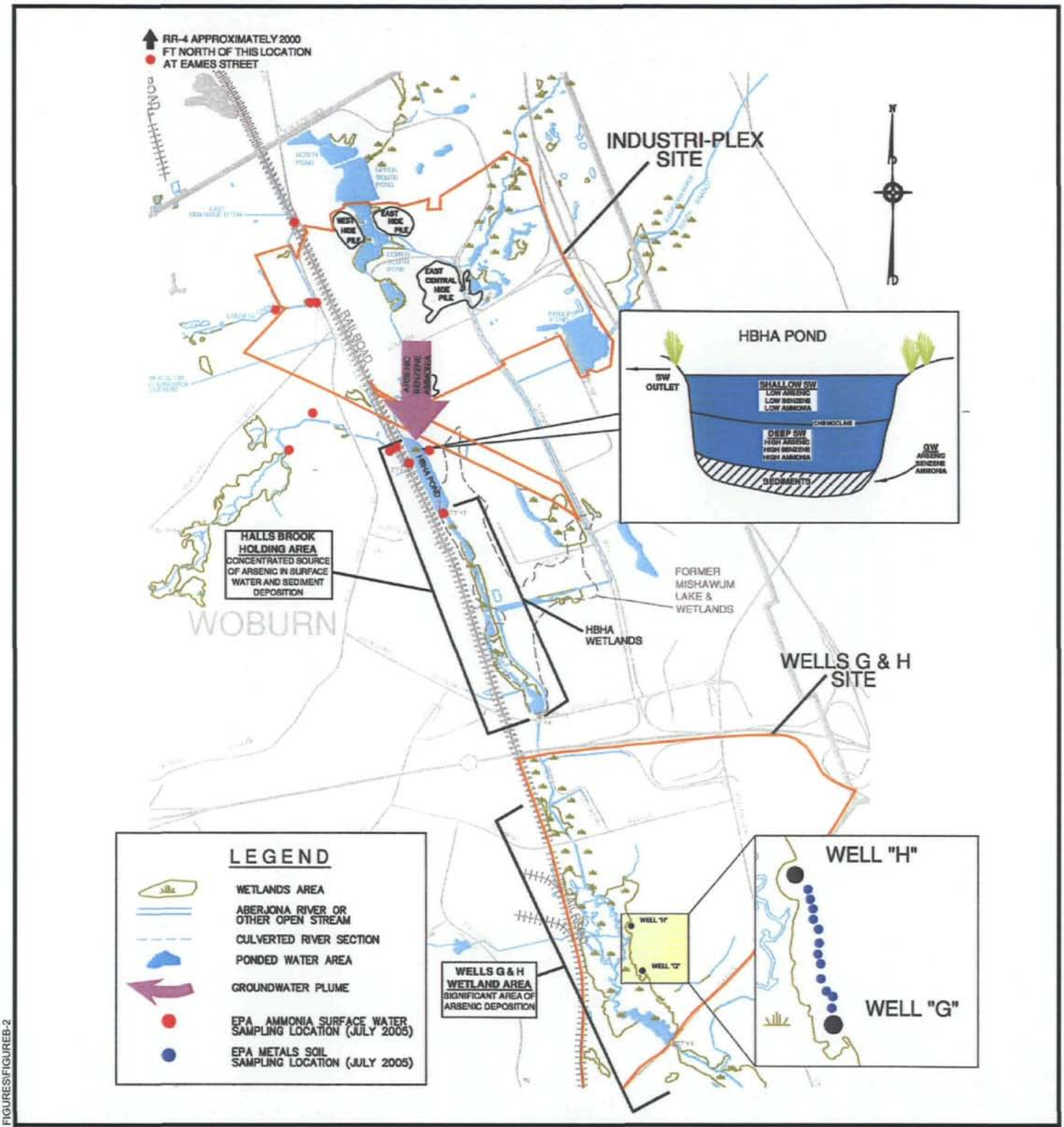
PROJECT ORGANIZATION CHART

Surface Water Monitoring Plan
Industri-Plex Superfund Site Operable Unit 2
Woburn, Massachusetts



ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

IPS1194.0001M007.100/QAPP.Fig1



SOURCE:
USEPA, 2005.
Fact Sheet Supplementing the
June 2005 Proposed Plan.

Title:

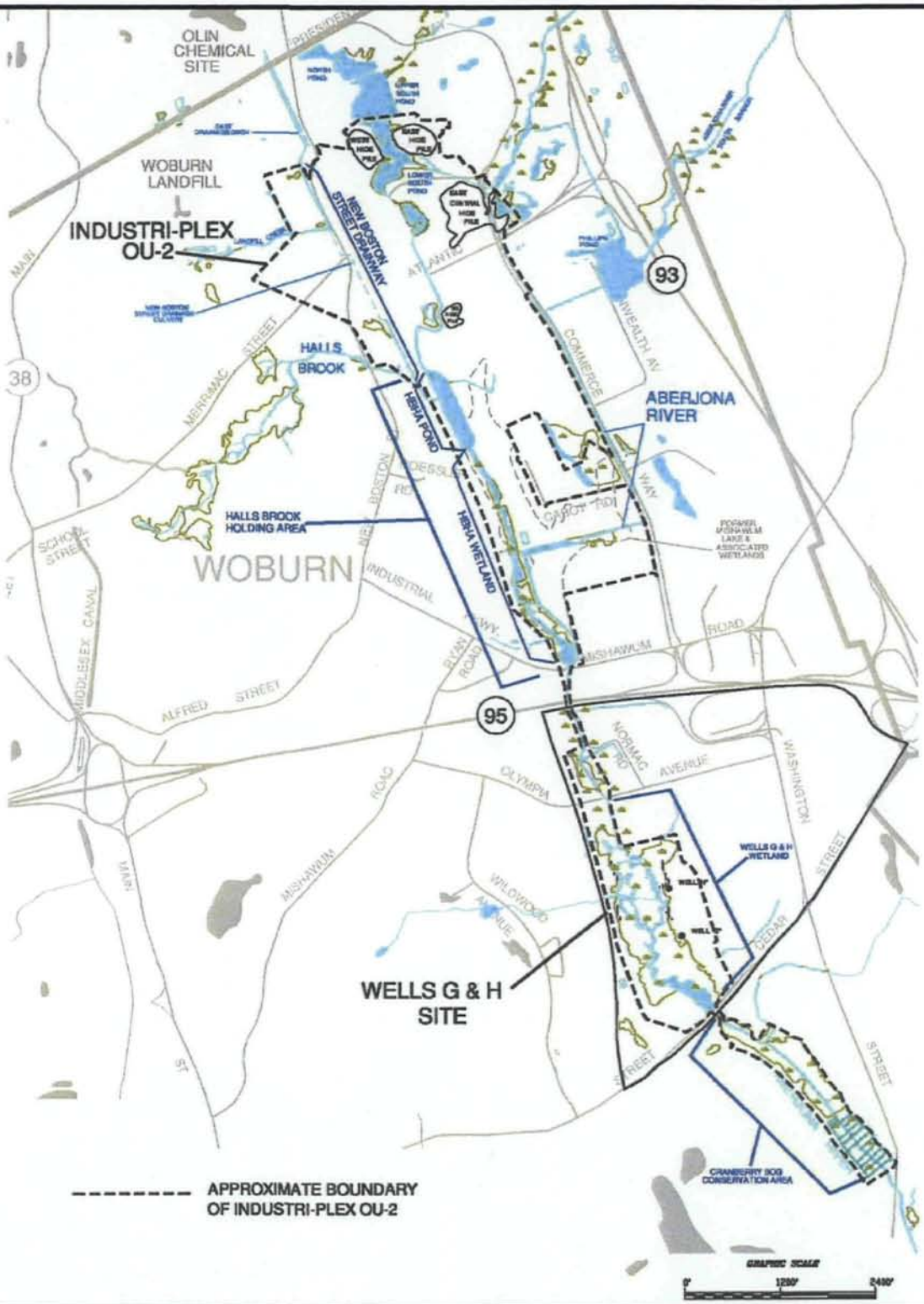
CONTAMINANT MIGRATION PATHWAYS INDUSTRI-PLEX OPERABLE UNIT 2

Prepared for:

INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES, INC. *Environmental Consulting & Management*	Compiled by: BH	Date: 5/15/08	FIGURE B-2
	Prepared by: CRS	Scale: NTS	
	Project Mgr.: LM	Office: MA	
	File No.: FIGUREB-2	Project No.:119401M07	

N:\PROJECTS\I-PLEX\119401M07\100\NEWFIGURES\5-15-08\B FIGURES\FIGUREB-2



■ APPROXIMATE SITE LOCATION

SOURCE:
USEPA, 2006. Record of Decision
Industri-Plex Superfund Site
Operable Unit 2.

Title:

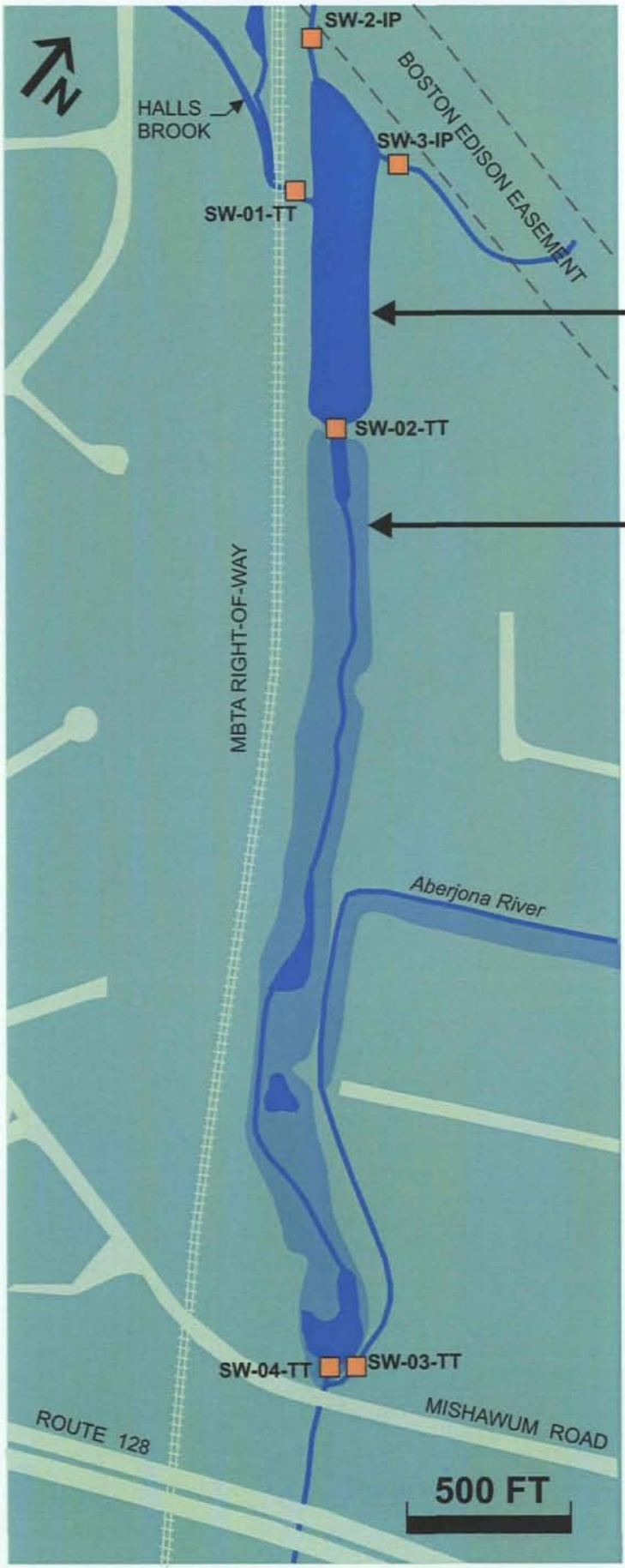
LOCATION OF INDUSTRI-PLEX OPERABLE UNIT 2

Prepared for:
INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: BH	Date: 5/15/08	FIGURE
Prepared by: CRS	Scale: AS SHOWN	B-3
Project Mgr.: LM	Office: MA	
File No.: IPS0110008	Project No.: 119401M07	

N:\PROJECTS\I-PLEX\119401M07\100\NEWFIGURES\5-15-08\B FIGURES\FIGUREB-3



LEGEND

SW-01-TT ■ APPROXIMATE LOCATION AND DESIGNATION OF SURFACE WATER MONITORING STATION

Title:

SURFACE WATER MONITORING STATIONS NORTH OF ROUTE 128

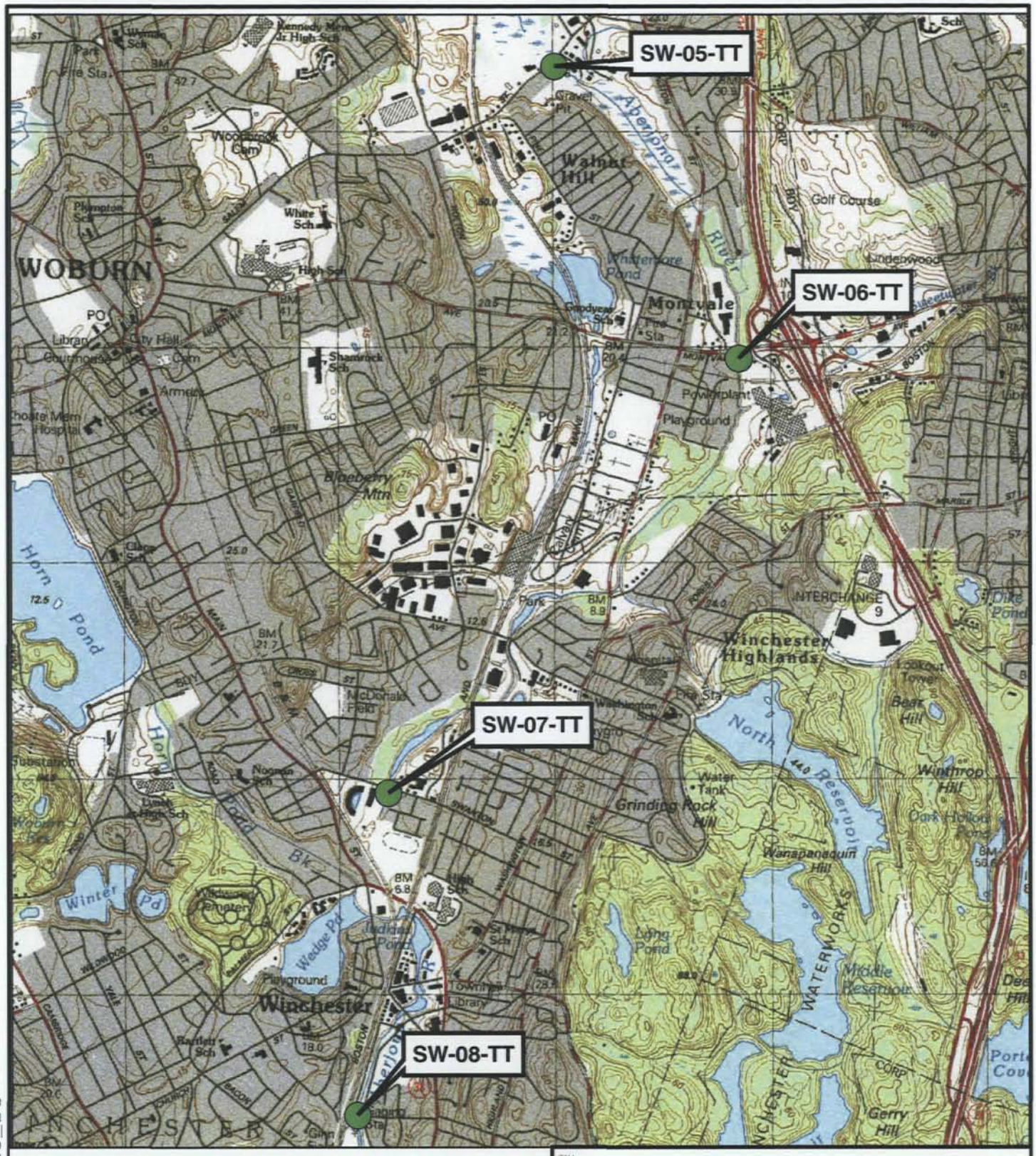
Prepared for:

INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES INC.
Environmental consulting & Management

Compiled by: LM	Date: 1/10/09	FIGURE
Prepared by: CRS	Scale: AS SHOWN	B-4
Project Mgr.: LM	Office: MA	
File No.: FIGUREB-4	Project No.: 119407M07	

N:\PROJECTS\I-PLEX\119401M07\100\NEWFIGURES\5-15-08\B FIGURES\FIGUREB-4



■ QUADRANGLE LOCATION

SOURCE:
USGS, 1987.
Reading (Massachusetts) Quadrangle
1:25,000–scale Topographic Map

N

0 1,000 2,000 Feet

Title:

SURFACE WATER MONITORING STATIONS SOUTH OF ROUTE 128

Prepared For:

INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled By: LM	Date: 1/13/09	FIGURE
Prepared By: CRS	Scale: AS SHOWN	B-5
Project Mgr.: LM	Office: MA	
File No.: IPS0110005	Project: 119401M	

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ATTACHMENT B-1

Alpha Analytical, Inc. Quality Manual

Quality Manual

Alpha Analytical, Inc.

Uncontrolled Document

D/B/A
Alpha Woods Hole Labs
Eight Walkup Drive
Westborough, MA 01581-1019
Telephone: (508) 898-9220
Facsimile: (508) 898-9193
Email: info@alphalab.com
Web site: www.alphalab.com

President: Mark Woelfel, Ext. 5115
Laboratory Director / Technical Director: Christopher Wakefield, Ext. 5124
Quality Assurance Officer: Ellen Collins, Ext. 5121

1 Mission Statement

The mission of Alpha Analytical Laboratory is quite simply to provide our clients with the greatest value in analytical service available. For the 'greatest value' is not only found in the data that is delivered, it is also found in the services provided.

- Data must be of the highest integrity, accuracy and precision.
- Consultation and educational services must be provided to support the customer in establishing data quality objectives and interpretation of the final data package.
- Support services such as sample containers, courier service and electronic data deliverables must be available to the client.

Alpha's mission continues with an established commitment to our community and environment. We must ensure that we do not produce any additional contamination to our environment or harm our neighbors and community in any way.

The value of Alpha's product is in the honesty and integrity with which each chemist, courier, login staff member, or office staff member performs their tasks. The client or employee must always feel satisfied that they received the greatest value in their lab experience at Alpha.

Alpha Analytical Labs will vigorously pursue its mission into the next millennium.

Mark Woelfel

President

Uncontrolled Document

1.1 Signature Page

Copy No. _____

Alpha Woods Hole Labs
Uncontrolled Document

Controlled Document

1.2 Management Authorization

President

Signature: Mark K Woelfel Date: 8/13/07

Name: Mark Woelfel

Laboratory Director / Technical Director

Signature: Christopher Wakefield Date: 8/13/07

Name: Christopher Wakefield

Quality Assurance Officer

Signature: Ellen Collins Date: 8.13.07

Name: Ellen Collins

ISSUE AMENDMENTS

Changes since last issue:

Numerous revisions to entire document.

Reordering of Appendices.

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3 Introduction

The Quality Manual (QM) of Alpha Woods Hole Labs (Westboro) describes the quality program in use at the laboratory. This Quality Manual provides employees, clients and accrediting agencies with the necessary information to become familiar with how the quality system operates within Alpha Woods Hole Labs. The quality program includes quality assurance, quality control, and the laboratory systems including feedback mechanisms for the automated continuous improvement of the laboratory operations to meet client needs.

Implementation of the laboratory operations is by documenting procedures, training personnel and reviewing operations for improvement. Written procedures are maintained as Standard Operating Procedures (SOPs). The SOPs are available to the staff as an uncontrolled, electronic, secure copy. The provisions of the QM are binding on all temporary and permanent personnel assigned responsibilities. All laboratory personnel must adhere strictly to the QM and SOPs.

Fifteen (15) sections comprise the QM. Related quality documentation including the listing of SOPs, forms, floor plan, equipment, personnel and laboratory qualifications are available. The QM sections provide overview descriptions of objectives, policies, services and operations.

3.1 Scope

The QM describes the requirements of the Laboratory to demonstrate competency in the operations for performing environmental tests for inorganic, organic, air and microbiological testing. The basis for the environmental tests is the methods found in documents published by the United States Environmental Protection Agency (EPA), ASTM, AOAC, APHA/AWWA/WEF and other procedures and techniques supplied by clients.

The QM includes requirements and information for assessing competence and determining compliance by the laboratory to the quality system. When more stringent standards or requirements are included in a mandated test method, by regulation, or specified in a project plan the laboratory demonstrates achievement of the client specified requirements through its documented processes.

The QM is for use by Alpha Woods Hole Labs for developing and implementing the quality system. Accrediting authorities and clients use the QM for assessing the competence of Alpha Woods Hole Labs.

3.2 References

An electronic register of external documents or books is available on the company intranet for staff to determine the latest edition or version of the reference methods, regulations or national standards. The Quality Assurance Department maintains the register. Management purchases automated update services, where available, to provide the laboratory with the latest hardcopy edition, where electronic means is not available.

3.3 Definitions

Appendix A lists the definitions as adopted by the laboratory. The definitions are from the standard approved in June, 2005, by the National Environmental Laboratory Accreditation Conference (NELAC). The definitions in Appendix A are updated, as necessary, after publication of the NELAC adopted Glossary.

4 Organization and Management

4.1 Legal Definition of Laboratory

Alpha Woods Hole Labs is a full service analytical laboratory. Testing services include Drinking Water, Waste Water, Ground Water, Waste material and Air. Alpha Woods Hole Labs is a privately held corporation incorporated in the state of Massachusetts. Alpha Analytical, Inc. does business as (D/B/A) Alpha Woods Hole Labs.

Alpha Woods Hole Labs has been in business since 1985. The types of businesses served include:

- Consulting firms,
- Engineering firms,
- Waste Management Companies,
- Industrial sites,
- Municipal agencies and
- Other commercial businesses.

4.2 Organization

The laboratory operates a quality system approach to management in order to produce data of known quality. The laboratory organization provides effective communication and lines of authority to produce analytical data meeting client specifications. The organizational design provides open communication while ensuring that pressures and day to day operating circumstances do not compromise the integrity of the reporting of the final data.

The President is responsible for directing all areas of the company. The following job functions report to the President:

- Operations Managers
- Quality Assurance Officer
- Client Services Manager
- Marketing / Business Development / Sales
- Financial Services
- Human Resources

The Operations Manager is responsible for directing all laboratory operational areas of the company. The following job functions report to the Operations Manager:

- Laboratory/ Technical Director(s)
- Department Managers

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The Laboratory/Technical Director(s) is responsible for the laboratory data generated by the organics testing, inorganics testing and metals testing areas.

The Departmental Managers (Supervisors) have the following responsibilities:

The organics managers direct personnel in the organics extraction and instrumental laboratories.

The wet chemistry manager directs personnel and supervisors in the wet chemistry and microbiological testing areas.

The metals manager directs personnel and supervisors in the metals sample preparation and instrumental laboratories.

The Quality Assurance (QA) Officer is responsible for interacting and communicating certification requirements, implementing the quality manual and reporting to the Laboratory Director and Senior Management the status of the quality program. The QAO oversees the Quality Systems Specialists.

The Client Services Manager is responsible for client interactions, project coordination and laboratory personnel notification of project requirements. Also the Client Services Manager is responsible for the areas of sample container preparation and transportation of containers and samples to and from the laboratory.

The Marketing, Business Development and Sales personnel are responsible for increasing the volume of work from current clients and adding new clients to the base business of Alpha Woods Hole Labs. The Marketing and Business Development personnel review all new work with the Laboratory Director, Operations Manager, President and/or Quality Assurance Officer before contractual commitment.

The CFO is responsible for maintaining and reporting on the financial status of the company. The Controller directs financial personnel on proper accounting procedures and maintaining the list of approved suppliers and subcontractors. The Controller reports directly to the CFO.

The Human Resource Administrator is responsible for personnel recruitment, hiring, performance reviews and maintaining the human resource and personnel training files.

Personnel job descriptions define the operational function duties and responsibilities. Administration and Laboratory personnel assignments may include cross-functional training and work performance in multiple areas of the operations. Multiple functional training ensures laboratory back up personnel during peak loads.

During the absence of any staff member, assignment of alternative personnel occurs by memo or e-mail. The Manager or Supervisor authorizes the assignment. The naming of alternative personnel assures the continuing performance of critical tasks during the primary's person absence and ensures that lines of communication remain open for continued decision making. The deputy for the Laboratory Director is the Quality Assurance (QA) Officer. The deputies for the Quality Assurance (QA) Officer are the Quality Systems Specialists.

For the purposes of NELAC Accreditation, the Lead Laboratory Technical Director is the Laboratory Director. The deputies for the Lead Technical Director are the Quality Assurance (QA) Officer, and the Departmental Managers.

4.3 Business Practices

Alpha maintains certification for the programs and analytes required by regulatory programs. The listing of qualifications from the various certifications, registrations and accreditation programs are available upon request. Alpha Woods Hole Labs operates Monday to Friday from 7:30 a.m. to

5:30 p.m. Management prepares and posts the holiday schedule for the year indicating closed operations. Sample delivery occurs during normal operating hours unless arranged in advance.

Alpha's reputation depends upon timely reporting and quality data. The standard turnaround time for engineering and consulting firms is five business days from time of sample receipt. Standard turnaround for all other clients is ten business days from time of sample receipt. The time of sample receipt is when the verification of the chain of custody and samples meets the laboratory sample acceptance policy. Laboratory management must approve any special arrangements for rush or expedited turnaround time. The basis for data quality depends on client, regulation or method performance criteria. Accuracy, precision, sensitivity and comparability are expressions of method performance criteria.

All work is performed in the strictest confidence. New and contract employees must review corporate policy and practice requirements for protecting client confidentiality and proprietary rights. The review occurs during orientation and ethics training. It is the policy of the laboratory to release data to the client authorized contact. Personnel assigned the duties of interacting with clients review project files and discuss data related only to the project. Personnel whose duties do not include routine client contact must check with the client service manager before discussing data with regulators or third parties.

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5 Quality System

Establishment, Audits, Essential Quality Controls and Data Verification

5.1 Establishment

The Mission Statement presents the policy and objectives for Alpha Woods Hole Labs. The Quality Manual provides the framework for the processes and operations to implement the Mission. The Quality Manual and documentation controlled by the laboratory system detail the management authorized operations for achieving the objectives of the company.

The laboratory operates a quality system approach to management in order to produce data of known quality. Alpha Woods Hole Labs is a full service laboratory designed to provide its clients with accurate, precise and reliable data within the best turn-around time and at the most reasonable prices. Alpha employs chemists of the highest training, ethics and caliber in the field of analytical chemistry. This and state-of-the-art instrumentation and automation combine to insure data of known and documented quality.

5.2 Quality Manual

The QA Officer is responsible for the publication and distribution of the Quality Manual. Management reviews and authorizes the manual. Implementation of major changes in the quality system occurs after revision of the appropriate Quality Manual section and authorization by management.

The authorization signatures found on the signature page of the manual signify management review and approval of the Quality Manual. The Signature section must be kept current and reflect any organizational changes affecting the authorizing positions. Updates of this manual occur at any time throughout the year. The issue number and date are changed to denote the latest revision date. The revision date for the signature section must be the most recent, indicating that all revisions have undergone management review.

Document control procedures (SOP/08-01) apply to the distribution of the Quality Manual. Distribution of controlled copies of the manual is only to an individual within the laboratory. Persons or organizations outside of Alpha Woods Hole Labs may receive uncontrolled copies. Copies are distinctly marked as "Uncontrolled Copies". A distribution list is maintained for all controlled copies of the Quality Manual. All parties listed on the controlled distribution list receive document updates. Copies marked as uncontrolled copies are not subject to updates.

5.3 Audits

Laboratory audits, both internal and external, review and examine the operations performed in the laboratory. Internal audits are self-reviews and external audits are reviews by external organizations to evaluate the ability of the laboratory to meet regulatory or project requirements.

A QA designee schedules internal process audits to ensure the completion of the annual audit of each operational area. The process audits are a more detailed review of the operations. Personnel from areas other than the one audited perform process audits. The use of personnel to perform the internal process audit allows exchange of practices to improve production flow and operations. Selected auditors are trained in auditing skills and processes.

The internal system audit is a review of the implementation of the documented quality system. The system audit includes sample tracking from receipt to disposal, a data audit of a completed report, and all operations not audited during the process audit.

The purpose of the internal system audit is:

- Verification that adequate written instructions are available for use;
- Analytical practices performed in the laboratory are consistent with SOPs;
- The quality control practices are applied during production;
- Corrective actions are applied as necessary;
- Deviations from approved protocols are occurring only with proper authorization and documentation;
- Reported data is correct and acceptable for reporting;
- SOPs, quality records, analytical records, electonic data files are maintained properly; and
- Personnel training and records are satisfactory and current.

Before a scheduled audit, the assigned auditor reviews checklists or the SOP specific to the area. The checklist may be from an external source or prepared by the auditor. The checklist must include all references to the documented quality system or referenced requirements document. After the audit, the auditor submits a summary or notes from the audit to the Laboratory Director or QAO as part of the audit report. The summary identifies discrepancies found during the audit. A copy of the summary form is presented to the person responsible for implementation or resolving the problem. The checklist, notes and summary comprise the audit report.

Technical personnel are responsible for the inspection and monitoring of in-process and final data. Personnel independent of those having direct responsibility for the work performed audit the quality system and processes.

Representatives sent by clients and government or accrediting agencies often perform external audits. These audits are most often announced inspections, but sometimes are not announced. The Quality Assurance Officer, Laboratory Director or assigned deputy, or appropriate Department Supervisor accompanies the external audit team through the laboratory. The auditors receive a brief overview of company objectives, activities, and facilities. Interviews with essential supervisory staff and technical staff are arranged, along with retrieval of any documentation pertinent to the audit. Auditors usually provide a report on their findings shortly after the audit. The QA Officer receives the audit report and copies are provided to laboratory personnel for review. Corrective actions are identified and distributed to responsible parties for implementation in response to any cited deficiencies.

5.4 Audit Review

Management reviews internal and external audit reports to evaluate system effectiveness. Tracking of the audit findings occurs through the nonconformance action process. The management and staff work together to establish a time line for resolving the audit findings. The Quality Assurance Officer tracks the time line and reports to the Laboratory Director on any outstanding audit findings.

5.5 Performance Audits

Alpha Woods Hole Labs participates in inter-laboratory comparisons and proficiency test programs required by clients and certifying agencies. The performance audits provide information on the data comparability of results generated by the laboratory. Test samples received by the

laboratory are handled following routine laboratory procedures. Proficiency test samples are unpacked, checked against the packing slip and examined for damage. Reporting requirements and deviations to routine practices are noted as required for any project.

Analysts demonstrate proficiency by analyzing either an external proficiency test sample, an internally prepared blind test sample or IDC before independent operation of a test method and at least once per year per analyst. The results of performance audits serve several purposes. The QA Officer may use performance audits for evaluating analyst proficiency, laboratory performance in a specified area to facilitate laboratory improvement efforts, and/or to provide information to an accrediting agency on correction of past performance of an external performance audit.

5.6 Corrective Actions

The corrective action program at Alpha Woods Hole Labs uses the Nonconformance Report form to document and follow through the corrective action process. The mechanism for recording, reviewing and acting upon all quality problems is self-explanatory as the form is completed. The process ensures continuous improvement of company performance by preventing the recurrence of quality problems.

Nonconformance forms are tracked for closure date and the type. Reports to management include the listing of open nonconformance reports and the frequency of the type of nonconformance occurring. A QA designee records the forms and monitors the completeness of the forms, as well as verifies the actions are complete and acceptable.

5.7 Managerial Review

The management review occurs at least once per year as part of the strategic planning process. Documentation of the management review meeting is by recording the meeting minutes and listing the attendees. The focus of the quality management review is the frequency of the type of nonconformance, closure status, audit progress and other quality assurance actions. Meetings include discussion and progress on quality system initiatives since the last meeting.

Prior to the meeting, an agenda is distributed to all personnel expected to be in attendance. The meeting is chaired by the Laboratory Director. Minutes are taken and distributed at the conclusion of the meeting by a]QA designee. If action is necessary on any issue, a Summary Report is generated and distributed to responsible parties for implementation. Actions are monitored by the QAO or designee until completion.

5.8 Essential Quality Control Procedures

The following general quality control principles apply to all tests. The manner implemented is dependent on the type of test performed. The laboratory SOP presents the specific quality control checks undertaken to ensure precision, accuracy and sensitivity of each test method.

Alpha Woods Hole Labs uses quality control samples to evaluate the following:

1. Adequate positive and negative controls to monitor blanks, spikes, reference toxicants, zero blanks;
2. Adequate tests to define the variability and/or reproducibility of laboratory results;
3. Measures to ensure the accuracy of the test data including sufficient calibration and/or continuing calibrations, use of certified reference materials, proficiency test samples;

4. Measures to evaluate test performance, such as method detection limits and quantitation limits or range of applicability such as linearity;
5. Selection of appropriate formulae to reduce raw data to final results such as linear regression, internal standards, or statistical packages;
6. Selection and use of reagents and standards of appropriate quality;
7. Measures to assure the selectivity of the test for its intended purpose;
8. Measures to assure constant and consistent test conditions for the method such as temperature, humidity, light, or specific instrument conditions.

All quality control measures are assessed and evaluated on an on-going basis, and quality control acceptance limits are used to determine the usability of the data. Control charts monitor the long-term method performance by analyte, by instrument for water matrices. Routine evaluation and reporting of the control chart performance provides supervisors and management with additional performance measures to ensure data comparability. Control limits are recalculated when trends are observed.

Where no reference method or regulatory criteria exist, the laboratory specifies the acceptance/rejection criteria in the SOP.. The test SOP specifies the QC samples performed per batch of samples. The quality control samples are categorized into the following:

- Method Blank
- Laboratory Duplicate
- Laboratory Control Sample (LCS)
- Matrix Spike (MS)
- Matrix Spike Duplicate (MSD)

The frequency is dependent on the reference method and test protocol. The following is the default requirement for quality control checks in lieu of any other guidance. The frequency for each quality control sample is generally one (1) per every 20 samples.

5.9 Data Reduction

After completion of the test procedure, the data reduction process begins.

Chromatography data may require the manual integration of peak areas or heights before reporting of results. The analyst must perform manual integration when software does not properly integrate or identify the peak. Manual integration must not occur for the purpose of achieving acceptable quality control or calibration. The analyst and reviewer sign and date the hardcopy of all manual integration. The analyst notes the rationale for performing the manual integration on the hardcopy printout and ensures the "TIC" marks from the software represent the integration area used for reporting the results. The analyst must minimize and avoid manual integration. The establishment of the proper integration parameters in the software reduces the number of manual integration occurrences.

The SOP for each test presents the formulas used for the specific test method. The formulas for the data calculations used throughout the laboratory are the following:

% Recovery (LCS)

$$\frac{MV}{TV} * 100 = \%R_{LCS}$$

where: MV = Measured Value

TV = True Value

% Recovery (MS or MSD)

$$\frac{MV - SV}{TV} * 100 = \%R_{MS}$$

where:
MV = Measured Value
TV = True Value
SV = Amount found in sample

Average ($\overline{X}$)

$$\sum_{i=1}^{n} X_i \Big/ n = \overline{X}$$

where:
$\overline{X}$ = Average of all values
X = Result of each measurement
n = Number of values

Relative Percent Difference (% RPD)

$$\frac{R_1 - R_2}{(R_1 + R_2)/2} * 100 = \%RPD$$

where:
R_1 = Larger of two observed values
R_2 = Smaller of two observed values

% Difference (%D)

$$\frac{X - \overline{X}}{\overline{X}} * 100 = \%D$$

where:
$\overline{X}$ = Average of all values
X = Result of measurement

Standard Deviation of the sample (S_x)

$$\sqrt{\frac{\sum (X - \overline{X})^2}{n-1}} = S_x$$

where:
$\overline{X}$ = Average of all values
X = Result of each measurement
n = Number of values

Relative Standard Deviation (%RSD)

$$\frac{S_x}{\overline{X}} * 100 = \%RSD$$

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where: $\overline{X}$ = Average of all values
Sx = Standard Deviation (n - 1)

MDL (See 40CFR Part 136 for details)

$$\left[\sqrt{\frac{\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2 / n}{n-1}} * t_{0.99}\right] = MDL$$

where: *MDL* = The method detection limit
X = Result of each measurement
n = Number of values
t(n-1,1 = .99) = The students' t value appropriate for a 99% confidence level and a standard deviation estimate with n-1 degrees of freedom. (See Students t Test Table)

Reporting Limit (RL)

Lowest calibration standard or greater
At least 3 times the calculated MDL

Reportable Detection Limit (RDL)

Lowest calibration standard or greater adjusted for sample/matrix

Control Limits

Upper Control Limit: $\overline{X} + 3 * S_x = UCL$

Lower Control Limit: $\overline{X} - 3 * S_x = LCL$

Warning Limits

Upper Warning Limit: $\overline{X} + 2 * S_x = UWL$

Lower Warning Limit: $\overline{X} - 2 * S_x = UWL$

Method of Standard Additions (MSA): (See EPA 7000A for details)

The simplest version of this technique is the single-addition method, in which two identical aliquots of the sample solution, each of volume Vx, are taken. To the first (labeled A) is added a known volume Vs of a standard analyte solution of concentration Cs. To the second aliquot (labeled B) is added the same volume Vs of the solvent. The analytical signals of A and B are measured and corrected for non-analyte signals. The unknown sample concentration Cx is calculated:

$$C_x = \frac{SB\ V_S C_s}{(SA - SB)\ V_X}$$

where SA and SB are the analytical signals (corrected for the blank) of solutions A and B, respectively. V_S and C_s should be chosen so that SA is roughly twice SB on the average,

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avoiding excess dilution of the sample. If a separation or concentration step is used, the additions are best made first and carried through the entire procedure.

Improved results can be obtained by employing a series of standard additions. To equal volumes of the sample are added a series of standard solutions containing different known quantities of the analyte, and all solutions are diluted to the same final volume.

For example, addition 1 should be prepared so that the resulting concentration is approximately 50 percent of the expected absorbance from the endogenous analyte in the sample. Additions 2 and 3 should be prepared so that the concentrations are approximately 100 and 150 percent of the expected endogenous sample absorbance.

The absorbance of each solution is determined and then plotted on the vertical axis of a graph, with the concentrations of the known standards plotted on the horizontal axis. When the resulting line is extrapolated to zero absorbance, the point of interception of the abscissa is the endogenous concentration of the analyte in the sample. The abscissa on the left of the ordinate is scaled the same as on the right side, but in the opposite direction from the ordinate. A linear regression program may be used to obtain the intercept concentration.

5.10 Document Control

The Document Control Procedure describes the process for controlled and uncontrolled documents. The use of the issue number allows for the retention of a previous document for historical information purposes.

Every document is assigned a unique identification number, which is present on each page of the document. A master list of documents includes the unique identification. Each controlled copy includes the issue number, issue date, effective date and page number.

Full document control includes the status of each document: active, inactive or archived. Inactive documents are procedures not currently requested, but may be in the future. Archived documents are procedures replaced with a later revision. Authorized personnel must review and approve each document and any subsequent revisions before use in the laboratory. Personnel authorized to review and approve a document have access to all necessary information on which to base their review and approval. The amendment section of the signature page of any SOP includes a brief description of the nature of the document change.

Standard Operating Procedures (SOPs) are instructions for repetitive or standard operations performed by the laboratory. The SOP author is the person familiar with the topic. The standard format for writing SOPs is set-up as a template for administration and technical SOPs. Each SOP is peer reviewed, authorized by management, and the Laboratory Director or QAO before final distribution and implementation. Personnel acknowledge approved documents as read, understood and agreed to by personnel through signed attestation forms or training records.

SOPs must receive evaluation and input by laboratory supervisors and key technical personnel. The content of each SOP must conform to applicable requirements of analytical methods and certification agencies. Within these constraints, the content of a SOP meets the needs of a particular area of the laboratory. A new or revised SOP is needed when regulatory programs update or add methods, or the scope of the existing method is extended or when activities are being performed without adequate documentation.

Updating, modifying and changing SOPs, forms and the contents of this QM are prompt and part of the routine practices. The prompt modification of these documents ensures the documents reflect the current practices and operations of the laboratory. Implementation of modifications required before issue of an updated SOP is authorized by the Departmental Manager on the SOP

Review Form. The justification and record for a request for an operational change to the SOP follows the nonconformance process. The record of the SOP change authorization by management, QA and other analysts is placed on the nonconformance form. A copy of the approved nonconformance form is retained with the SOP. During annual review of a document, (including but not limited to: SOPs, Ethics Policy, Quality Manual), requested changes are reviewed and the document reissued using the information from the nonconformance forms.

The laboratory maintains control over the possession and distribution of all documents that directly affect the quality of data. This includes, but is not limited to, documents such as the Quality Manual, Standard Operating Procedures, client instructions, Laboratory Work Instructions, data sheets, check lists and forms. The List of Forms lists the current forms, form number and issue date.

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6 Personnel

6.1 Laboratory Management Responsibilities

Management is responsible for communicating the requirements of the quality system, client specifications and regulatory needs to all personnel. Management job descriptions detail the responsibilities of each position.

Laboratory management has job descriptions for all positions in the laboratory defining the level of qualifications, training, and experience and laboratory skills. During initial training, management provides documented operations procedures, observes personnel performance, and evaluates personnel proficiency. Management documents technical laboratory staff's proficiency initially and on a continuing basis through use of laboratory control samples and purchased proficiency evaluation standards. Management requires successful proficiency demonstration before allowing independent production testing.

Management is responsible for verification of proper sample management and all aspects of data reporting. The communication of the operating practices of the laboratory is through the document control and attestation process.

6.2 Laboratory Staff Requirements

Recruitment is the responsibility of the Operations Manager and HR Department, with input from other personnel as required. The Training Program procedure details the process for requirement and training to ensure personnel have adequate skills and competence for the job function.

A job description details the necessary requirements for each job and includes position title, minimum educational requirements, skills, responsibilities and reporting relationships and any supervisory responsibility.

Initial training of new employees and contract staff includes laboratory ethics and quality policies, as well as execution of an Ethics Agreement. Any employee found to knowingly report data values, that are not actual values obtained or improperly manipulated, or intentionally report dates and times of data analyses that are not the actual dates and times of analysis, will lead to disciplinary action, including termination, as outlined in Section K of the Employee Handbook. Each employee must report to the Laboratory Director or QA Officer any accidental or suspected intentional reporting of non-authentic data by others for follow up action. The review of the laboratory ethics policy occurs annually with all personnel. The annual review includes annual renewals of the Ethics Agreement.

Orientation training for all new employees includes review of the laboratory business practices, employment specifications, Ethics Policy, Quality Manual, Chemical Hygiene Plan, and all SOPs required for the job function.

Managers ensure the training for new employees and review the continuing training for current employees. Training includes on-site and off-site programs presented by staff members, contractors, equipment manufacturers, and institutions of higher learning.

Training of new personnel to any job assignment takes place on-site according to the Training Program procedure. Laboratory personnel may perform their assigned methods/protocols without supervision only after documentation of acceptable proficiency. Training records lists the current training status.

Off-site training takes place on an as-needed basis. Recommendations and suggestions regarding educational programs come from all levels of staff. The Laboratory Director approves off-site training. It is the employee's responsibility to present a copy of any certificates or attendance information to the HR Director. The information is added to the individual's training record.

6.3 Training

The Quality Manual and related documentation is available to all employees. Cross training, supervisory training and other related training takes place on a scheduled and as-needed basis. Training ensures the communication and understanding of all personnel in the laboratory-documented procedures and practices.

All personnel undertake orientation training sessions upon initial employment. Orientation training includes laboratory business practices, employment specifications, Ethics Policy, Quality Manual, Chemical Hygiene Plan, and all SOPs required for the job function.

On-the-job training includes demonstration of skills during job performance, initial demonstration of proficiency, and review of SOPs. Safety and health training takes place on an annual basis with careful introduction to new principles. Personnel have access to the Chemical Hygiene Plan and Material Safety Data Sheets. On-site training includes side-by-side hands-on training, formal classroom type instruction on the SOP or a meeting to discuss procedural changes or to address questions related to the laboratory operation. All training is documented via the Training Attestation Form which is signed by all in attendance that they understood and will implement what was presented to them.

Training is an on-going opportunity to evaluate the laboratory operations. The updating of SOPs, Quality Manual and other related information documents all changes to the quality system. In all cases, training is documented via the Training Attestation Form.

6.4 Records

The QA Department is responsible for maintaining training records. Attestation forms, certificates, demonstration of capability forms and other records of training are placed in the individual's training file.

The Quality Assurance Officer or designee notifies appropriate personnel when a revision is complete for the controlled version of a document. Laboratory staff must implement the change as of the effective date. The manager of the area determines when a change is significant to require training.

Resumes and job descriptions are included in the training record files. The Human Resources Department reviews the job descriptions, resumes and training records to ensure up-to-date information on the job descriptions and resumes. The Human Resources Department and the individual update the resume on an as needed basis.

7 Physical Facilities – Accommodation and Environment

This laboratory facility has a total area of 25,000 square feet with more than 32 linear feet of laboratory bench space per employee and over 64 linear feet of fume hood space. The floor plan is available upon request.

The laboratory functional areas include:

- Administration and offices
- Sample receiving
- Sample management
- Microbiological
- General analytical chemistry
- Metals sample preparation
- Organic sample preparation
- Metals analysis
- Volatiles gas chromatography (GC)
- Volatiles gas chromatography/mass spectrometry (GC/MS)
- Volatiles air analysis
- Semivolatiles gas chromatography/mass spectrometry (GC/MS)
- Semivolatiles gas chromatography (GC)
- Miscellaneous facility mechanical and storage areas.

All chemicals are stored in appropriate cabinets and properly disposed of as required. All flammable solvents are stored in OSHA and NFPA approved cabinets. Acids are stored in OSHA acid cabinets. A separate waste area houses the sample and chemical waste before pickup by a licensed waste hauler.

7.1 Environment

Lighting, noise, humidity, heating, ventilation and air conditioning satisfy the needs of the testing performed on the premises. The laboratory building design ensures regulated temperature control for analytical equipment. Air-handling systems minimize airborne contaminants that may jeopardize sample integrity or analytical performance.

The analytical instrumentation is in separate rooms from laboratory activities that involve the use of large quantities of organic solvents or inorganic acids. A separate room provides the facilities for the microbiological testing.

Standards and other materials requiring below 0°C storage temperatures are placed in freezers and separated from samples or potential contaminating materials. Refrigerators provide cooling needs for samples and materials with temperature requirements of below room temperature and greater than freezing. Sample and standard storage areas are monitored and controlled for temperature. Sample storage areas for volatiles are separated from other samples and monitored for any effects due to cross contamination.

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Bulk hazardous waste containers are located away from the testing activities. Waste disposal uses lab pack procedures and those designated by the regulatory authorities. The Chemical Hygiene Plan and the Waste Management and Disposal SOP (SOP/14-01) include the procedures for handling and disposing of chemicals used in the laboratory.

The working and storage environments are maintained in a safe and appropriate manner. A Chemical Hygiene Plan details the requirements for safety and chemical handling. Safety measures that protect property and personnel from injury or illness include: fume hoods, fire extinguishers, fire blankets, alarm systems, safety training, protective clothing, emergency showers, eyewashes, and spill control kits.

7.2 Work Areas

Good housekeeping is the responsibility of all personnel. Each person is responsible for assuring clean and uncluttered work areas. The job descriptions list specific housekeeping duties. Records, samples and waste materials are the common cause for clutter in the laboratory.

Management does not allow accumulation of boxed records in the laboratory operating area. Removal of administration and laboratory records to the record storage area occurs to reduce clutter and ensure traceability. The individual filling the laboratory record box, labels the box with the contents, date and laboratory area. Authorized personnel assign and record into a permanent record the box number, discard date and box contents. Authorized personnel review the box label for number, discard date and contents. Boxes are stored on site and off-site for the record retention period identified in the NELAC and EPA regulations, whichever is more stringent.

Sample management personnel remove samples to the sample storage area after all data is correct and complete. Sample coolers are removed to a designated storage area for recycling. Samples are stored in the designated process storage areas until testing is complete. Sample removal from the process storage occurs after mailing of the final report. The sample management staff places the samples in the archive storage area for thirty days after report release. The archive sample storage area is not controlled or monitored. Based on client specifications, samples are properly disposed or returned to the client.

Waste materials, expired reagents and materials not routinely used are stored in designated areas away from the work areas. Hazardous waste labeled accumulation containers in the laboratory collect designated waste streams for later bulk disposal. Laboratory personnel remove the less than five-gallon accumulation containers when full from the laboratory and place the containers in the bulk hazardous waste area. Refer to the Waste Management and Disposal SOP (SOP/14-01). Personnel identifying out of date reagents and standards remove the materials to the proper disposal area for discard of the material.

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7.3 Security

Alpha Woods Hole Labs provides a secure environment for our employees, guests, clients, samples and analytical data. Security procedures require that all exterior doors remain locked unless manned. Access to the laboratory is limited to employees and contractors. Visitors not under signed contract are required to sign the Visitors Log and must be accompanied by a laboratory employee at all times within the testing areas.

The defined high security area is the sample management area. Identification card locks on the internal doors control entry into the laboratory area. An employee must accompany visitors, suppliers and other non-contract individuals not assigned to the area.

All doors are locked after hours and require a key for entry. Audible alarms alert the staff when sample cold storage refrigeration units shutdown or malfunction. The security alarm continuously monitors for smoke and fire related heat. When the alarm is activated, the appropriate emergency response officers are notified. The local emergency offices have the emergency contact list for the laboratory.

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8 Equipment and Reference Materials

8.1 Maintenance

The laboratory has a proactive equipment maintenance program. The laboratory maintains service contracts for major equipment, which include routine preventative maintenance visits by the service provider. Technical personnel perform manufacturer's specified maintenance on a routine basis to ensure equipment operates at peak performance.

Procedures and schedules for preventive maintenance are available in the test method SOPs. A brief summary of some common preventive maintenance procedures is provided in Appendix E. All instrument preventative and corrective maintenance are recorded in the maintenance logbook assigned to the equipment. After instrument maintenance or repair, the instruments must successfully calibrate following the method SOP. Laboratory personnel must demonstrate quality control performance before sample analysis.

The laboratory maintains a stock of spare parts and consumables for analytical equipment. Backup instrumentation for some analytical equipment is available on site for use in case of major equipment failure. The person discovering or suspecting an equipment maintenance problem or failure tags the equipment with 'out of service', date and initials of person tagging the equipment. If routine maintenance measures do not eliminate the problem, the Laboratory Director is notified and the appropriate equipment service provider is contacted.

All major laboratory equipment has individual and traceable maintenance logbooks in which to document manufacturer's recommended maintenance procedures, specific cleaning procedures, comments on calibration, replacement of small worn or damaged parts, and any work by outside contractors. The person performing routine or non-routine maintenance signs and dates the maintenance logbook. If an instrument is down for maintenance, a complete record of all steps taken to put it back into service is recorded including reference to the new calibration and quality control checks. Any equipment service providers working on the equipment are recorded in the logbook and reference made to the service report presented by the person preparing the report.

Record repetitive or on-going equipment problems other than normal maintenance requirements on nonconformance action forms. The nonconformance action form notifies management and the Quality Assurance Officer of a problem affecting the performance and data quality.

The laboratory groups some equipment into a single laboratory equipment maintenance logbook. Examples include: autopipets, thermometer calibration and refrigerator temperature monitoring. The identity of each item is by serial number or a laboratory-designated item number. The same data recorded for major equipment applies to this documentation.

The maintenance records shall include:

- Equipment name;
- Manufacturer's name, type identification, serial number or other unique identification;
- Date received, date put into service, condition when received;
- Current location;
- Details of past maintenance and future schedule;
- A history of any damage, malfunction, modification or repair;
- Dates and results of calibration or verification.

The maintenance logbook may include the reference to the location of the equipment operational and maintenance manuals. The logbook may include the reference to laboratory run logbook or data files for the calibration and quality checks of daily or frequent calibrations.

The Courier Supervisor ensures that maintenance and records for transportation vehicles are complete. The purchasing process is used for ordering garage maintenance, the garage work order is reviewed, and the vehicle checked for condition. The Controller receives all paperwork for completion of the maintenance process.

8.1.1 Microbiology General Equipment Maintenance

Optics of the Quebec colony counter and microscope are cleaned prior to each use. The stage of the microscope is also cleaned and the microscope is kept covered when not in use.

Glassware is checked for residual alkaline or acid residue utilizing bromthymol blue (BTB) on each day of media preparation.

8.2 Equipment Listing

A listing of the major equipment used for testing is available upon request. The equipment list details the unique identification number, equipment location, serial number, model number, and purchase date. The unique identification number is attached to the piece of equipment.

The laboratory performs analyses using state of the art equipment. In addition to the major equipment, the most common equipment used in the laboratory are: thermometers, balances, autopipets, water baths, hot plates, autoclaves, pH meters, conductivity meters and a variety of labware. The SOPs list the calibration and verification requirements for all laboratory equipment used in measurements.

8.3 Laboratory Water

Laboratory water is first purified from two central reverse osmosis systems and piped to all laboratory areas. The microbiological area checks the laboratory grade water for meeting the drinking water certification criteria. The Laboratory Water Logbook lists the frequency and criteria for the laboratory water. The laboratory staff documents the daily, monthly and annual water quality checks. Please refer to Table 8-1 for tested parameters, monitoring frequency and control limits for each parameter. Additional parameters may be tested for at the laboratory's discretion.

Additional polishing of the water occurs in laboratory areas requiring additional removal of contaminants. Where additional treatment occurs in the test area, the test area records the water quality checks from the most frequently used tap. At a minimum the quality of the laboratory grade water is monitored daily by conductivity measurements. Records of the daily checks are found in the Laboratory Grade Water logbook for each area. If out of specification results occur, a nonconformance action form is submitted.

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TABLE 8-1

Parameter	Monitoring Frequency	Control Limits
Conductivity	Daily	<2 µmhos/cm @ 25°C
pH	Daily	5.5 - 7.5
Total Organic Carbon	Monthly	< 1.0 mg/L
Total Residual Chlorine	Monthly	< detection limit
Ammonia Nitrogen	Monthly	< 0.1 mg/L
Metals: Cd, Cr, Cu, Pb, Ni and Zn	Monthly (Required Annually)	< 0.05 mg/L
Total Metals	Monthly (Required Annually)	< 0.1 mg/L
Heterotrophic Plate Count	Monthly	< 1000 CFU/mL
Water Quality Test (Biosuitability)	Annually	0.8 – 3.0 ratio

8.4 Reference Materials

Reference materials include: Class 1 weights, NIST thermometers and reference standards. Logbooks record the reference materials used for calibration and verification. The Department Supervisor maintains any certificates received with the reference materials. Laboratory personnel record in the standards logbook the reference standards date received, unique identification number, expiration date and number of containers. Each laboratory area, records the unique identifier on the reference standard certificate and the Department Manager maintains the certificate. The identifier allows traceability from the certificate to the analytical data.

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9 Measurement Traceability and Calibration

9.1 General Requirements

All measuring operations and testing equipment having an effect on the accuracy or validity of tests are calibrated and/or verified before put into service and on a continuing basis. The results are recorded in the instrument specific logbook. The laboratory has a program for the calibration and verification of its measuring and test equipment. The program includes all major equipment and minor equipment such as balances, thermometers and control standards. The Quality Manual and method SOP describe the calibration records, frequency and personnel responsibilities.

9.2 Traceability of Calibration

The program of calibration and/or verification and validation of equipment is such that measurements are traceable to national standards, where available. Calibration certificates indicate the traceability to national standards, provide the results, and associated uncertainty of measurement and/or a statement of compliance with identified metrological specifications. A body that provides traceability to a national standard calibrates reference standards. The laboratory maintains a permanent file of all such certifications.

9.3 Reference Standards and Materials

Alpha Woods Hole Labs has a program for calibration and verification of reference standards. The results and program are recorded in the appropriate instrument logbook. Required in-service checks between calibrations and verifications are described in method SOPs and are recorded in the appropriate instrument logbook.

Calibration standards are maintained within the area of consumption. A logbook of use is maintained and use is limited strictly to method required calibrations. Each calibration standard is identified as to test method used, date received, date opened, and expiration date. Calibrations are verified by using a second source or lot number of the calibration standard. Calibration check procedures are stated in applicable test method SOPs.

Reference standards of measurement in the laboratory's possession (such as calibration weights or traceable thermometers) are used for calibration only and for no other purpose.

9.4 Calibration General Requirements

Each calibration record is dated and labeled with method, instrument, analysis date, analyst(s) and each analyte name, concentration and response. For electronic processing systems that compute the calibration curve, the equation for the curve and the correlation coefficient are recorded in the appropriate instrument logbook. This is also true for manually prepared curves. Criteria for acceptance of a calibration curve is established and documented in the appropriate instrument logbook.

Initial calibration requires a standard curve that brackets the expected sample concentration. Initial calibration generally uses three to five standards depending on the equipment and reference method specifications. Before the start of each analytical sequence, initial calibration is verified by using a continuing calibration standard. Calibration verification or continuing calibration uses a standard from a second source or lot number than that used for initial calibration. The acceptance criteria for the continuing calibration standard must meet acceptance criteria before analysis of any samples. When the acceptance criteria is not within limits, review maintenance protocols and perform any necessary maintenance before starting the initial calibration sequence.

9.5 Equipment Calibration

The SOP used for the analysis defines the instrument and equipment calibration required. The following defines the general practices for equipment calibration of selected equipment.

9.5.1 Gas Chromatography/Mass Spectrometry (GC/MS)

The GC/MS is hardware tuned before performing the initial and continuing calibrations. Results must meet the peak ratio specifications of the analytical methods. For volatiles analyses, bromofluorobenzene (BFB) is used, and for semivolatiles analyses, decafluorotriphenylphosphine (DFTPP) is used for instrument tuning..

The mass spectrometer response is calibrated by analyzing a set of five or more initial calibration solutions, as appropriate, for each GC/MS method. Each solution is analyzed once, unless the method or the client requires multiple analyses. The relative response factor for each analyte is calculated for internal standard calibration. The calibration factor for external standard calibration is calculated using the expressions found in the laboratory method SOP. Calibration is acceptable when all acceptance criteria are within control limits.

The initial calibration is verified through the analysis of a continuing calibration standard every 12 hours. The concentration of the continuing calibration standard is dependent on the requirements of the specific method. The relative response factors for all analytes of interest are calculated and verified against the initial calibration mean relative response factors. The percent difference (%D) for each analyte is calculated and must be less than the acceptance criteria stated in the method.

An acceptable continuing calibration run must have measured percent differences for the analytes within method specified ranges. If any criteria for an acceptable calibration are not met, either instrument maintenance must be performed until the continuing calibration analysis meets all criteria or a new initial calibration is established before any samples are analyzed. No samples may be analyzed unless the acceptance criteria are met for the initial and continuing calibration.

Additional quality control samples are part of the GC/MS analysis. These include internal standards, surrogates, method blanks, instrument blanks, laboratory control samples, matrix spikes and matrix spike duplicates. The frequency and control criteria are defined in the laboratory SOP.

9.5.2 Gas Chromatography (GC)

Internal standard calibration or external standard calibration is utilized for analysis by GC. The method-specified number of calibration standards is used. Each solution is analyzed once and the analyte relative response factors or calibration factors are calculated. The mean relative response factor for each analyte is then obtained by using the expression in the formula listed in the SOP. Integrated areas are utilized for these expressions.

For multiple response pesticides, PCBs or hydrocarbons the quantitation consists of the average of selected peaks or the integration of the area defined by a reference standard. The SOP details the integration criteria for each compound.

The initial calibration is verified through the analysis of a continuing calibration standard every 12 hours or 20 samples. The concentration of the continuing calibration standard is dependent on the requirements of the specific method. The relative response factors for all analytes of interest are calculated and verified against the initial calibration mean relative response factors. The percent difference (%D) for each analyte is calculated. The percent drift (%d) may be calculated when calibration factors are used for quantitation.

An acceptable continuing calibration must have measured percent differences or percent drift for the analytes within method specified ranges. Should any criteria for an acceptable calibration not be met, either instrument maintenance is performed until the continuing calibration analysis meets all criteria, or a new calibration is established before any samples are analyzed. No samples may be analyzed unless the acceptance criteria are met for the initial and continuing calibration.

Other standard checks may be required for a specified reference method. Instrument performance checks specified in the reference method must be performed and be within the acceptance limits stated in the reference method. Additional quality control samples are part of the GC analysis. These include internal standards, surrogates, method blanks, instrument blanks, laboratory control samples, matrix spikes and matrix spike duplicates. The frequency and control criteria are defined in the laboratory SOP.

9.5.3 Cold Vapor Atomic Absorption Spectrophotometry (CVAA)

An initial calibration is performed daily with freshly prepared working standards that bracket the expected concentration range of the sample. A minimum of a three-point calibration curve is acquired which must have a correlation coefficient of 0.995 or better. The initial calibration is verified every 10 samples. The continuing calibration is required to be within method-defined criteria, depending on the analytical method employed. Continuing calibration blanks are run at the same frequency. Analysis of samples cannot begin until an initial calibration verification has been performed and is found to be within ± 10% of the true value.

9.5.4 Inductively Coupled Plasma Emission Spectrophotometry-Mass Spectrometry (ICP-MS)

Initial calibration and instrument tune is performed daily, not to exceed 24 hours, and continuing calibrations are performed every 10 samples. Initial calibration consists of a minimum of three standards and a Blank that bracket the expected concentration range of the samples. Analysis of samples cannot begin until an initial calibration verification has been performed and is found to be within method-defined criteria. The continuing calibration is required to be within method-defined criteria. Interference check standards are performed at the beginning of the sequence. Acceptance criteria are stated in the SOP.

9.5.5 Inductively Coupled Plasma Emission Spectrophotometry (ICP)

Initial calibration is performed daily, not to exceed 24 hours, and continuing calibrations are performed every 10 samples. Initial calibration consists of one standard and a Blank that bracket the expected concentration range of the samples. Analysis of samples cannot begin until an initial calibration verification has been performed and is found to be within 5% of the true value. The continuing calibration is required to be within 10% of the true value. Interference check standards are performed at the beginning and end of the sequence. Acceptance criteria are stated in the SOP.

9.5.6 Thermometers

Laboratory thermometers are checked annually for accuracy against certified, NIST traceable thermometers. Correction factors derived from the annual calibrations are applied to temperature readings where applicable. The analyst records the corrected temperature for all observations.

NIST traceable thermometers are calibrated professionally and re-certified every year. Records of thermometer calibrations are retained in one logbook by the QA Department.. All thermometers are tagged with the ID number, correction factor to be applied and the expiration of the calibration check.

NOTE: Electronic-based thermometers are calibrated on a quarterly basis by an outside instrument service company. Thermometers are tagged with calibration information by the vendor, including the ID number, correction factor to be applied and the expiration of the calibration check. Certificates are kept on file in the QA Department.

Thermometers are not used past the calibration expiration date or if the thermometer is not reading properly. Replacement thermometers are calibrated and the maintenance logbook is updated when a change in the thermometer is required due to breakage, damage or expired calibration.

9.5.7 Balances

Calibration checks are performed for each day of use, for each balance. The calibration consists of a minimum of two weights, which bracket the weight to be measured. Additional calibration check procedures are performed on balances utilized in Microbiology laboratory. This additional procedure consists of a deflection test, which is performed to ensure that 100mg is detectable at a weight of 150 grams.

The balance logbook lists the acceptance criteria and performance criteria for the various balances used in the laboratory. Calibration weight measurements must meet the acceptance criteria listed on the record form.

Each balance is serviced and calibrated by a professional semi-annually. Balances are labeled with the balance number, date of service and the expiration date for the annual service check. The balance number used for any measurements requiring traceability is recorded with measurement data. Balances are not used past the expiration date or when the weight check is not within acceptable criteria. The accuracy of the calibration weights used by Alpha Woods Hole Labs is verified annually by an accredited calibration service.

9.5.8 Automatic Pipettes

Delivery volumes for the automatic pipettes are checked and recorded gravimetrically before use and also on a monthly basis. The verification is performed at the volume of use or bracketting the volume range of use. The check must be within the criteria stated in the laboratory logbook.

Autopipette calibration is also performed once per year. Each pipette is checked throughout the volume range of use by measuring seven replicate volumes and weighing. Acceptance criteria for continued use is 5% RSD and between 95.0-105 % recovery. Pipettes failing acceptance criteria are tagged and removed from service until repaired and the criteria are met, or discarded and replaced. Automatic pipettes are labeled with a unique ID number, volumes verified and expiration date.

9.5.9 Ion Chromatography

The ion chromatograph calibration is by analyzing a set of five or more initial calibration solutions, with concentrations of analytes appropriate to the analytical methods. The concentrations must bracket the expected concentration range of the samples analyzed. Procedures for verifying the calibration curve are method specific. The initial calibration is performed at the start of each day. The calibration curve is verified at least after every 20 samples.

9.5.10 pH Meters

pH meters are calibrated prior to use for each day of use. The meter is calibrated following the procedure for pH analysis. The records of the calibration are recorded in an instrument logbook or in the raw data for the analysis being performed. At least two buffer solutions that bracket the measurement range for the analysis are used for calibration. A second source check standard is used at the end of a run to verify meter stability. Buffer solutions used for calibration are NIST certified. Standard buffer solutions are not retained or re-used. The lot number of the buffer solutions is recorded in the data record to ensure traceability of the measurement to NIST.

9.5.11 Conductivity Meters

Three calibration standards of potassium chloride (KCL) solutions are analyzed annually on each instrument range. The calibration standards are used to verify instrument performance. The acceptance criteria are defined in the test SOP. If unacceptable performance is found, the cell is cleaned and rechecked. The cell is not used until satisfactory performance is achieved.

A single KCL standard solution is used to calibrate each range of the instrument. A second standard is used to check the calibration each day the meter is used. The check standard is near the measurement range for the samples to be analyzed. The acceptance criteria is ± 20% of the true value. The meter is labeled with expiration date for the annual calibration. A check standard that is NIST traceable is used to allow traceability. The check standard is performed at the end of the analysis run or at least after every 20 samples.

9.5.12 Autoclave

The date, contents, sterilization time and temperature, total cycle time and analyst's initials are recorded each time the autoclave is used. Autoclave cycles must be completed within 45 minutes when a 15 minute sterilization time is used. Autoclave timing mechanisms are checked quarterly with a stopwatch to verify timing controls. A maximum temperature thermometer is used with each cycle to ensure the sterilization temperature is reached.

Spore strips or ampules are used weekly to confirm sterilization. BTSure ampules are utilized as follows: An indicator ampule is placed in most challenging area of sterilizer. Load is processed according to standard operating instructions. Remove from sterilizer and allow to cool for a minimum of 10 minutes. (Chemical indicator on label changes from green to black when processed.) Place the autoclaved indicator and un-autoclaved control indicator in an upright position in the plastic crusher provided. Gently squeeze crusher to break glass ampules. Incubate both indicators at 55-60°C for 48 hours. Examine appearance for color change. Yellow color indicates bacterial growth. No color change indicates adequate sterilization.

Calibration is conducted and certified annually by an outside service provider and recorded. Certificates are kept on file. Routine maintenance includes cleaning the autoclave seal to ensure freedom of caramelized media and cleaning drain screens to remove any debris buildup. For the efficient operation of the unit, overcrowding is avoided.

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10 Test Methods and Standard Operating Procedures

10.1 Methods Documentation

Analysis consists of setting up proper instrument operating conditions, executing acceptable calibrations, monitoring instrument performance tests, analyzing prepared samples, and collecting data from the analyses. The test method SOP describes the instrumental analysis procedures, quality control frequencies and acceptance criteria. EPA accepted methods, national recognized methods or client-specified methods are the basis for performance criteria, instrument conditions and the steps of the procedure. The method performance requirements of the published methods are followed unless otherwise specified by the client.

The reference methods define the instrument operating conditions. In many of the reference methods, a range or general guidance on the operating conditions is defined. Documented modifications to the operating conditions clarify the reference methods or improve the quality of the results. In all cases where the method modifications are adopted, the performance criteria from the reference method must be met. Modifications to the operating conditions are stated in the SOP. Changes in the operating conditions made at the time of the analysis are documented in the appropriate laboratory or sequence log. A revision to the SOP takes place, when a day to day change in the operating condition improves performance for all matrices.

The laboratory SOPs include the operation of measurement equipment. The SOPs contain the following information, as applicable:

- The equipment used in the procedure, including equipment type
- Equipment calibration and process for obtaining the measurement from the calibration
- The step by step instructions to perform the measurement
- Acceptance criteria for the calibrations
- Corrective action for failed acceptance criteria, including assessment of previous calibration results
- The basis used for the calibration standards such as traceability to NIST or EPA or demonstration of comparability
- Frequency at which the equipment will be calibrated, adjusted and checked
- The records maintained to document the calibration and use of measurement equipment
- The calibration status for the equipment
- The environmental conditions necessary before measurement equipment may be calibrated or used for measurement
- Allowed adjustments to measurement equipment, including software, which will not invalidate the laboratory analysis
- Maintenance of the equipment and record keeping to track performance before and after maintenance is completed
- Define the standards, reagents and sample handling, interferences, preservation, and storage in order to assure measurement performance

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10.2 Standard Operating Procedures (SOPs)

Alpha Woods Hole Labs maintains SOPs that accurately reflect all phases of current laboratory activities such as assessing data integrity, nonconformance actions, handling customer complaints, sample receipt and storage, purchasing of all materials, and all test methods. These documents include equipment manuals provided by the manufacturer, internally written documents, and published methods with documented changes or modifications.

Copies of all SOPs are accessible to all personnel in either electronic or written form. The SOPs are organized in a standard format with the signatures of the approving authorities. Each SOP clearly indicates the effective date of the document and the issue number.

10.3 Laboratory Method Manual (s)

All SOPs are posted as secure documents on the Alpha Intranet. Directories are available for each laboratory and adminstrative area. Each SOP includes or references where applicable:

1) identification of the test method and where applicable;
2) applicable matrix or matrices;
3) method detection limit;
4) scope and application;
5) summary of method;
6) definitions;
7) interferences;
8) safety;
9) equipment and supplies
10) reagents and standards
11) sample collection, preservation, shipment and storage;
12) quality control;
13) calibration and standardization;
14) procedure;
15) calculations;
16) method performance;
17) pollution prevention;
18) data assessment and acceptance criteria for quality control measurements;
19) corrective actions for out-of-control data;
20) contingencies for handling out-of-control or unacceptable data;
21) waste management;
22) references; and
23) any tables, diagrams, flowcharts and validation data.

In cases where modifications to the published method have been made by the laboratory or where the referenced method is ambiguous or provides insufficient detail, these changes or clarifications are clearly described in the SOP.

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10.4 Test Methods

The laboratory uses appropriate methods and procedures for all tests and related activities within its responsibility (including sampling, handling, transport and storage, preparation of items, estimation of uncertainty of measurement and analysis of test data). The method and procedures are consistent with the accuracy required, and with any standard specification relevant to the calibrations or tests concerned. When the use of mandated methods for a sample matrix is required, only those methods are used. Where methods are employed that are not required, the methods are fully documented and validated and are available to the client and other recipients of the relevant reports.

The client requests the reference method for sample analysis usually based on the regulatory program. The client services staff may assist the client with method selection when the client specifies the regulatory program, but is unsure of the correct method required. The Laboratory Director or Quality Assurance Officer recommends methods for non-regulatory programs. In all cases, recommendation of methods is based on client-defined method performance criteria. Client services may recommend a procedure that meets the client method performance criteria.

10.5 Method Validation/Initial Demonstration of Method Performance

Before acceptance and use of any method, satisfactory initial demonstration of method performance is required. In all cases, appropriate forms are completed and retained by the laboratory and made available upon request. All associated supporting data necessary to reproduce the analytical results are retained. Initial demonstration of method performance is completed each time there is a significant change in instrument type, personnel or method. Initial demonstration of method performance acceptance criteria is defined in the SOP.

10.6 Sample Aliquots

The aliquot sampling process from a submitted sample is part of a test method. The laboratory uses documented and appropriate procedures and techniques to obtain representative sub-samples. Sample aliquots removed for analysis are homogenized and representative portions removed from the sample container. Personnel record observations made during aliquot sampling in the test method logbooks.

10.7 Data Verification

Calculations and data transfers are subject to appropriate checks. A second person recalculates all manual calculations. An independent qualified analyst also reviews the data. A Client Services representative reviews data for project and method performance requirements where applicable. A QA representative reviews data for project and method performace requirements when requested by a Client. Final report review is performed by an authorized company signatory.

For drinking water suppliers, every effort is made to notify the Client within 24-hours of obtaining valid data of any results that exceed any established maximum contaminant level or reportable concentration. Analyst or Department Supervisor notifies the Client Services Department of the sample number(s), Client name, analysis and sample results (preliminary or confirmed). The Client Services Department notifies the client.

The laboratory Process Planning and Control Procedure describes the practices to ensure that the reported data is free of transcription errors and calculation errors. Manually entered data into the LIMS is dual entered and checked by the LIMS to minimize transcription errors. The laboratory test method SOP describes the quality control measures used to assure method performance before reporting data.

10.8 Labeling of Standards and Reagents

The purchase, receipt and storage of consumable materials used for the technical operations of the laboratory include the following:

a) The laboratory retains records of manufacturer's statement of purity, of the origin, purity and traceability of all chemical and physical standards.

b) Original reagent containers are labeled with the date opened and the expiration date.

c) Detailed records are maintained on reagent and standards preparation. These records indicate traceability to purchased stocks or neat compounds and include the date of preparation and preparer's initials.

d) Where calibrations do not include the generation of a calibration curve, records show the calibration date and type of calibration standard used.

e) All prepared reagents and standards are uniquely identified and the contents are clearly identified with preparation date, concentration and preparer's initials.

10.9 Computers and Electronic Data Related Requirements

Computers or automated equipment are used for the capture, processing, manipulation, recording, reporting, storage or retrieval of test data. The laboratory ensures that computer software is documented and adequate. The goals of the software development methodology, existing system validations and the change control system are to ensure that:

- the software systems perform the required functions accurately,
- the users understand how to use the system, and
- auditors can assure themselves of the validity of the analytical data.

The computer systems used at Alpha Woods Hole Labs are purchased. A coordinated effort is made with the supplier to assure the computer operations meet the laboratory requirements for data integrity. Alpha Woods Hole Labs has a formal validation program of its computer systems. The validation program is a comprehensive program to ensure data transmitted, reported or manipulated by electronic means is correct and free of errors. The validation and verification approach is separated into three areas.

1. New software is developed and validated using test data. Records of validation include the test data report, date and initials. Where formulas are part of the program, documentation includes manual verification of the final calculated values. New software includes the development of macros for spreadsheets and other tools using commercial software packages.
2. Reasons for changes to software are identified through flaws in existing documentation or the need to improve system processes and are documented on the Nonconformance Report. Final implementation of the change is documented on the nonconformance action form. The tracking and timelines of making the change is readily available. This process also provides the complete documentation of all software and electronic data reporting problems.

3. Verification of system integrity is through routine maintenance, protection from unauthorized access and electronic verification programs. Routine maintenance including system backups are performed on a scheduled basis. The backup process and password and access protections are defined in the Process & Data Control Procedure. Electronic verification may be used to assure the commercially purchased software is performing at its original specifications. This includes virus checking of all network operation at least once per week. Documentation of all verification and maintenance operations is retained in the equipment logbook for the computer network.

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11 Sample Handling, Sample Acceptance Policy and Sample Receipt

The Sample Login and Custody procedures define the process for sample management from sample receipt through analysis and to disposal. These procedures detail the process for sample receipt, records and storage pending analysis.

Clients or Alpha's Courier service deliver samples to the laboratory during normal business hours. Sample receiving occurs in the sample management area.

Client service personnel place bottle orders. The orders are filled following the bottle order instruction form. Blanks are prepared as needed with minimal storage. All glass containers are wrapped in bubble wrap or mesh sleeves to prevent breakage. The containers are placed in plastic coolers or shipping packages and Chain-of Custody forms, seals and labels enclosed. The bottle order is shipped by third party, picked up by the client or client representative or delivered by Alpha courier to the client.

11.1 Sampling Supplies

11.1.1 Sample Containers

Sample containers provided by Alpha Woods Hole Labs include labels, preservatives and a blank chain of custody form. Preservatives and containers are lot controlled and verified as appropriate for the indicated type of analysis.

Each lot of containers used for the collection of samples for microbiological analysis is checked for sterility prior to distribution. Sterility checks are performed by Microbiology staff and results recorded in Microbiology Sample Container Sterility Log.

11.1.2 Chain of Custody

Chain of custody forms must accompany all samples received by Alpha personnel. The chain of custody form indicates the sample origin and arrival at the laboratory and identifies the analyses requested.

11.1.3 Reagent Water

Alpha Woods Hole Labs supplies laboratory pure water for field QC blanks. Water used for volatile organics must be free of volatile compounds below the method detection limit. The quality of the laboratory water is monitored for conductivity once per day. Additional water quality criteria may be monitored based on client specific requests. The water quality in the microbiological laboratory is monitored for chemical parameters as required by the EPA certification manual for drinking water.

11.2 Sample Tracking

Alpha Woods Hole Labs routinely uses an internal chain-of-custody for sample tracking control purposes. When requested or required by regulation a legal custody program is used in addition to the routine laboratory practices. Legal custody practices must be arranged at the time of contractual commitment.

For legal custody the process must include complete and continuous records of the physical possession, storage, and disposal of sample containers, collected samples, sample aliquots, and sample extracts or digestates. For legal custody a sample is in someone's custody if:

1. It is in one's actual physical possession;
2. It is in one's view, after being in one's physical possession;
3. It is in one's physical possession and then locked up so that no one can tamper with it;
4. It is kept in a secured area, restricted to authorized personnel only.

The routine sample handling and tracking process includes unique identification of all sample containers, initials of the person removing the sample from the sample management area and documentation of the date of sample removal for disposal.

Samples are assigned a unique identification number from the LIMS program. Each sample container label includes a unique identifier for the container. The person handling the sample is recorded along with the unique identifier in the container tracking records in LIMS.

11.3 Sample Acceptance Policy

The sample management personnel check for proper sample labeling, preservation and handling at the time of arrival at the laboratory. The client and client services manager specifies the proper sample preservation, containers, cooling and other criteria on the project review form and in the LIMS. Sample management staff record all observations and immediate notify client services of any discrepancies or questions arising during sample receipt.

It is possible for samples or sample containers to be lost, damaged, or determined to be unsuitable, for whatever reason, after initial receipt at Alpha Woods Hole Labs. Should this happen, the event is recorded on the nonconformance action form by the observer. The problem is brought to the attention of a client services manager who reports it to the client. Plans for disposition of the affected samples or container are agreed upon with the client, carried out, and recorded in the project records.

11.4 Sample Receipt Protocols

The sample management staff receives all samples. A unique job number is assigned to each shipment of samples received from a client. The in-house records for the incoming job, including the internal Chain-of-Custody, are initiated with a Sample Delivery Group (SDG) form. The client and the sample management personnel sign the sample custody form at the time of receipt at the laboratory. Samples received via overnight courier are signed on the bill of lading. The bill of lading, SDG form and the sample custody form are completed for external courier delivered samples.

The sample management staff examines the shipping containers, their contents, and accompanying client documentation. Information about the sample identification, the location, date and time of collection, collector's name, preservation type, sample type, presence and condition of custody seals, the state of preservation of the samples and other required information is noted on the SDG form. Any discrepancies in documentation or problems with sample condition such as appropriate sample containers, thermal preservation variation, holding times and adequate sample volumes are noted and brought to the attention of the client via the nonconformance action form. The Client Services Manager provides clarification or further instruction to the sample management staff on the processing of the samples that are incomplete or missing required information.

The sample management staff logs the samples on the computer and a durable label for each container is printed. The custodian attaches each label to the appropriate sample container. The following information is recorded for tracking internal custody: laboratory sample ID, client sample ID, sample matrix and storage location. Sample receipt and log-in specifically requires: date and

time of laboratory receipt of sample(s); sample collection date; unique laboratory ID code; field ID code supplied by sample submitter; requested analyses; signature or initials of data logger; comments from inspection for sample acceptance or rejection and in some cases, sample bottle codes.

11.5 Storage Conditions

Alpha Woods Hole Labs stores samples under proper environmental conditions to ensure their integrity and security. Samples are stored at temperatures that meet specifications of the methodology, regulatory agencies and client directives. Refrigerators are monitored and controlled to be within 4 ± 2°C. Chemical, temperature, holding times and container storage requirements are listed in the LIMS project database.

Client Quality Assurance Project Plans may list preservation requirements differing from the laboratory. The sample management staff reviews project information for projects specific handling. Addition of chemical preservative to sample containers normally is done in the field at the time of sampling. Chemical preservation and temperature preservation checks at the time of receipt are recorded except for volatile organic compounds, bacteria, sulfite, and dissolved oxygen preservation. Any differences from laboratory or client specific requirements are recorded on nonconformance action forms and contact made with the client by the Client Services Manager or designee.

Sample storage facilities are located within the sample management area, which is secured by locked doors. Internal chain-of-custody procedures and documentation pertaining to sample possession, removal from storage, and transfer are outlined in the sample custody procedure. Samples are returned to the sample management area after the sample portion is removed for analysis. Extracts and digestates are tracked and follow the same internal custody operation. Extracts and digestates are removed to the waste disposal area after analysis to allow for proper disposal.

Sample storage precautions are used to ensure that cross contamination does not occur during sample storage. Refrigerator storage blanks are monitored for volatile compounds as necessary. Storage blanks from the volatiles storage refrigerator are placed in the refrigerator every Monday replacing the blanks placed in the refrigerator the previous Monday. The storage blank information allows the assessment of potential cross contamination in the sample storage refrigerator.

Temperatures of cold storage areas are monitored and recorded daily. Corrective action is done as necessary when temperatures are not within the control criteria. Temperatures are measured with NIST traceable thermometers. All temperature records indicate the thermometer used for obtaining the measurement. The Datalogger is linked to thermocouples that are in most refrigerators and freezers in the Sample Storage area. The Datalogger is calibrated and certified by an outside vendor on a quarterly basis.

11.6 Sample Disposal

Samples are held for thirty days after the report is released to the client. Upon written client request samples are held for up to six months in an uncontrolled area. Requests for controlled sample storage must be arranged at the time of contractual commitment

An authorized waste carrier is contracted to pick up waste as needed and dispose of it, in accordance with all regulatory requirements. Post-analysis disposition of samples is dependent upon project specific requests. Remaining sample material may be returned to the client, safely discarded, or archived for a specific time prior to disposal. The waste disposal SOP defines the specific requirements for sample disposal and other waste disposal operations.

The sample management staff are responsible for the archival and disposal of raw samples, extracts and digestates. Raw and prepared samples may not be archived or disposed until all of the designated analyses are complete and resultant analytical data is sent to clients. Samples in storage are retained a minimum of 30 days after reporting the results to the client. Any samples requiring more than 30 days are archived.

When a client has requested the return of samples, the sample management staff prepares and ships the samples according to the same custody procedures in which the samples were received and following any client specified requirements. Protection of the samples during delivery is ensured by the implementation of special packaging procedures. Packages are delivered by a commercial carrier whose procedures for protecting the samples are not within the control of this laboratory. Clients are informed that a commercial carrier will deliver their samples if required.

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12 Records

Alpha Woods Hole Labs has a record system that produces unequivocal, accurate records, which document all laboratory activities. The laboratory retains records of all original observations, calculations and derived data, calibration records and a copy of the test for ten years minimum. The system retains records longer than the minimum upon the request of authorized clients, agencies or another regulator.

12.1 Record Keeping System and Design

The record keeping system allows reconstruction of all laboratory processes that produced the analytical data of the sample.

a) The records include the names of personnel involved in sampling, preparation, calibration or testing.

b) All information relating to laboratory facilities equipment, analytical methods, and activities such as sample receipt, preparation, or data verification are documented.

c) The record keeping system guarantees retrieval of all working files and archived records for inspection and verification purposes.

d) All documentation entries are signed or initialed by responsible staff.

e) All generated data requiring operator logging on appropriate logsheets or logbooks are recorded directly, promptly and legibly in permanent ink

f) Entries in records are not obliterated by any method. All corrections to errors are made by one line marked through the error. The person making the correction signs and dates the correction.

g) Data entry is minimized by electronic data transfer and ensuring the number of manual data transcriptions is reduced.

12.2 Records Management and Storage

1. All records including calibration and test equipment, certificates and reports are safely stored, held secure and in confidence to the client.
2. The laboratory maintains all hardware and software necessary for reconstruction of data.
3. Records that are stored or generated by computers have hard copy or write-protected backup copies.
4. Alpha Woods Hole Labs has established a record management system, for control of all laboratory notebooks.
5. Access to archived information is carefully controlled and is limited to authorized personnel. These records are protected against fire, theft, loss, environmental deterioration, vermin, and in the case of electronic records, electronic or magnetic sources.
6. In the event that Alpha Woods Hole Labs transfers ownership or goes out of business, there is a plan to ensure that the records are maintained or transferred according to the client's instructions. A shell corporation will be developed to maintain continuity of our record keeping systems as requested and/or required by both state and federal laws.

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Alpha Woods Hole Labs retains all original hard copy or electronic raw data for calibrations, samples, and quality control measures for ten years, including:

1. Analysts work sheets and data output records,
2. Reference to the specific method,
3. Calculation steps including definition of symbols to reduce observations to a reportable value,
4. Copies of all final reports
5. Archived SOPs,
6. Correspondence relating to laboratory activities for a specific project,
7. All nonconformance action reports, audits and audit responses,
8. Proficiency test results and raw data,
9. Data review and cross checking.

The basic information to tie together analysis and peripherals such as strip charts, printouts, computer files, analytical notebooks and run logs for Alpha Woods Hole Labs includes:

1. Unique ID code for each Laboratory sample or QC sample;
2. Date of analysis;
3. Instrument identification and operating conditions;
4. SOP reference and version;
5. Any and all calculations;
6. Analyst's or operator's initials/signature.

In addition, Alpha Woods Hole Labs maintains records of:

1. Personnel qualifications, experience and training
2. Initial and continuing demonstration of proficiency for each analyst
3. A log of names, initials and signatures for all individuals who are responsible for signing or initialing any laboratory records.

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12.3 Laboratory Sample Tracking

A record of all procedures to which a sample is subjected while in the possession of the laboratory is maintained. These include but are not limited to all records pertaining to:

a) Sample preservation including appropriate sample container and compliance with holding time requirement;

b) Sample identification, receipt, acceptance or rejection and log-in;

c) Sample storage and tracking including shipping receipts, transmittal forms, and internal routing and assignment records; this includes interlaboratory transfers of samples, extracts and digestates.

d) Sample preparation including cleanup and separation protocols, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;

e) Sample analysis;

f) Standard and reagent origin, receipt, preparation, and use;

g) Equipment receipt, use, specification, operating conditions and preventative maintenance;

h) Calibration criteria, frequency and acceptance criteria;

i) Data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions;

j) Method performance criteria including expected quality control requirements;

k) Quality control protocols and assessment;

l) Electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries;

m) All automated sample handling systems;

n) Records storage and retention; and

o) Disposal of hazardous samples including the date of sample or sub-sample disposal and the name of the responsible person.

p) The COC records account for all time periods associated with the samples.

q) The COC records include signatures of all individuals who had access to individual samples. Signatures (written or electronic) of all personnel who physically handle the samples. Time of day and calendar date of each transfer or handling procedure

r) Common carrier documents.

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13 Laboratory Report Format and Contents

The Process Planning and Control Procedure details the recording and reporting of data as required by the client and in accordance with relevant environmental regulations.

Clients specify the report delivery and deliverables required for the work submitted. Report delivery includes standard turnaround and rush turnaround. Clients specify the delivery address or multiple addresses and method of delivery such as U.S. Mail, facsimile or electronic at the start of the project. Alpha Woods Hole Labs provides data deliverables in hardcopy or electronic format. At the start of any project, the electronic deliverable formats required must be received before sample arrival.

Reporting packages are available for routine regulatory reporting requirements. Regulatory reporting packages include only the information requested by the regulatory agency. In addition to regulatory report packages, Alpha Woods Hole Labs prepares a standard report format. The standard report format includes:

1. Title: "Certification of Analysis"
2. Name and address of the laboratory
3. Laboratory Job Number, page number and total number of pages included in the report.
4. Name and address of the client
5. Alpha sample number, Client identification, Sample location
6. Samples identified that do not meet the sample acceptance requirements for project.
7. Date of sample receipt, sample collection, analysis date and time, report date and analyst
8. Identification of data reported by subcontractors
9. Test name and EPA reference method number
10. Delivery method and sampling procedures when collected by lab personnel
11. Deviations or modifications that affect data quality
12. Statement that results relate only to the sample tested
13. Statement that report must be copied in full unless the laboratory provides written permission for partial copies
14. Glossary, References and limits of liability
15. Units of measure and reporting detection limit
16. Quality control data for: % Recovery surrogates, % Recovery of LCS, % RPD of LCSD, Blank analysis, % Recovery Matrix Spike, %RPD of Laboratory Duplicates, as applicable
17. Signature, title and date of report

Results transmitted by facsimile or other electronic means include a statement of confidentiality and return of the materials at the laboratory's expense.

The laboratory notifies the client in writing of any circumstance that causes doubt on the validity of the results. The amended or modified report lists the change, reason for the change, affected page numbers, date of the amendment and authorized signature.

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14 Outside Support Services and Supplies

When Alpha Woods Hole Labs purchases outside services and supplies in support of tests, the laboratory uses only those outside services and supplies that are of adequate quality to maintain confidence in the tests.

The Supplier & Subcontractor Evaluation procedure describes the process for assessment, approval and monitoring of all suppliers and subcontractors used by the laboratory. Where no independent assurance of the quality of outside support services or supplies is available, the laboratory ensures that purchased equipment, materials, and services comply with specifications by evaluating method performance before routine use.

The laboratory checks shipments upon receipt as complying with purchase specifications. The use of purchased equipment and consumables is only after the evaluation and compliance to the specifications is complete. The Purchasing Procedure describes the details for receipt and inspection of purchased product.

The Purchasing Procedure describes the process for raising, review, placement and changes to purchase orders. It is company policy to purchase from third party certified suppliers and subcontractors wherever possible. Purchases must be from suppliers approved by the Laboratory. Laboratory or sampling subcontractors specified by the client are noted as "Trial" on the purchase order. This identifies the subcontractor as a non-approved subcontractor.

The laboratory maintains records of all suppliers and subcontractors from whom it obtains support services or supplies required for tests.

14.1 Subcontracting Analytical Samples

The laboratory approves testing and sampling subcontractors by review of current state, national or other external parties' certifications or approvals. The laboratory maintains current certification or approval documents as part of the purchasing records. This document must indicate current approval for the subcontracted work.

The Sample Receipt and Login Procedure describes the process for sample handling when subcontracting samples. The quotation form lists the subcontractor in order to notify the client of any subcontracted work. Client notification of subcontracted work is in writing before releasing samples to the subcontractor.

The review of subcontractor documents for completeness and meeting the specifications defined for the project follows the laboratory process for reporting and verification of process data. The person responsible for receiving the order reviews the information supplied by the subcontractor instead of the Department Supervisor. Documented report reviews and any requested corrections are written on the Nonconformance Report.

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15 Client Relations

15.1 Client Service

The majority of the client services occur from personnel in the administration, sample receiving and sampling areas. Client service involves inquiries into services offered, technical consulting, placing orders, and receiving orders, providing updates on the status of orders and completing orders. Personnel interacting with clients must document and review client specific project requirements. Personnel must document client interactions following the appropriate laboratory procedures. Each person must communicate deviations, modifications and client requests following the laboratory defined procedures.

15.2 Project Management

During staff meetings the laboratory management reviews requests for new work. The Laboratory Director addresses all capacity and capability issues. Where conflicts in workload arise, client notification is immediate. The Project Information Form contains the documentation of all project information. Cooperation between laboratory and client services staff allows direct communication and scheduling. Management arranges complex scheduling and coordination between departmental areas.

The Inquiry & Sales Procedure describes the process for inquiry receipt and actions taken of inquiries, processing sales orders and process for requesting sample containers. This procedure also describes the process for handling subcontracted samples. The Order and Sample Receipt Procedure details the receiving, recording and storing of orders pending receipt and samples pending analysis.

15.3 Complaint Processing

The laboratory staff documents all clients or other parties' complaints or concerns regarding the data quality or laboratory operations. The Nonconformance Report records complaints, correcting the concern, and resolving the concern with the client or other party. The process uses the same form and process as the nonconformance action process. Where repetitive corrective actions indicate a problem, an audit of the area is immediate to ensure the corrective action has effectively solved the concern.

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16 Appendix A – Definitions

The following definitions are from Appendix A of the 2003 NELAC Standard. The laboratory adopts these definitions for all work performed in the laboratory.

Acceptance Criteria: specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation: the process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one. (NELAC)

Accrediting Authority: the Territorial, State or Federal agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation. (NELAC)[1.4.2.3]

Accrediting Authority Review Board (AARB): five voting members from Federal and State Accrediting Authorities and one-non-voting member from USEPA, appointed by the NELAP Director, in consultateion with the NELAC Board of Directors, for the purposes stated in 1.4.7.e (NELAC)[1.4.7]

Accuracy: the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS).

Assessor Body: the organization that actually executes the accreditation process, i.e., receives and reviews accreditation applications, reviews QA documents, reviews proficiency testing results, performs on-site assessments, etc., whether EPA, the State, or contracted private party. (NELAC)

Analyst: the designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality. (NELAC)

Applicant Laboratory or **Applicant:** the laboratory or organization applying for NELAP

Assessment: the evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of NELAC). (NELAC)

Assessment Criteria: the measures established by NELAC and applied in establishing the extent to which an appliant is in conformance with NELAC requirements. (NELAC)

Assessment Team: the group of people authorized to perform the on-site inspection and proficiency testing data evaluation required to establish whether an applicant meets the criteria for NELAP accreditation. (NELAC)

Assessor: one who performs on-site assessments of accreditating authorities and laboratories' capability and capacity for meeting NELAC requirements by examining the records and other physical evidence for each one of the tests for which accreditation has been requested. (NELAC)

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Audit: a systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity. (EPA-QAD)

Batch: environmental samples, which are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same NELAC-defined matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples. (NELAC Quality Systems Committee)

Blank: a sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. Blanks include:

Equipment Blank: a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (NELAC)

Field Blank: blank prepared in the field by filling a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)

Instrument Blank: a clean sample (e.g. distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Method Blank; a sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses, (NELAC)

Reagent Blank: (method reagent blank): a sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytial procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps. (QAMS)

Blind Sample: a sub-sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process. (NELAC)

Calibration: set of operations which establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. (VIM: 6.11)

1) In calibration of support equipment the values realized by standards are established through the use of Reference Standards that are traceable to the International System of Units (SI).

2) In calibration according to test methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the Laboratory with a certificate of analysis or purity, or prepared by the Laboratory using support equipment that has been calibrated verified to meet specifications.

Calibration Curve: the graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (NELAC)

Calibration Method: a defined technical procedure for performing a calibration. (NELAC)

Calibration Standard: a substance or reference material used to calibrate an instrument. (QAMS)

Certified Reference Material (CRM): a reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body. (ISO Guide 30 - 2.2)

Chain of Custody Form: record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; collector; time of collection; preservation; and requested analyses. (NELAC)

Clean Air Act: the enabling legislation in 42 U.S.C. 7401 *et seq.*, Public Law 91-604, 84 Stat. 1676 Pub.L. 95-95, 91 Stat., 685 and Pub. L. 95-190, 91 Stat., 1399, as amended, empowering EPA to promulgate air quality standards, monitor and to enforce them. (NELAC)

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA/Superfund): the enabling legislation in 42 U.S.C. 9601-9675 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C. 9601 et seq., to eliminate the health and environmental threats posed by hazardous waste sites. (NELAC)

Confidential Business Information (CBI): information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. NELAC and its representatives agree to safeguaring identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation: verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to:

Second column confirmation
Alternate wavelength
Derivatization
Mass spectral interpretation
Alternative detectors or
Additional cleanup procedures.
(NELAC)

Conformance: an affirmative indication or judgement that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Contributor: a participant in NELAC who is not a Voting Member. Contributors include representatives of laboratories, manufacturers, industry, business, consumers, academia, laboratory associations, laboratory accreditation associations, counties, municipalities, and other political subdivisions, other federal and state officials not engaged in environmental activities, and other persons who are interested in the objectivies and activities of NELAC.

Corrective Action: the action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Critical Finding: a finding or a combination of findings that results in a significant negative effect on data quality or defensibility, if not corrected. (NELAC)

Data Audit: a qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality (i.e., that they meet specified acceptance criteria.) (NELAC)

Data Reduction: the process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form. (EPA-QAD)

Deficiency: See Finding and Critical Finding

Delegate: any environmental official of the States or the Federal government not sitting in the House of Representatives, who is eligible to vote in the House of Delegates. (NELAC)

Demonstration of Capability: a procedure to establish the ability of the analyst to generate acceptable accuracy. (NELAC)

Denial: to refuse to accredit in total or in part a laboratory applying for initial accreditation or resubmission of initial application. (NELAC) [4.4.1]

Detection Limit: the lowest concentration or amount of the target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value. See Method Detection Limit. (NELAC)

Document Control: the act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed. (ASQC)

Environmental Laboratory Advisory Board (ELAB): a Federal Advisory Committee, with members appointed by EPA and composed of a balance of non-state, non-federal representatives, from the environmental laboratory community, and chaired by an ELAB member. (NELAC)

Environmental Monitoring Management Council (EMMC): an EPA Committee consisting of EPA managers and scientists, organized into a Policy Council, a Steering Group, *ad hoc* Panels, and work groups addressing specific objectives, established to address EPA-wide monitoring issues. (NELAC)

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA): the enabling legislation under 7 U.S.C. 135 *et seq.*, as amended, that empowers the EPA to register insecticides, fungicides, and rodenticides. (NELAC)

Federal Water Pollution Control Act (Clean Water Act, CWA): the enabling legislation under 33 U.S.C 1251 et seq., Public Law 92-50086 Stat. 8.16, that empowers EPA to set discharge limitations, write discharge permits, monitor, and bring enforcement action for non-compliance. (NELAC)

Field Measurement: The determination of physical, biological, or radiological properties, or chemical constituents; that are measured on-site, close in time and space to the matrices being sampled/measured, following accepted test methods. This testing is performed in the field outside of a fixed-laboratory or outside of an enclosed structure that meets the requirements of a mobile laboratory.

Field of Accreditation: (previously Field of Testing) NELAC's approach to accrediting laboratories by matrix, technology/method and analyte/analyte group. Laboratories requesting accreditation for a matrix-technology/method-analyte/analyte group combination or for an updated/improved method are required to submit only that portion of the accreditation process not previously addressed. (NELAC)

Field of Proficiency Testing: NELAC's approach to offering proficiency testing by matrix, technology, and analyte/analyte group.

Finding: an assessment conclusion, referenced to a NELAC Standard and supported by objective evidence that identifies a deviation from a NELAC requirement. **See Critial Finding.**

Governmental Laboratory: as used in these standards, a laboratory owned by a Federal, state or tribal government; includes government-owned contractor-operated laboratories. (NELAC)

Holding Times (Maximum Allowable Holding Times): the maximum times that samples may be held prior to analysis and still be considered valid or not compromised. (40 CFR part 136)

Inspection: an activity such as measuring, examining, testing, or guaging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformance is achieved for each characteristic. (ANSI/ASQC_E4-1994)

Interim Accreditation: temporary accreditation status for a laboratory that has met all accreditation criteria except for a pending on-site assessment which has been delayed for reasons beyond the control of the laboratory. (NELAC)

Internal Standard: a known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method. (NELAC)

Laboratory: Body that calibrates and/or tests. (ISO 25)

Laboratory Control Sample (however named, such as laboratory fortified blank , spiked blank or QC check sample): a sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system. (NELAC).

Laboratory Duplicate: aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently. (NELAC)

Legal Chain of Custody Protocols: procedures employed to record the possession of samples from the time of sampling until analysis and are performed at the special request of the client. These protocols include the use of a Chain of Custody Form that documents the collection, transport, and receipt of compliance samples by the laboratory. **In addition, these protocols document all handling of the samples within the laboratory.** (NELAC)

Limit of Detection (LOD): An estimate of the minimum amount of a substance that an analytical process an reliably detect A LOD is analyte-and-matrix-specific and may be laboratory-dependent.

Limits of Quantitation (LOQ): The minimum levels, concentrations, or quantities of a target variable (e.g.target analyte) that can be reported with a specified degree of confidence.

Manager (however named): the individual designated as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory. A supervisor may report to the manager. In some cases, the supervisor and the manager may be the same individual. (NELAC)

Matrix: the substrate of a test sample.

Field of Accreditation Matrix: these matrix definitions shall be used when accrediting a laboratory (see Field of Accreditation).

- Drinking water: Any aqueous sample that has been designated a potable or potential potable water source.
- Non-Potable Water: Any aqueous sample excluded from the definition of a drinking water matrix. Includes surface water, groundwater, effluents, water treatment chemicals, and TCLP or other extracts.
- Solid and Chemical Materials: includes soils, sediments, sludges, products and by-rpoducts of an industrial process that results in a matrix not previously defined.
- Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.
- Air and Emissions: whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter or other device. (NELAC)

Quality System Matrix: These matrix definitions are an expansion of the field of accreditation matrices and shall be used for purposes of batch and quality control requirements (see Appendix D of Chapter 5). These matrix distinctions shall be used:

- Aqueous: any aqueous sample excluded from the definition of Drinking Water matrix or Saline/Estuarine source. Includes surface water, groundwater, effluents, and TCLP or other extracts.
- Drinking water: Any aqueous sample that has been designated a potable or potential potable water source.

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- Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.
- Non-aqueous liquid: Any organic liquid with <15% settleable solids.
- Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.
- Solids: Includes soils, sediments, sludges and other matrices with >15% settleable solids.
- Chemical Waste: A product or by-product of a industrial process that results in a matrix not previously defined.
- Air and Emissions: whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbent tube, impinger solution, filter or other device. (NELAC)

Matrix Spike (spiked sample, fortified sample): a sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of Target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency. (QAMS).

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): a second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte. (QAMS).

May: denoted permitted action, but not required action. (NELAC)

Measurement Quality Objectives (MQOs): the desired sensitivity, range, precision, and bias of a measurement.

Measurement System: a test method, as implementd at a particular laboratory, and which includes the equipment used to perform the test and the operator(s).

Method: 1. See Test Method. 2. Logical sequence of operations, described generically, used in the performance of measurements. (VIM 2.4)

Method Detection Limit :one way to establish a Limit of Detection, defined as the minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

Mobile Laboratory: A portable enclosed structure with necessary and appropriate accommodation and environmental conditions as described in Chapter 5, within which testing is performed by analysts. Examples include but are not limited to trailers, vans and skid-mounted structures configured to house ttesting equipment and personnel.

Must: denotes a requirement that must be met. (Random House College Dictionary)

National Accreditation Database: the publicly accessible database listing the accreditation status of all laboratories participating in NELAP. (NELAC)

National Institute of Standards and Technology (NIST): an agency of the US Department of Commerce's Technology Administration that is working with EPA, States, NELAC, and other public and commercial entities to establish a system under which private sector companies and interested States can be accreditied by NIST to provide NIST-traceable

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proficiency testing (PT) to those laboratories testing drinking water and wastewater. (NIST)

National Environmental Laboratory Accreditation Conference (NELAC): a voluntary organization of State and Federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories. A subset of NELAP. (NELAC)

National Environmental Laboratory Accreditation Program (NELAP): the overall National Environmental Laboratory Accreditation Program of which NELAC is a part. (NELAC)

National Voluntary Laboratory Accreditation Program (NVLAP): a program administered by NIST that is used by providers of proficiency testing to gain accreditation for all compound/matrices for which NVLAP accreditation is available, and for which the provider intends to provide NELAP PT samples. (NELAC)

Negative Control: measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results. (NELAC)

NELAC Standards: the plan of procedures for consistently evaluating and documenting the ability of laboratories performing environmental measurements to meet nationally defined standards established by the National Environmental Laboratory Accreditation Conference. (NELAC)

NELAP Recognition: the determination by the NELAP Director that an accrediting authority meets the requirements of the NELAP and is authorized to grant NELAP accreditation to laboratories. (NELAC)

Performance Audit: the routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory. (NELAC)

Positive Control: measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects. (NELAC)

Precision: the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (NELAC).

Preservation: refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample. (NELAC)

Primary Accrediting Authority: the agency or department designated at the Territory, State or Federal level as the recognized authority with responsibility and accountability for granting NELAC accreditation for a specified field of testing. (NELAC)

Procedure: Specified way to carry out an activity or a process. Procedures can be documentd or not. (ISO 9000: 2000 and Note 1)

Proficiency Testing: a means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an exteranl source. (NELAC) [2.1]

Proficiency Testing Oversight Body/Proficiency Testing Provider Accreditor (PTOB/PTPA): an organization with technical expertise, administrative capacity and financial resources sufficient to implement and operate a national program of PT provider evaluation and oversight that meets the responsibilities and requirements established by the NELAC Standards. (NELAC)

Proficiency Testing Program: the aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories.

Proficiency Testing Study Provider: any person, private party, or government entity that meets stringent criteria to produce and distribute NELAC PT samples, evaluate study results against published performance criteria and report the results to the laboratories, primary accrediting authorities, PTOB/PTPA and NELAP. (NELAC)

Proficiency Test Sample (PT): a sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria . (QAMS).

Protocol: a detailed written procedure for field and/or laboratory operation (e.g., sampling, analysis) which must be strictly followed. (EPA-QAD).

Quality Assurance: an integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. (QAMS,).

Quality Assurance [Project] Plan (QAPP): a formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EPA-QAD)

Quality Control: the overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users. (QAMS).

Quality Control Sample: a sample used to assess the performance of all or a portion of the measurement system. QC samples may be Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking.

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, the ensure the quality of its product and the utility of its product to the users.

Quality System: a structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC. (ANSI/ASQC E-41994)

Raw Data: any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments. If exact copies of raw data have been prepared (e.g., tapes

which have been transcribed verbatim, data and verified accurate by signature), the exact copy or exact transcript may be submitted. (EPA–QAD)

Recognition: previously known as reciprocity. The mutual agreement of two or more parties (i.e. States) to accept each other's findings regarding the ability of environmental testing laboratories in meeting NELAC standards. (NELAC)

Reference Material: a material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30 - 2.1)

Reference Standard: a standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived. (VIM - 6.08)

Reference Toxicant: the toxicant used in performing toxicity tests to indicate the sensitivity of a test organism and to demonstrate the laboratory's ability to perform the test correctly and obtain consistent results (see Chapter 5, Appendix D, Section 2.1f). (NELAC)

Replicate Analyses: the measurements of the variable of interest performed identically on two or more sub-samples of the same sample within a short time interval. (NELAC)

Requirement: Denotes a mandatory specification; often designated by the term "shall". (NELAC)

Resource Conservation and Recovery Act (RCRA): the enabling legislation under 42 USC 321 *et seq.* (1976), that gives EPA the authority to control hazardous waste from the "cradle-to-grave", including its generation, transportation, treatment, storage and disposal. (NELAC)

Revocation: the total or partial withdrawal of a laboratory's accreditation by the accrediting authority. (NELAC) [4.4.3]

Safe Drinking Water Act (SDWA): the enabling legislation, 42 USC 300f *et seq.* (1974), (Public Law 93-523), that requires the EPA to protect the quality of drinking water in the U.S. by setting maximum allowable contaminant levels, monitoring, and enforcing violations.

Sample Tracking: procedures employed to record the possession of the samples from the time of samping until analysis, reporting and archiving. These procedures include the use of a Chain of Custody Form that documents the collection, transport, and receipt of compliance samples to the laboratory. In addition, access to the laboratory is limited and controlled to protect the integrity of the samples. (NELAC)

Secondary Accrediting Authority: the Territorial, State or federal agency that grants NELAC accreditation to laboratories, based upon their accreditation by a NELAP-recognized Primary Accrediting Authority. See also **Recognition** and **Primary Accrediting Authority**. (NELCA)

Selectivity: (Analytical chemistry) the capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. (EPA-QAD)

Sensitivity: the capability of a test method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (NELAC)

Shall: denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled. (ANSI).

Should: denotes a guideline or recommendation whenever noncompliance with the specification is permissible. (ANSI).

Standard Operating Procedures (SOPs): a written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks. (Glossary of Quality Assurance Terms, QAMS, 8/31/92).

Spike: a known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes. (NELAC)

Standard: the document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of NELAC and meets the approval requirements of NELAC procedures and policies. (ASQC)

Standard Operating Procedures (SOPs): a written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks. (QAMS)

Standard Method: a test method issued by an organization generally recognized as competent to do so.

Standardized Reference Material (SRM): a certified reference material produced by the U.S. National Institute of Standards and Technology or other equivalent organization and characterized for absolute content, independent of analyical method.

Statistical Minimum Significant Difference (SMSD): the minimum difference between the control and a test concentration that is statishtically significant; a measure of test sensitivity or power. The power of a test depends in part of the number of replicates per concentration, the significance level selected, e.g. 0.05, and the type of statistical analysis. If the variability remains constant, the sensitivity of the test increases as the number of replicates is increased. (NELAC)

Supervisor (however named): the individual(s) designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training and experience to perform the required analyses. (NELAC)

Surrogate: a substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes. (QAMS).

Suspension: temporary removal of a laboratory's accreditation for a defined period of time, which shall not exceed six months, to allow the laboratory time to correct deficiencies or area of non-compliance with the NELAC standards. (NELAC) [4.4.2]

Technical Director: individual(s) who has overall responsibility for the technical operation of the environmental testing laboratory. (NELAC).

Technology: a specific arrangement of analytical instruments, detection systems, and/or preparation techniques.

Test: a technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate. (ISO/IEC Guide 2 - 12.1, amended)

Test Method: an adoption of a scientific technique for performing a specific measurement, as documented in a laboratory SOP or as published by a recognized authority.

Testing Laboratory: laboratory that performs tests. (ISO/IEC Guide 2 - 12.4)

Testing Sensitivity/Power: the minimum significant difference (MSD) between the control and test concentration that is statistically significant. It is dependent on the number of replicates per concentration, the selected significance level, and the type of statistical analysis (see Chapter 5, Appendix D, Section 2.4.a). (NELAC)

Tolerance Chart: A chart in which the plotted quality control data is assessed via a tolerance level (e.g. +/- 10% of a mean) based on the precision level judged acceptable to meet overall quality/data use requirements instead of a statistical acceptance criteria (e.g. +/- 3 sigma). (applies to radiobioassay laboratories). (ANSI)

Toxic Substances Control Act (TSCA): the enabling legislation in 15 USC 2601 et seq. (1976), the provides for testing, regulaing, and screening all chemicals produced or imported into the United States for possible toxic effects prior to commercial manufacture. (NELAC)

Traceability: the property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons. (VIM - 6.12)

United States Environmental Protection Agency (EPA): the federal governmental agency with responsibility for protecting public health and safeguarding and improving the natural environment (i.e. the air, water and land) upon which human life depends. (US-EPA)

Validation: the confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfulled.

Verification: confirmation by examination and provision of evidence that specified requirements have been met. (NELAC)

NOTE - In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment.

The result of verification leads to a decision either to restore in service, to perform adjustments, or to repair, or to downgrade, or to declare obsolete. In all cases, it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.

Voting Member: Officials in the employ of the Government of the United States, and the States, the Territories, the Possessions of the United States, or the District of Columbia

and who are actively engaged in environmental regulatory programs or accreditation of environmental laboratories. (NELAC)

Work Cell: a well-defined group of analysts that together perform the method analysis. The members of the group and their specific functions within the work cell must be fully documented. (NELAC)

Working Range: the difference between the Limit of Quantitation and the upper limit of measurement system calibration.

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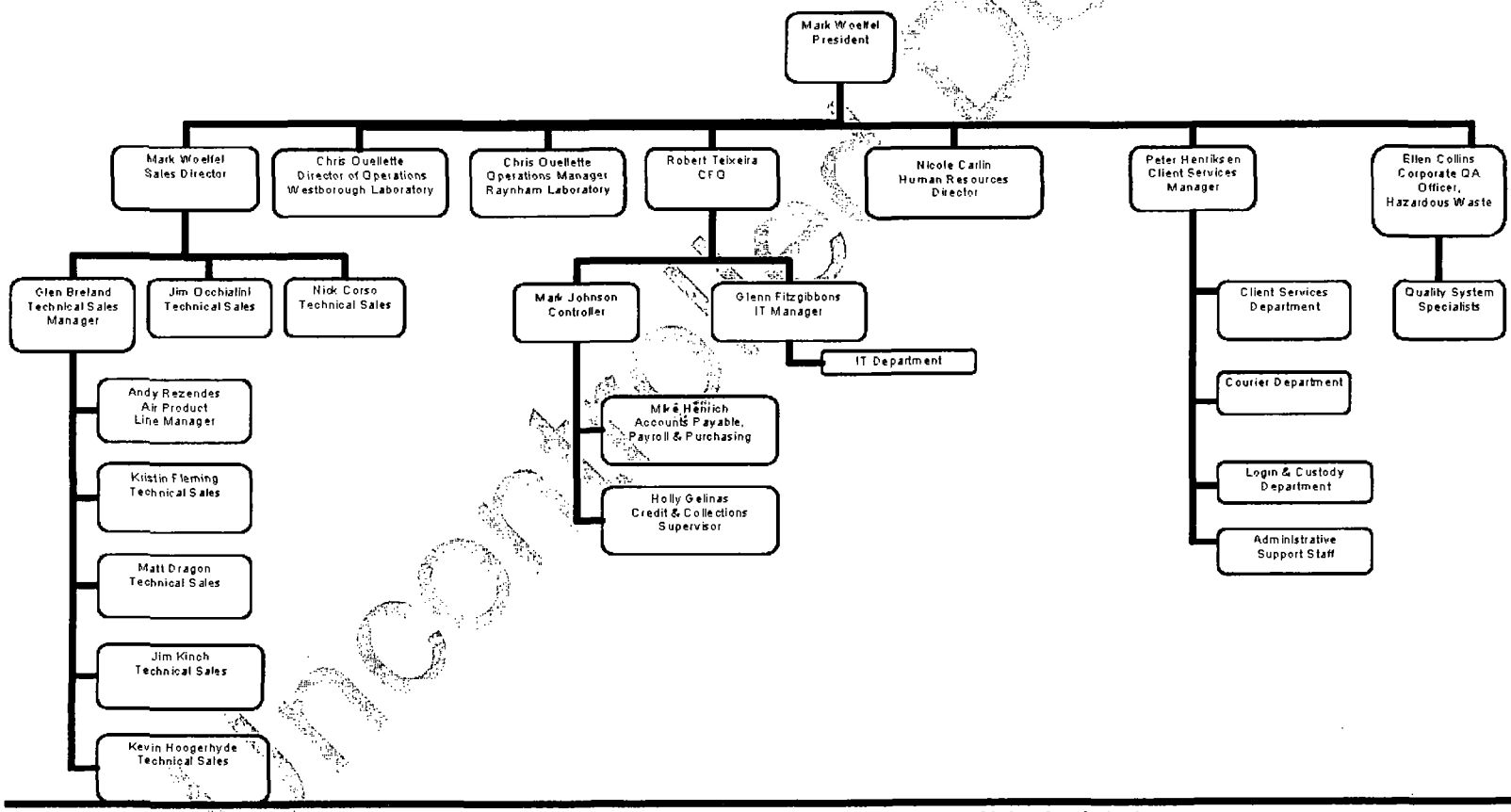
17 Appendix B – Organization Charts

The following charts provides an overview of the organizational structure of Alpha Woods Hole Labs. The chart also identifies the key personnel responsible for the listed positions. For the various laboratory areas, the individual departmental supervisors are noted. For a listing of all current key personnel, please refer to Section 19, Appendix D.

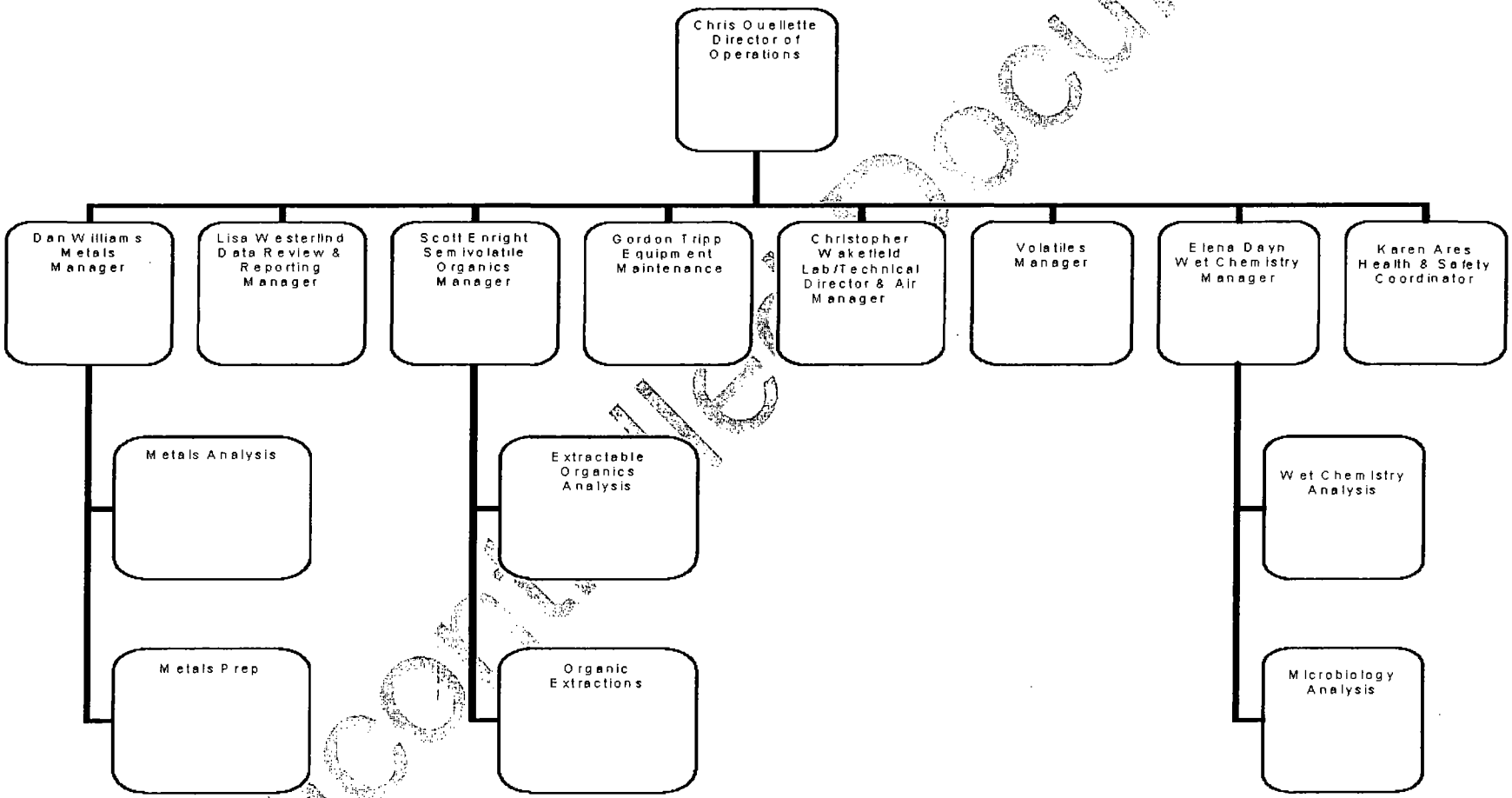
ORGANIZATIONAL CHART

-CORPORATE STRUCTURE-



ORGANIZATIONAL CHART

-OPERATIONS STRUCTURE-



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18 Appendix C – List of Key Personnel

The following is a listing of all current key personnel.

The following is a list of the laboratory organization. Each position notes the name of the current staff member who is responsible for the duties associated with the position.

President / Sales Manager: Mark Woelfel

Director of Operations: Christopher Ouellette

Laboratory Director / Technical Director: Christopher Wakefield

Quality Assurance Officer: Ellen M. Collins

Quality Systems Specialists: Amy Rice, Elizabeth Simmons

Human Resources Director: Nicole Carlin

Vice Presidents, Technical Sales: Glen Breland, James Occhialini, Nick Corso

Technical Sales Representatives: Jim Kinch, Kristin Fleming, Matt Dragon, Peter Debroczy, Kevin Hoogerhide

Chief Financial Officer: Robert Teixeira

Controller: Mark Johnson

A/P, Payroll, Purchasing: Michael Henrich

Credit & Collections Supervisor: Holly Gelinas

Information Technology: Glenn Fitzgibbons

Client Services Supervisor: Peter Henriksen

Login & Custody Supervisor: Peter Henriksen

Wet Chemistry Supervisor: Elena Dayn

Metals Supervisor: Daniel Williams

SemiVolatile and Organic Extractions Supervisor: Scott Enright

Volatiles (Interim Supervisor): Scott Enright

Air Supervisor: Christopher Wakefield

Data Review and Report Generation Supervisor: Lisa Westerlind

Equipment Maintenance: Gordon Tripp

Environmental Health & Safety Coordinator: Karen Ares

Hazardous Materials Consultant: Veolia ES Technical Solutions

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19 Appendix D – Preventive Maintenance Procedures

Optimized Service-Calibration Intervals		
Equipment	**Frequency**	**Type of Calibration or Maintenance**
Balances	semiannually daily	cleaning & operations check by service technician (external) calibration verification using Class S-1 certified weights
COD Reactor	annually annually	complete operations check by service technician (external) reaction temperature verification
Conductivity Bridge	annually each use	verification of cell constant complete operations check by service technician (external) calibration verification
DI Water System	as needed monthly annually daily	complete operations check by service technician (external) Residual Chlorine check Biosuitability testing (external) pH and Conductivity check
DO Meter	annually each use	complete operations check by service technician (external) calibration against air as specified by manufacturer
Emergency/Safety Equipment	annually monthly	fire extinguishers and emergency exit lighting check eye washes, showers, fire blanket and first aid kits checked
Freezers	daily	temperature verification
Gas Chromatographs	as needed as needed beginning and end of batch and 10 to 20 samples as per method	injection port preparation; cleaning of detectors initial multi-point calibration continuing calibration verification (CCV) against initial calibration
ICP	Every other day Daily Annually Annually As needed	Change pump tubing Calibration, profile Complete operations check by service technician (external), Linear Dynamic Range determination Clean torch, clean nebulizer, clean spray chamber
Lachat analyzer	Daily As needed	Calibration, clean lines Change tubing, change O-rings
Mass Spectrometers (GC & ICP)	bi-annually as needed 12 hour or daily	change of mechanical pump oil by service technician (external) cleaning of source BFB, DFTPP or ICP-MS tune analysis followed by ICAL or CCV
Mercury Analyzer	monthly each use	clean cell and change pump windings calibration using multi-point curve
Auto-pipettes	Monthly Annually	verification of accuracy verification of precision
Microwave	Quarterly Annually	power and temperature verification RPM verification
Ovens	annually daily	complete operations check by service technician (external) temperature verification
pH Meters	annually each use	complete operations check by service technician (external) calibration using certified buffers
Refrigerators (General Use)	daily	temperature verification
Refrigerators (Sample Management)	daily	temperature verification
Spectrophotometer	Semi-annually Semi-annually daily	cleaning & operations check by service technician (external) wavelength verification (external) continuing calibration verification (CCV) against initial calibration
TCLP Rotator	annually	RPM verification
Thermometers (Mercury/Alcohol)	annually	calibration against NIST traceable thermometer (internal)
Thermometers (digital)	Quarterly	calibration against NIST traceable thermometer (external)
Thermometer (NIST Traceable)	annually	calibration and certification of conformance (external)
Turbidity meter	annually each use	cleaning & operations check by service technician (external) calibration using formazin
Weights (Class S-1)	annually	service/calibration and certification of conformance (external)

20 Appendix E – List of Analytical Methods

Lists of accredited methods used to analyze samples in the potable, non-potable, solid and hazardous waste and air categories are found in the following attached certificates of approval.

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The Commonwealth of Massachusetts

Department of Environmental Protection

Division of Environmental Analysis

Senator William X. Wall Experiment Station

certifies

M- MA086 **ALPHA WOODS HOLE LABS**
8 WALKUP DR
WESTBOROUGH, MA 01581-1019

Laboratory Director: **CHRISTOPHER WAKEFIELD**

for the analysis of **NON POTABLE WATER (CHEMISTRY)**
POTABLE WATER (MICROBIOLOGY)
POTABLE WATER (CHEMISTRY)
pursuant to 310 CMR 42.00

This certificate supersedes all previous Massachusetts certificates issued to this laboratory. The laboratory is regulated by and shall be responsible for being in compliance with Massachusetts regulations at 310 CMR 42.00.

This certificate is valid only when accompanied by the latest dated Certified Parameter List as issued by the Massachusetts D.E.P. Contact the Division of Environmental Analysis to verify the current certification status of the laboratory.

Certification is no guarantee of the validity of the data. This certification is subject to unannounced laboratory inspections.

Issued: **01 JUL 2007**

Expires: **30 JUN 2008**

Director, Division of Environmental Analysis

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Certified Parameter List as of: 06 AUG 2007

M-MA086 ALPHA WOODS HOLE LABS
WESTBOROUGH MA

NON POTABLE WATER (CHEMISTRY) **Effective Date** 06 AUG 2007 **Expiration Date** 30 JUN 2008

Analytes and Methods

ALUMINUM	EPA 200.7	POTASSIUM	EPA 200.7
ALUMINUM	EPA 200.8	ALKALINITY, TOTAL	SM 2320B
ANTIMONY	EPA 200.7	CHLORIDE	SM 4500-CL-E
ANTIMONY	EPA 200.8	FLUORIDE	SM 4500-F-B,C
ARSENIC	EPA 200.7	SULFATE	SM 15 426C
ARSENIC	EPA 200.8	AMMONIA-N	SM18-B,E/19,20-B,C-TTR
BERYLLIUM	EPA 200.7	AMMONIA-N	SM18-B,H/19,20-B,G-AP
BERYLLIUM	EPA 200.8	AMMONIA-N	EPA 350.1
CADMIUM	EPA 200.7	AMMONIA-N	LACHAT 10-107-06-1-B
CADMIUM	EPA 200.8	NITRATE-N	SM 4500-NO3-F
CHROMIUM	EPA 200.7	NITRATE-N	EPA 353.2
CHROMIUM	EPA 200.8	KJELDAHL-N	SM18-B,E/19,20 B,C-TTR
COBALT	EPA 200.7	KJELDAHL-N	SM18-B,C-NES
COPPER	EPA 200.7	KJELDAHL-N	EPA 351.1
COPPER	EPA 200.8	ORTHOPHOSPHATE	SM 4500-P-E
IRON	EPA 200.7	PHOSPHORUS, TOTAL	SM 4500-P-B,E
LEAD	EPA 200.7	CHEMICAL OXYGEN DEMAND	SM 5220D
MANGANESE	EPA 200.7	CHEMICAL OXYGEN DEMAND	EPA 410.4
MANGANESE	EPA 200.8	BIOCHEMICAL OXYGEN DEMAND	SM 5210B
MERCURY	EPA 245.1	TOTAL ORGANIC CARBON	SM 5310C
MOLYBDENUM	EPA 200.7	CYANIDE, TOTAL	SM 4500-CN-C,E
NICKEL	EPA 200.7	NON-FILTERABLE RESIDUE	SM 2540D
NICKEL	EPA 200.8	CHLORINE, TOTAL RESIDUAL	SM 4500-CL-D
SELENIUM	EPA 200.7	OIL AND GREASE	EPA 1664
SELENIUM	EPA 200.8	PHENOLICS, TOTAL	SM 14TH 510 A,C
SILVER	EPA 200.7	PHENOLICS, TOTAL	EPA 420.1
SILVER	EPA 200.8	VOLATILE HALOCARBONS	EPA 624
STRONTIUM	EPA 200.7	VOLATILE AROMATICS	EPA 624
THALLIUM	EPA 200.7	CHLORDANE	EPA 608
THALLIUM	EPA 200.8	ALDRIN	EPA 608
TITANIUM	EPA 200.7	DIELDRIN	EPA 608
VANADIUM	EPA 200.7	DDD	EPA 608
ZINC	EPA 200.7	DDE	EPA 608
ZINC	EPA 200.8	DDT	EPA 608
PH	SM 4500-H-B	HEPTACHLOR	EPA 608
SPECIFIC CONDUCTIVITY	EPA 120.1	HEPTACHLOR EPOXIDE	EPA 608
SPECIFIC CONDUCTIVITY	SM 2510B	POLYCHLORINATED BIPHENYLS (WATER)	EPA 608
TOTAL DISSOLVED SOLIDS	SM 2540C	POLYCHLORINATED BIPHENYLS (OIL)	EPA 600/4-81-045
HARDNESS (CACO3), TOTAL	SM 2340B		
CALCIUM	EPA 200.7		
MAGNESIUM	EPA 200.7		
SODIUM	EPA 200.7		

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Certified Parameter List as of: 06 AUG 2007

M-MA086 ALPHA WOODS HOLE LABS
WESTBOROUGH MA

POTABLE WATER (CHEMISTRY) Effective Date 01 JUL 2007 Expiration Date 30 JUN 2008

Analytes	Methods
ANTIMONY	EPA 200.8
ARSENIC	EPA 200.8
BARIUM	EPA 200.7
BARIUM	EPA 200.8
BERYLLIUM	EPA 200.7
BERYLLIUM	EPA 200.8
CADMIUM	EPA 200.7
CADMIUM	EPA 200.8
CHROMIUM	EPA 200.7
CHROMIUM	EPA 200.8
COPPER	EPA 200.7
COPPER	EPA 200.8
LEAD	EPA 200.8
MERCURY	EPA 245.1
NICKEL	EPA 200.7
NICKEL	EPA 200.8
SELENIUM	EPA 200.8
THALLIUM	EPA 200.8
NITRATE-N	EPA 300.0
NITRATE-N	EPA 353.2
NITRATE-N	SM 4500-NO3-F
NITRITE-N	EPA 300.0
NITRITE-N	EPA 353.2
NITRITE-N	SM 4500-NO3-F
FLUORIDE	EPA 300.0
FLUORIDE	SM 4500-F-C
SODIUM	EPA 200.7
SULFATE	EPA 300.0
CYANIDE, TOTAL	SM 4500-CN-C,E
TURBIDITY	EPA 180.1
TURBIDITY	SM 2130B
CHLORINE, RESIDUAL FREE	SM 4500-CL-D
CALCIUM	EPA 200.7
ALKALINITY, TOTAL	SM 2320B
TOTAL DISSOLVED SOLIDS	SM 2540C
PH	EPA 150.1
PH	SM 4500-H-B
TRIHALOMETHANES	EPA 524.2
VOLATILE ORGANIC COMPOUNDS	EPA 524.2
1,2-DIBROMOETHANE	EPA 504.1
1,2-DIBROMO-3-CHLOROPROPANE	EPA 504.1
HALOACETIC ACIDS	SM 6251B

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Certified Parameter List as of: 01 JUL 2007

M-MA086 ALPHA WOODS HOLE LABS
WESTBOROUGH MA

POTABLE WATER (MICROBIOLOGY) Effective Date 01 JUL 2007 Expiration Date 30 JUN 2008

Analytes and Methods

HETEROTROPHIC PLATE COUNT	SM9215B
TOTAL COLIFORM	MF-SM9222B
TOTAL COLIFORM	ENZ. SUB. SM9223
FECAL COLIFORM	EC-SM9221E
FECAL COLIFORM	MF-SM9222D
E. COLI	ENZ. SUB. SM9223

Massachusetts Department of Environmental Protection
Division of Environmental Analysis
William X. Wall Experiment Station

RECORD OF PROFICIENCY

This is to attest that ***Alpha Analytical Labs, 8 Walkup Dr., Westborough, MA*** participated in an interlaboratory "Round Robin" evaluation of two new analytical procedures developed by the Massachusetts Department of Environmental Protection to quantitate Volatile Petroleum Hydrocarbons (VPH) and Extractable Petroleum Hydrocarbons (EPH). This study was conducted during the Spring and Fall of 1997, and involved the analyses of water and soil samples contaminated with gasoline and fuel oil. As part of this evaluation effort, ***Alpha Analytical Labs*** demonstrated proficiency in the following:

- ◊ Analysis of water sample by the Volatile Petroleum Hydrocarbon (VPH) method
- ◊ Analysis of soil sample by the Volatile Petroleum Hydrocarbon (VPH) method
- ◊ Analysis of water sample by the Extractable Petroleum Hydrocarbon (EPH) method
- ◊ Analysis of soil sample by the Extractable Petroleum Hydrocarbons (EPH) method

This Record concerns a one-time testing and evaluation effort, and does NOT constitute certification or continuing certification of laboratory proficiency pursuant to 310 CMR 42.00 or any other Massachusetts regulation.

As with any analytical procedure, satisfactory performance is best assured through the adoption and continuous application of a suitable Quality Assurance/Quality Control program.

2-6-98
date

Oscar C. Pancorbo, Ph.D.
Division and Station Director

New Jersey Department of Environmental Protection

National Environmental Laboratory Accreditation Program

ANNUAL CERTIFIED PARAMETER LIST AND CURRENT STATUS

Effective as of 07/01/2006 until 06/30/2007

Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: CAP03 -- Atmospheric Organic Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	CAP03.00210	AE	GC/MS, Canisters	[EPA TO-15]	Acrylonitrile
Certified	Yes	NY	CAP03.00225	AE	GC/MS, Canisters	[EPA TO-15]	Benzene
Certified	Yes	NY	CAP03.00230	AE	GC/MS, Canisters	[EPA TO-15]	Benzyl chloride
Certified	Yes	NY	CAP03.00250	AE	GC/MS, Canisters	[EPA TO-15]	Bromodichloromethane
Certified	Yes	NY	CAP03.00255	AE	GC/MS, Canisters	[EPA TO-15]	Bromoform
Certified	Yes	NY	CAP03.00260	AE	GC/MS, Canisters	[EPA TO-15]	Bromomethane
Certified	Yes	NY	CAP03.00265	AE	GC/MS, Canisters	[EPA TO-15]	Butadiene (1,3-)
Certified	Yes	NY	CAP03.00275	AE	GC/MS, Canisters	[EPA TO-15]	Carbon tetrachloride
Certified	Yes	NY	CAP03.00300	AE	GC/MS, Canisters	[EPA TO-15]	Chlorobenzene
Certified	Yes	NY	CAP03.00305	AE	GC/MS, Canisters	[EPA TO-15]	Chloroethane
Certified	Yes	NY	CAP03.00310	AE	GC/MS, Canisters	[EPA TO-15]	Chloroform
Certified	Yes	NY	CAP03.00315	AE	GC/MS, Canisters	[EPA TO-15]	Chloromethane
Certified	Yes	NY	CAP03.00355	AE	GC/MS, Canisters	[EPA TO-15]	Dichlorobenzene (1,2-)
Certified	Yes	NY	CAP03.00365	AE	GC/MS, Canisters	[EPA TO-15]	Dichlorobenzene (1,4-)
Certified	Yes	NY	CAP03.00368	AE	GC/MS, Canisters	[EPA TO-15]	Dichlorodifluoromethane
Certified	Yes	NY	CAP03.00370	AE	GC/MS, Canisters	[EPA TO-15]	Dichloroethane (1,1-)
Certified	Yes	NY	CAP03.00375	AE	GC/MS, Canisters	[EPA TO-15]	Dichloroethane (1,2-)
Certified	Yes	NY	CAP03.00380	AE	GC/MS, Canisters	[EPA TO-15]	Dichloroethene (1,1-)
Certified	Yes	NY	CAP03.00384	AE	GC/MS, Canisters	[EPA TO-15]	Dichloroethene (cis-1,2-)
Certified	Yes	NY	CAP03.00385	AE	GC/MS, Canisters	[EPA TO-15]	Dichloroethene (trans-1,2-)
Certified	Yes	NY	CAP03.00395	AE	GC/MS, Canisters	[EPA TO-15]	Dichloropropane (1,2-)
Certified	Yes	NY	CAP03.00400	AE	GC/MS, Canisters	[EPA TO-15]	Dichloropropene (cis-1,3-)
Certified	Yes	NY	CAP03.00401	AE	GC/MS, Canisters	[EPA TO-15]	Dichloropropene (trans-1,3-)
Certified	Yes	NY	CAP03.00405	AE	GC/MS, Canisters	[EPA TO-15]	Dichlorotetrafluoroethane (1,2-)
Certified	Yes	NY	CAP03.00465	AE	GC/MS, Canisters	[EPA TO-15]	Ethylbenzene
Certified	Yes	NY	CAP03.00490	AE	GC/MS, Canisters	[EPA TO-15]	Hexachlorobutadiene (1,3-)
Certified	Yes	NY	CAP03.00505	AE	GC/MS, Canisters	[EPA TO-15]	Hexane (n-)
Certified	Yes	NY	CAP03.00525	AE	GC/MS, Canisters	[EPA TO-15]	Methyl ethyl ketone
Certified	Yes	NY	CAP03.00535	AE	GC/MS, Canisters	[EPA TO-15]	Methyl isobutyl ketone
Certified	Yes	NY	CAP03.00550	AE	GC/MS, Canisters	[EPA TO-15]	Methyl tert-butyl ether
Certified	Yes	NY	CAP03.00555	AE	GC/MS, Canisters	[EPA TO-15]	Methylene chloride (Dichloromethane)

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New Jersey Department of Environmental Protection

National Environmental Laboratory Accreditation Program

ANNUAL CERTIFIED PARAMETER LIST AND CURRENT STATUS

Effective as of 07/01/2006 until 06/30/2007

Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: CAP03 -- Atmospheric Organic Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	CAP03.00625	AE	GC/MS, Canisters	[EPA TO-15]	Styrene
Certified	Yes	NY	CAP03.00635	AE	GC/MS, Canisters	[EPA TO-15]	Trichlorobenzene (1,2,4-)
Certified	Yes	NY	CAP03.00640	AE	GC/MS, Canisters	[EPA TO-15]	Trimethylbenzene (1,3,5-)
Certified	Yes	NY	CAP03.00645	AE	GC/MS, Canisters	[EPA TO-15]	Trimethylbenzene (1,2,4-)
Certified	Yes	NY	CAP03.00650	AE	GC/MS, Canisters	[EPA TO-15]	Trimethylpentane (2,2,4-)
Certified	Yes	NY	CAP03.00655	AE	GC/MS, Canisters	[EPA TO-15]	Tetrachloroethane (1,1,2,2-)
Certified	Yes	NY	CAP03.00660	AE	GC/MS, Canisters	[EPA TO-15]	Tetrachloroethene
Certified	Yes	NY	CAP03.00665	AE	GC/MS, Canisters	[EPA TO-15]	Toluene
Certified	Yes	NY	CAP03.00670	AE	GC/MS, Canisters	[EPA TO-15]	Trichloroethane (1,1,1-)
Certified	Yes	NY	CAP03.00675	AE	GC/MS, Canisters	[EPA TO-15]	Trichloroethane (1,1,2-)
Certified	Yes	NY	CAP03.00680	AE	GC/MS, Canisters	[EPA TO-15]	Trichloroethene
Certified	Yes	NY	CAP03.00684	AE	GC/MS, Canisters	[EPA TO-15]	Trichlorofluoromethane
Certified	Yes	NY	CAP03.00685	AE	GC/MS, Canisters	[EPA TO-15]	Trichloro (1,1,2-) trifluoroethane (1,2,2-)
Certified	Yes	NY	CAP03.00700	AE	GC/MS, Canisters	[EPA TO-15]	Vinyl acetate
Certified	Yes	NY	CAP03.00705	AE	GC/MS, Canisters	[EPA TO-15]	Vinyl bromide
Certified	Yes	NY	CAP03.00710	AE	GC/MS, Canisters	[EPA TO-15]	Vinyl chloride
Certified	Yes	NY	CAP03.00730	AE	GC/MS, Canisters	[EPA TO-15]	Xylenes (total)
Certified	Yes	NY	CAP03.06190	AE	GC/MS	[EPA TO-13A]	Benzo(a)pyrene
Certified	Yes	NY	CAP03.06300	AE	GC/MS	[EPA TO-13A]	Naphthalene
Certified	Yes	NY	CAP03.06430	AE	GC/MS, CANISTERS	[EPA TO-14A]	Benzene
Certified	Yes	NY	CAP03.06440	AE	GC/MS, CANISTERS	[EPA TO-14A]	Benzyl chloride
Certified	Yes	NY	CAP03.06443	AE	GC/MS, CANISTERS	[EPA TO-14A]	Bromodichloromethane
Certified	Yes	NY	CAP03.06450	AE	GC/MS, CANISTERS	[EPA TO-14A]	Bromomethane
Certified	Yes	NY	CAP03.06460	AE	GC/MS, CANISTERS	[EPA TO-14A]	Carbon tetrachloride
Certified	Yes	NY	CAP03.06470	AE	GC/MS, CANISTERS	[EPA TO-14A]	Chlorobenzene
Certified	Yes	NY	CAP03.06480	AE	GC/MS, CANISTERS	[EPA TO-14A]	Chloroethane
Certified	Yes	NY	CAP03.06490	AE	GC/MS, CANISTERS	[EPA TO-14A]	Chloroform
Certified	Yes	NY	CAP03.06500	AE	GC/MS, CANISTERS	[EPA TO-14A]	Chloromethane
Certified	Yes	NY	CAP03.06520	AE	GC/MS, CANISTERS	[EPA TO-14A]	Dichlorobenzene (1,2-)
Certified	Yes	NY	CAP03.06530	AE	GC/MS, CANISTERS	[EPA TO-14A]	Dichlorobenzene (1,3-)
Certified	Yes	NY	CAP03.06540	AE	GC/MS, CANISTERS	[EPA TO-14A]	Dichlorobenzene (1,4-)
Certified	Yes	NY	CAP03.06550	AE	GC/MS, CANISTERS	[EPA TO-14A]	Dichlorodifluoromethane

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New Jersey Department of Environmental Protection

National Environmental Laboratory Accreditation Program

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Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: CAP03 -- Atmospheric Organic Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	CAP03.06560	AE	GC/MS, CANISTERS	[EPA TO-14A]	Dichloroethane (1,1-)
Certified	Yes	NY	CAP03.06570	AE	GC/MS, CANISTERS	[EPA TO-14A]	Dichloroethane (1,2-)
Certified	Yes	NY	CAP03.06580	AE	GC/MS, CANISTERS	[EPA TO-14A]	Dichloroethene (1,1-)
Certified	Yes	NY	CAP03.06590	AE	GC/MS, CANISTERS	[EPA TO-14A]	Dichloroethene (cis-1,2-)
Certified	Yes	NY	CAP03.06591	AE	GC/MS, CANISTERS	[EPA TO-14A]	Dichloroethene (trans-1,2-)
Certified	Yes	NY	CAP03.06600	AE	GC/MS, CANISTERS	[EPA TO-14A]	Methylene chloride (Dichloromethane)
Certified	Yes	NY	CAP03.06610	AE	GC/MS, CANISTERS	[EPA TO-14A]	Dichloropropane (1,2-)
Certified	Yes	NY	CAP03.06620	AE	GC/MS, CANISTERS	[EPA TO-14A]	Dichloropropene (cis-1,3-)
Certified	Yes	NY	CAP03.06630	AE	GC/MS, CANISTERS	[EPA TO-14A]	Dichloropropene (trans-1,3-)
Certified	Yes	NY	CAP03.06640	AE	GC/MS, CANISTERS	[EPA TO-14A]	Dichlorotetrafluoroethane (1,2-)
Certified	Yes	NY	CAP03.06650	AE	GC/MS, CANISTERS	[EPA TO-14A]	Ethylbenzene
Certified	Yes	NY	CAP03.06660	AE	GC/MS, CANISTERS	[EPA TO-14A]	Hexachlorobutadiene (1,3-)
Certified	Yes	NY	CAP03.06670	AE	GC/MS, CANISTERS	[EPA TO-14A]	Styrene
Certified	*Yes*	*NY*	*CAP03.06680*	*AE*	*GC/MS, CANISTERS*	*[EPA TO-14A]*	*Tetrachloroethane (1,1,2,2-)*
Certified	Yes	NY	CAP03.06690	AE	GC/MS, CANISTERS	[EPA TO-14A]	Tetrachloroethene
Certified	Yes	NY	CAP03.06700	AE	GC/MS, CANISTERS	[EPA TO-14A]	Toluene
Certified	Yes	NY	CAP03.06710	AE	GC/MS, CANISTERS	[EPA TO-14A]	Trichlorobenzene (1,2,4-)
Certified	Yes	NY	CAP03.06720	AE	GC/MS, CANISTERS	[EPA TO-14A]	Trichloroethane (1,1,1-)
Certified	Yes	NY	CAP03.06721	AE	GC/MS, CANISTERS	[EPA TO-14A]	Trichloroethane (1,1,2-)
Certified	Yes	NY	CAP03.06730	AE	GC/MS, CANISTERS	[EPA TO-14A]	Trichloroethene
Certified	Yes	NY	CAP03.06740	AE	GC/MS, CANISTERS	[EPA TO-14A]	Trichlorofluoromethane
Certified	Yes	NY	CAP03.06750	AE	GC/MS, CANISTERS	[EPA TO-14A]	Trichloro (1,1,2-) trifluoroethane (1,2,2-)
Certified	Yes	NY	CAP03.06760	AE	GC/MS, CANISTERS	[EPA TO-14A]	Trimethylbenzene (1,2,4-)
Certified	Yes	NY	CAP03.06770	AE	GC/MS, CANISTERS	[EPA TO-14A]	Trimethylbenzene (1,3,5-)
Certified	Yes	NY	CAP03.06780	AE	GC/MS, CANISTERS	[EPA TO-14A]	Vinyl chloride
Certified	Yes	NY	CAP03.06785	AE	GC/MS, CANISTERS	[EPA TO-14A]	Xylenes (total)

KEY: AE = Air and Emissions, BT = Biological Tissues, DW = Drinking Water, NPW = Non-Potable Water, SCM = Solid and Chemical Materials

New Jersey Department of Environmental Protection

National Environmental Laboratory Accreditation Program

ANNUAL CERTIFIED PARAMETER LIST AND CURRENT STATUS

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Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: SDW01 -- Microbiological Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SDW01.02000	DW	Membrane Filter (MF) Technique	[SM 9222 B + 9221 F]	Total coliform / Fecal coli or E. coli
Certified	Yes	NY	SDW01.05000	DW	ONPG-MUG (Autoanalysis Colilert System)	[SM 9223B]	Total coliform / E. coli
Certified	Yes	NY	SDW01.14000	DW	Pour Plate	[SM 9215 B]	Heterotrophic bacteria

Category: SDW02 – Inorganic Parameters Including Na + Ca

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SDW02.02000	DW	Automated Cadmium Reduction	[SM 4500-NO3 F]	Nitrate
Certified	Yes	NY	SDW02.13000	DW	Manual Potentiometric Ion Select Electrode	[SM 4500-F C]	Fluoride
Certified	Yes	NY	SDW02.14000	DW	Ion Chromatography	[EPA 300.0]	Fluoride
Certified	Yes	NY	SDW02.19000	DW	Ion Chromatography	[EPA 300.0]	Sulfate
Certified	Yes	NY	SDW02.20000	DW	ICP	[EPA 200.7]	Sodium
Certified	Yes	NY	SDW02.24000	DW	Gravimetric At 180	[SM 2540 C]	Total dissolved solids (TDS)
Certified	Yes	NY	SDW02.27000	DW	ICP	[EPA 200.7]	Calcium
Certified	Yes	NY	SDW02.29000	DW	Electrometric Titration	[SM 2320 B]	Alkalinity

Category: SDW03 -- Analyze-Immediately Inorganic Parameter

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SDW03.08000	DW	Electrometric	[EPA 150.1] [SM 4500-H B]	pH

Category: SDW04 -- Inorganic Parameters, Metals

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SDW04.03000	DW	ICP	[EPA 200.7]	Aluminum
Certified	Yes	NY	SDW04.06000	DW	AA, Platform Furnace	[EPA 200.9]	Antimony
Certified	Yes	NY	SDW04.12000	DW	ICP/MS	[EPA 200.8]	Arsenic
Certified	Yes	NY	SDW04.17000	DW	ICP/MS	[EPA 200.8]	Barium

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Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: SDW04 -- Inorganic Parameters, Metals

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SDW04.20000	DW	ICP	[EPA 200.7]	Beryllium
Certified	Yes	NY	SDW04.21000	DW	ICP/MS	[EPA 200.8]	Beryllium
Certified	Yes	NY	SDW04.24000	DW	ICP	[EPA 200.7]	Cadmium
Certified	Yes	NY	SDW04.25000	DW	ICP/MS	[EPA 200.8]	Cadmium
Certified	Yes	NY	SDW04.28000	DW	ICP	[EPA 200.7]	Chromium
Certified	Yes	NY	SDW04.29000	DW	ICP/MS	[EPA 200.8]	Chromium
Certified	Yes	NY	SDW04.32000	DW	AA, Platform Furnace	[EPA 200.9]	Copper
Certified	Yes	NY	SDW04.33000	DW	ICP	[EPA 200.7]	Copper
Certified	Yes	NY	SDW04.34000	DW	ICP/MS	[EPA 200.8]	Copper
Certified	Yes	NY	SDW04.39000	DW	AA, Platform Furnace	[EPA 200.9]	Lead
Certified	Yes	NY	SDW04.40000	DW	ICP/MS	[EPA 200.8]	Lead
Certified	Yes	NY	SDW04.47000	DW	Automated Cold Vapor	[EPA 245.2]	Mercury
Certified	Yes	NY	SDW04.52000	DW	ICP	[EPA 200.7]	Nickel
Certified	Yes	NY	SDW04.53000	DW	ICP/MS	[EPA 200.8]	Nickel
Certified	Yes	NY	SDW04.56000	DW	AA, Platform Furnace	[EPA 200.9]	Selenium
Certified	Yes	NY	SDW04.57000	DW	ICP/MS	[EPA 200.8]	Selenium
Certified	Yes	NY	SDW04.64000	DW	AA, Platform Furnace	[EPA 200.9]	Thallium
Certified	Yes	NY	SDW04.65000	DW	ICP/MS	[EPA 200.8]	Thallium

Category: SDW05 -- Organic Parameters, Chromatography

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SDW05.12010	DW	Solvent Extract, GC	[EPA 504.1]	Dibromoethane (1,2-) (EDB)
Certified	Yes	NY	SDW05.12020	DW	Solvent Extract, GC	[EPA 504.1]	Dibromo-3-chloropropane (1,2-)
Certified	Yes	NY	SDW05.21010	DW	SPE/GC, ECD	[SM 6251 B]	Monochloroacetic acid (MCAA)
Certified	Yes	NY	SDW05.21020	DW	SPE/GC, ECD	[SM 6251 B]	Dichloroacetic acid
Certified	Yes	NY	SDW05.21030	DW	SPE/GC, ECD	[SM 6251 B]	Trichloroacetic acid
Certified	Yes	NY	SDW05.21040	DW	SPE/GC, ECD	[SM 6251 B]	Monobromoacetic acid (MBAA)
Certified	Yes	NY	SDW05.21050	DW	SPE/GC, ECD	[SM 6251 B]	Bromochloroacetic acid
Certified	Yes	NY	SDW05.21060	DW	SPE/GC, ECD	[SM 6251 B]	Dibromoacetic acid

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Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: SDW06 -- Organic Parameters, Chromatography/MS

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SDW06.01010	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Bromoform
Certified	Yes	NY	SDW06.01020	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Chloroform
Certified	Yes	NY	SDW06.01030	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dibromochloromethane
Certified	Yes	NY	SDW06.01040	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Bromodichloromethane
Certified	Yes	NY	SDW06.02010	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Benzene
Certified	Yes	NY	SDW06.02020	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Carbon tetrachloride
Certified	Yes	NY	SDW06.02030	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Chlorobenzene
Certified	Yes	NY	SDW06.02040	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichlorobenzene (1,2-)
Certified	Yes	NY	SDW06.02050	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichlorobenzene (1,3-)
Certified	Yes	NY	SDW06.02060	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichlorobenzene (1,4-)
Certified	Yes	NY	SDW06.02080	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichloroethane (1,2-)
Certified	Yes	NY	SDW06.02090	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichloroethene (cis-1,2-)
Certified	Yes	NY	SDW06.02100	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichloroethene (trans-1,2-)
Certified	Yes	NY	SDW06.02110	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Methylene chloride (Dichloromethane)
Certified	Yes	NY	SDW06.02120	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichloropropane (1,2-)
Certified	Yes	NY	SDW06.02130	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Ethylbenzene
Certified	Yes	NY	SDW06.02160	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Styrene
Certified	Yes	NY	SDW06.02170	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Tetrachloroethane (1,1,2,2-)
Certified	Yes	NY	SDW06.02180	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Tetrachloroethene
Certified	Yes	NY	SDW06.02190	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Trichloroethane (1,1,1-)
Certified	Yes	NY	SDW06.02200	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Trichloroethene
Certified	Yes	NY	SDW06.02210	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Toluene
Certified	Yes	NY	SDW06.02220	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Trichlorobenzene (1,2,4-)
Certified	Yes	NY	SDW06.02230	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichloroethene (1,1-)
Certified	Yes	NY	SDW06.02240	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Trichloroethane (1,1,2-)
Certified	Yes	NY	SDW06.02250	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Vinyl chloride
Certified	Yes	NY	SDW06.02260	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Xylenes (total)
Certified	Yes	NY	SDW06.03010	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Bromobenzene
Certified	Yes	NY	SDW06.03020	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Bromochloromethane
Certified	Yes	NY	SDW06.03040	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Butyl benzene (n-)
Certified	Yes	NY	SDW06.03050	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Sec-butylbenzene
Certified	Yes	NY	SDW06.03060	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Tert-butylbenzene

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New Jersey Department of Environmental Protection

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ANNUAL CERTIFIED PARAMETER LIST AND CURRENT STATUS

Effective as of 07/01/2006 until 06/30/2007

Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: SDW06 -- Organic Parameters, Chromatography/MS

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SDW06.03070	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Chloroethane
Certified	Yes	NY	SDW06.03090	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Chlorotoluene (2-)
Certified	Yes	NY	SDW06.03100	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Chlorotoluene (4-)
Certified	Yes	NY	SDW06.03130	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dibromomethane
Certified	Yes	NY	SDW06.03140	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichlorodifluoromethane
Certified	Yes	NY	SDW06.03150	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichloropropane (1,3-)
Certified	Yes	NY	SDW06.03160	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichloropropane (2,2-)
Certified	Yes	NY	SDW06.03170	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichloropropene (1,1-)
Certified	Yes	NY	SDW06.03180	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichloropropene (cis-1,3-)
Certified	Yes	NY	SDW06.03190	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Dichloropropene (trans-1,3-)
Certified	Yes	NY	SDW06.03200	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Hexachlorobutadiene (1,3-)
Certified	Yes	NY	SDW06.03210	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Isopropylbenzene
Certified	Yes	NY	SDW06.03220	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Isopropyltoluene (4-)
Certified	Yes	NY	SDW06.03230	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Propylbenzene (n-)
Certified	Yes	NY	SDW06.03240	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Tetrachloroethane (1,1,1,2-)
Certified	Yes	NY	SDW06.03250	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Trichlorobenzene (1,2,3-)
Certified	Yes	NY	SDW06.03260	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Trichlorofluoromethane
Certified	Yes	NY	SDW06.03270	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Trichloropropane (1,2,3-)
Certified	Yes	NY	SDW06.03280	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Trimethylbenzene (1,2,4-)
Certified	Yes	NY	SDW06.03300	DW	GC/MS, P & T or Direct Injection, Capillary	[EPA 524.2]	Trimethylbenzene (1,3,5-)

Category: SHW04 -- Inorganic Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NJ	SHW04.02100	NPW	Acid Digestion For GFAA, Micro assc Aqueous	[SW-846 3015, Rev. 0, 9/94]	Metals
Certified	Yes	NY	SHW04.05000	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Aluminum
Certified	Yes	NY	SHW04.05500	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Aluminum
Certified	Yes	NY	SHW04.07000	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Antimony
Certified	Yes	NY	SHW04.09500	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Arsenic
Certified	Yes	NY	SHW04.12000	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Barium

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Effective as of 07/01/2006 until 06/30/2007

Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: SHW04 -- Inorganic Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW04.13500	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Beryllium
Certified	Yes	NY	SHW04.14000	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Beryllium
Certified	Yes	NY	SHW04.15100	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Boron
Certified	Yes	NY	SHW04.16000	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Cadmium
Certified	Yes	NY	SHW04.17500	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Calcium
Certified	Yes	NY	SHW04.19000	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Chromium
Certified	Yes	NY	SHW04.21000	NPW	Colorimetric	[SW-846 7196A, Rev. 1, 7/92]	Chromium (VI)
Certified	Yes	NY	SHW04.22500	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Cobalt
Certified	Yes	NY	SHW04.23000	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Cobalt
Certified	Yes	NY	SHW04.24500	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Copper
Certified	Yes	NY	SHW04.25000	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Copper
Certified	Yes	NY	SHW04.26000	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Iron
Certified	Yes	NY	SHW04.28000	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Lead
Certified	Yes	NY	SHW04.30500	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Magnesium
Certified	Yes	NY	SHW04.31500	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Manganese
Certified	Yes	NY	SHW04.31600	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Manganese
Certified	Yes	NY	SHW04.33000	NPW	AA, Manual Cold Vapor	[SW-846 7470A, Rev. 1, 9/94]	Mercury - liquid waste
Certified	Yes	NY	SHW04.34000	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Molybdenum
Certified	Yes	NY	SHW04.34005	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Molybdenum
Certified	Yes	NY	SHW04.36000	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Nickel
Certified	Yes	NY	SHW04.38000	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Potassium
Certified	Yes	NY	SHW04.40600	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Selenium
Certified	Yes	NY	SHW04.41500	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Silver
Certified	Yes	NY	SHW04.43000	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Sodium
Certified	Yes	NY	SHW04.45000	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Thallium
Certified	Yes	NY	SHW04.45500	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Thallium
Certified	Yes	NY	SHW04.47100	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Tin
Certified	Yes	NY	SHW04.47500	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Vanadium
Certified	Yes	NY	SHW04.47505	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Vanadium
Certified	Yes	NY	SHW04.49000	NPW	ICP	[SW-846 6010B, Rev. 2, 12/96]	Zinc
Certified	Yes	NY	SHW04.49500	NPW	ICP/MS	[SW-846 6020, Rev. 0, 9/94]	Zinc

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8 WALKUP DR
WESTBOROUGH, MA 01581

Category: SHW05 – Organic Parameters, Prep. / Screening

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NJ	SHW05.01000	NPW	Separatory Funnel Extraction	[SW-846 3510C, Rev. 3, 12/96]	Semivolatile organics

Category: SHW06 – Organic Parameters, Chromatography

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW06.23040	NPW	GC, Extraction, ECD, Capillary	[SW-846 8151A. Rev. 1, 9/96]	D (2,4-)
Certified	Yes	NY	SHW06.23050	NPW	GC, Extraction, ECD, Capillary	[SW-846 8151A, Rev. 1, 9/96]	T (2,4,5-)
Certified	Yes	NY	SHW06.23060	NPW	GC, Extraction, ECD, Capillary	[SW-846 8151A. Rev. 1, 9/96]	TP (2,4,5-) (Silvex)

Category: SHW07 -- Organic Parameters, Chromatography/MS

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW07.04140	NPW	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Chloroethyl vinyl ether (2-)
Certified	Yes	NY	SHW07.04230	NPW	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Dichloroethene (trans-1,2-)
Certified	Yes	NY	SHW07.04360	NPW	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Butanone (2-)
Certified	Yes	NY	SHW07.04500	NPW	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Hexachlorobutadiene (1,3-)
Certified	Yes	NY	SHW07.05005	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	N-Nitrosodimethylamine
Certified	Yes	NY	SHW07.05006	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	N-Nitroso-di-n-propylamine
Certified	Yes	NY	SHW07.05010	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	N-Nitrosodiphenylamine
Certified	Yes	NY	SHW07.05038	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Benzidine
Certified	Yes	NY	SHW07.05040	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Dichlorobenzidine (3,3'-)
Certified	Yes	NY	SHW07.05090	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Hexachlorobutadiene (1,3-)
Certified	Yes	NY	SHW07.05100	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Hexachlorocyclopentadiene
Applied	No	NY	SHW07.05132	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Bis (2-chloroethyl) ether
Applied	No	NY	SHW07.05150	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Chlorophenyl-phenyl ether (4-)
Applied	No	NY	SHW07.05160	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Bromophenyl-phenyl ether (4-)
Certified	Yes	NY	SHW07.05340	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Benzo(k)fluoranthene
Certified	Yes	NY	SHW07.05460	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Dichlorophenol (2,4-)
Applied	No	NY	SHW07.05500	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Methylphenol (2-)

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8 WALKUP DR
WESTBOROUGH, MA 01581

Category: SHW07 -- Organic Parameters, Chromatography/MS

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Applied	No	NY	SHW07.05510	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Methylphenol (4-)
Certified	Yes	NY	SHW07.05560	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Trichlorophenol (2,4,5-)
Certified	Yes	NY	SHW07.05691	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Dichlorobenzene (1,2-)
Certified	Yes	NY	SHW07.05692	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Dichlorobenzene (1,3-)
Certified	Yes	NY	SHW07.05700	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Dichlorobenzene (1,4-)
Certified	Yes	NY	SHW07.05750	NPW	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Pyridine

Category: SHW09 -- Miscellaneous Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	No	NY	SHW09.02000	NPW	Distillation	[SW-846 9010B, Rev. 2, 12/96]	Cyanide

Category: WPP01 -- Microbiological Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	WPP01.01000	NPW	MPN, Dilution	[SM 9221 C & E]	Fecal coliform
Certified	Yes	NY	WPP01.02000	NPW	Membrane Filter (MF), Single Step	[SM 9222 D]	Fecal coliform
Certified	Yes	NY	WPP01.03000	NPW	MPN, Dilution	[SM 9221 B]	Total coliform
Certified	Yes	NY	WPP01.04000	NPW	MF Single Step or Two Step	[SM 9222 B]	Total coliform
Certified	Yes	NY	WPP01.10000	NPW	Pour Plate	[SM 9215 B]	Heterotrophic plate count

Category: WPP02 -- Inorganic Parameters, Nutrients and Dema

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	WPP02.01000	NPW	Electrometric or Phenolphthalein	[EPA 305.1] [SM 2310 B(4A)]	Acidity as CaCO3
Certified	Yes	NY	WPP02.01500	NPW	Electrometric or Color Titration	[SM 2320 B] [EPA 310.1]	Alkalinity as CaCO3
Certified	Yes	NY	WPP02.04000	NPW	Distillation, Automated Phenate	[EPA 350.2 + .1] [SM 4500-NH3 H]	Ammonia
Certified	Yes	NY	WPP02.05000	NPW	Dissolved Oxygen Depletion	[EPA 405.1] [SM 5210 B]	Biochemical oxygen demand

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8 WALKUP DR
WESTBOROUGH, MA 01581

Category: WPP02 -- Inorganic Parameters, Nutrients and Dema

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	WPP02.06000	NPW	ICP	[EPA 200.7]	Boron
Certified	Yes	NY	WPP02.07100	NPW	Ion Chromatography	[EPA 300.0]	Bromide
Certified	Yes	NY	WPP02.08000	NPW	Digestion, ICP	[EPA 200.7]	Calcium
Certified	Yes	NY	WPP02.10500	NPW	Spectrophotometric Manual/Auto	[EPA 410.4] [SM 5220 D]	Chemical oxygen demand
Certified	Yes	NY	WPP02.12500	NPW	Colorimetric, Automated (Ferricyanide)	[EPA 325.1 OR .2] [SM 4500-Cl E]	Chloride
Certified	Yes	NY	WPP02.12600	NPW	Ion Chromatography	[EPA 300.0]	Chloride
Certified	Yes	NY	WPP02.13500	NPW	Colorimetric (Platinum-Cobalt)	[EPA 110.2] [SM 2120 B]	Color
Certified	Yes	NY	WPP02.15000	NPW	Distillation, Spectrophotometric (Manual)	[EPA 335.2] [SM 4500-CN C, E]	Cyanide
Certified	Yes	NY	WPP02.16500	NPW	Distillation + Electrode, Manual	[EPA 340.2] [SM 4500-F B, C]	Fluoride
Certified	Yes	NY	WPP02.18100	NPW	Ion Chromatography	[EPA 300.0]	Fluoride
Certified	Yes	NY	WPP02.20100	NPW	Ca + Mg Carbonates, ICP	[EPA 200.7]	Hardness - total as CaCO3
Certified	Yes	NY	WPP02.22000	NPW	Digestion, Distillation, Automated Phenate	[EPA 351.1]	Kjeldahl nitrogen - total
Certified	Yes	NY	WPP02.24000	NPW	Digestion, ICP	[EPA 200.7]	Magnesium
Certified	Yes	NY	WPP02.26100	NPW	Ion Chromatography	[EPA 300.0]	Nitrate
Certified	Yes	NY	WPP02.27000	NPW	Cadmium Reduction, Automated	[EPA 353.2] [SM 4500-NO3 F]	Nitrate - nitrite
Certified	Yes	NY	WPP02.28000	NPW	Spectrophotometric, Manual	[EPA 354.1] [SM 4500-NO2 B]	Nitrite
Certified	Yes	NY	WPP02.28600	NPW	Ion Chromatography	[EPA 300.0]	Nitrite
Certified	Yes	NY	WPP02.29100	NPW	Gravimetric, Hexane Extractable Material-LL	[EPA 1664A]	Oil & grease - hem-LL
Certified	Yes	NY	WPP02.29150	NPW	Gravimetric, Hexane Extractable Material-SPE	[EPA 1664A]	Oil & grease - hem-SPE
Certified	Yes	NY	WPP02.30000	NPW	Combustion or Oxidation	[EPA 415.1] [SM 5310 B, C or D]	Total organic carbon (TOC)
Certified	Yes	NY	WPP02.31500	NPW	Ascorbic Acid, Manual Single Reagent	[SM 4500-P, E] [EPA 365.2]	Orthophosphate
Certified	Yes	NY	WPP02.32100	NPW	Ion Chromatography	[EPA 300.0]	Orthophosphate
Certified	Yes	NY	WPP02.32500	NPW	Manual Distillation, Colorimetric 4AAP	[EPA 420.1]	Phenols
Certified	Yes	NY	WPP02.34000	NPW	Persulfate Digestion + Manual	[EPA 365.2 + .3] [SM 4500-P B5 + E]	Phosphorus (total)
Certified	Yes	NY	WPP02.36500	NPW	Digestion, ICP	[EPA 200.7]	Potassium
Certified	Yes	NY	WPP02.38000	NPW	Gravimetric, 103-105 Degrees C	[EPA 160.3]	Residue - total
Certified	Yes	NY	WPP02.38500	NPW	Gravimetric, 180 Degrees C	[EPA 160.1] [SM 2540 C]	Residue - filterable (TDS)
Certified	Yes	NY	WPP02.39000	NPW	Gravimetric, 103-105 Degrees C, Post Washing	[EPA 160.2] [SM 2540 D]	Residue - nonfilterable (TSS)
Certified	Yes	NY	WPP02.44000	NPW	Digestion, ICP	[EPA 200.7]	Sodium
Certified	Yes	NY	WPP02.45500	NPW	Wheatstone Bridge	[EPA 120.1] [SM 2510 B]	Specific conductance
Certified	Yes	NY	WPP02.46500	NPW	Turbidimetric	[EPA 375.4] [OTHER 426C SM 15th Ed.]	Sulfate
Certified	Yes	NY	WPP02.47100	NPW	Ion Chromatography	[EPA 300.0]	Sulfate

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8 WALKUP DR
WESTBOROUGH, MA 01581

Category: WPP02 -- Inorganic Parameters, Nutrients and Dema

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Applied	No	NY	WPP02.48000	NPW	Colorimetric (Methylene Blue)	[EPA 376.2] [SM 4500-S D]	Sulfides
Certified	Yes	NY	WPP02.48500	NPW	Colorimetric (Methylene Blue)	[EPA 425.1] [SM 5540 C]	Surfactants

Category: WPP03 -- Analyze-Immediately Inorganic Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	WPP03.09000	NPW	Electrometric	[EPA 150.1] [SM 4500-H B]	pH

Category: WPP04 -- Inorganic Parameters, Metals

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	WPP04.02000	NPW	Digestion, ICP	[EPA 200.7]	Aluminum
Certified	Yes	NY	WPP04.04000	NPW	Digestion, AA Furnace	[EPA 204.2]	Antimony
Certified	Yes	NY	WPP04.04100	NPW	Digestion, Platform Furnace	[EPA 200.9]	Antimony
Certified	Yes	NY	WPP04.04500	NPW	Digestion, ICP	[EPA 200.7]	Antimony
Certified	Yes	NY	WPP04.05000	NPW	Digestion, AA Furnace	[EPA 206.5 + .2]	Arsenic
Certified	Yes	NY	WPP04.05100	NPW	Digestion, Platform Furnace	[EPA 200.9]	Arsenic
Certified	Yes	NY	WPP04.05600	NPW	Digestion, ICP	[EPA 200.7]	Arsenic
Certified	Yes	NY	WPP04.08000	NPW	Digestion, ICP	[EPA 200.7]	Barium
Certified	Yes	NY	WPP04.11000	NPW	Digestion, ICP	[EPA 200.7]	Beryllium
Certified	Yes	NY	WPP04.12000	NPW	Digestion, AA Furnace	[EPA 213.2]	Cadmium
Certified	Yes	NY	WPP04.12100	NPW	Digestion, Platform Furnace	[EPA 200.9]	Cadmium
Certified	Yes	NY	WPP04.13500	NPW	Digestion, ICP	[EPA 200.7]	Cadmium
Certified	Yes	NY	WPP04.15000	NPW	0.45u Filter, Colorimetric DPC	[SM 3500-Cr D]	Chromium (VI)
Certified	Yes	NY	WPP04.16500	NPW	Digestion, AA Furnace	[EPA 218.2]	Chromium
Certified	Yes	NY	WPP04.16600	NPW	Digestion, Platform Furnace	[EPA 200.9]	Chromium
Certified	Yes	NY	WPP04.18000	NPW	Digestion, ICP	[EPA 200.7]	Chromium
Certified	Yes	NY	WPP04.19500	NPW	Digestion, ICP	[EPA 200.7]	Cobalt
Applied	No	NY	WPP04.21000	NPW	Digestion, AA Furnace	[EPA 220.2]	Copper

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ANNUAL CERTIFIED PARAMETER LIST AND CURRENT STATUS

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Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: WPP04 -- Inorganic Parameters, Metals

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Applied	No	NY	WPP04.21100	NPW	Digestion, Platform Furnace	[EPA 200.9]	Copper
Certified	Yes	NY	WPP04.21500	NPW	Digestion, ICP	[EPA 200.7]	Copper
Certified	Yes	NY	WPP04.26500	NPW	Digestion, ICP	[EPA 200.7]	Iron
Certified	Yes	NY	WPP04.27500	NPW	Digestion, AA Furnace	[EPA 239.2]	Lead
Certified	Yes	NY	WPP04.27600	NPW	Digestion, Platform Furnace	[EPA 200.9]	Lead
Certified	Yes	NY	WPP04.28000	NPW	Digestion, ICP	[EPA 200.7]	Lead
Certified	Yes	NY	WPP04.31000	NPW	Digestion, ICP	[EPA 200.7]	Manganese
Certified	Yes	NY	WPP04.33000	NPW	Manual Cold Vapor	[EPA 245.1]	Mercury
Certified	Yes	NY	WPP04.33500	NPW	Automated Cold Vapor	[EPA 245.2]	Mercury
Certified	Yes	NY	WPP04.35000	NPW	Digestion, ICP	[EPA 200.7]	Molybdenum
Applied	No	NY	WPP04.37000	NPW	Digestion, AA Furnace	[EPA 249.2]	Nickel
Applied	No	NY	WPP04.37100	NPW	Digestion, Platform Furnace	[EPA 200.9]	Nickel
Certified	Yes	NY	WPP04.37500	NPW	Digestion, ICP	[EPA 200.7]	Nickel
Certified	Yes	NY	WPP04.45000	NPW	Digestion, AA Furnace	[EPA 270.2]	Selenium
Certified	Yes	NY	WPP04.45500	NPW	Digestion, ICP	[EPA 200.7]	Selenium
Certified	Yes	NY	WPP04.47000	NPW	Digestion, AA Furnace	[EPA 272.2]	Silver
Certified	Yes	NY	WPP04.47100	NPW	Digestion, Platform Furnace	[EPA 200.9]	Silver
Certified	Yes	NY	WPP04.48000	NPW	Digestion, ICP	[EPA 200.7]	Silver
Certified	Yes	NY	WPP04.49500	NPW	Digestion, AA Furnace	[EPA 279.2]	Thallium
Certified	Yes	NY	WPP04.49600	NPW	Digestion, Platform Furnace	[EPA 200.9]	Thallium
Certified	Yes	NY	WPP04.50000	NPW	Digestion, ICP	[EPA 200.7]	Thallium
Certified	Yes	NY	WPP04.51100	NPW	Digestion, ICP	[EPA 200.7]	Tin
Certified	Yes	NY	WPP04.54000	NPW	Digestion, ICP	[EPA 200.7]	Vanadium
Dropped	No	NY	WPP04.56000	NPW	Digestion, AA Furnace	[EPA 289.2]	Zinc
Certified	Yes	NY	WPP04.56500	NPW	Digestion, ICP	[EPA 200.7]	Zinc

Category: WPP05 -- Organic Parameters, Chromatography

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	WPP05.09010	NPW	Extract/GC (ECD)	[EPA 608]	Aldrin

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Category: WPP05 -- Organic Parameters, Chromatography

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	WPP05.09020	NPW	Extract/GC (ECD)	[EPA 608]	Alpha BHC
Certified	Yes	NY	WPP05.09030	NPW	Extract/GC (ECD)	[EPA 608]	Beta BHC
Certified	Yes	NY	WPP05.09040	NPW	Extract/GC (ECD)	[EPA 608]	Delta BHC
Certified	Yes	NY	WPP05.09050	NPW	Extract/GC (ECD)	[EPA 608]	Lindane (gamma BHC)
Certified	Yes	NY	WPP05.09060	NPW	Extract/GC (ECD)	[EPA 608]	Chlordane
Certified	Yes	NY	WPP05.09070	NPW	Extract/GC (ECD)	[EPA 608]	DDD (4,4'-)
Certified	Yes	NY	WPP05.09080	NPW	Extract/GC (ECD)	[EPA 608]	DDE (4,4'-)
Certified	Yes	NY	WPP05.09090	NPW	Extract/GC (ECD)	[EPA 608]	DDT (4,4'-)
Certified	Yes	NY	WPP05.09100	NPW	Extract/GC (ECD)	[EPA 608]	Dieldrin
Certified	Yes	NY	WPP05.09110	NPW	Extract/GC (ECD)	[EPA 608]	Endosulfan I
Certified	Yes	NY	WPP05.09120	NPW	Extract/GC (ECD)	[EPA 608]	Endosulfan II
Certified	Yes	NY	WPP05.09130	NPW	Extract/GC (ECD)	[EPA 608]	Endosulfan sulfate
Certified	Yes	NY	WPP05.09140	NPW	Extract/GC (ECD)	[EPA 608]	Endrin
Certified	Yes	NY	WPP05.09150	NPW	Extract/GC (ECD)	[EPA 608]	Endrin aldehyde
Certified	Yes	NY	WPP05.09170	NPW	Extract/GC (ECD)	[EPA 608]	Heptachlor
Certified	Yes	NY	WPP05.09180	NPW	Extract/GC (ECD)	[EPA 608]	Heptachlor epoxide
Certified	Yes	NY	WPP05.09190	NPW	Extract/GC (ECD)	[EPA 608]	Methoxychlor
Certified	Yes	NY	WPP05.09200	NPW	Extract/GC (ECD)	[EPA 608]	Toxaphene
Certified	Yes	NY	WPP05.11010	NPW	Extract/GC (ECD)	[EPA 608]	PCB 1016
Certified	Yes	NY	WPP05.11020	NPW	Extract/GC (ECD)	[EPA 608]	PCB 1221
Certified	Yes	NY	WPP05.11030	NPW	Extract/GC (ECD)	[EPA 608]	PCB 1232
Certified	Yes	NY	WPP05.11040	NPW	Extract/GC (ECD)	[EPA 608]	PCB 1242
Certified	Yes	NY	WPP05.11050	NPW	Extract/GC (ECD)	[EPA 608]	PCB 1248
Certified	Yes	NY	WPP05.11060	NPW	Extract/GC (ECD)	[EPA 608]	PCB 1254
Certified	Yes	NY	WPP05.11070	NPW	Extract/GC (ECD)	[EPA 608]	PCB 1260

Category: WPP06 -- Organic Parameters, Chromatography/MS

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	WPP06.02007	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Acrolein

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WESTBOROUGH, MA 01581

Category: WPP06 -- Organic Parameters, Chromatography/MS

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	WPP06.02009	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Acrylonitrile
Certified	Yes	NY	WPP06.02010	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Benzene
Certified	Yes	NY	WPP06.02020	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Bromodichloromethane
Certified	Yes	NY	WPP06.02030	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Bromoform
Certified	Yes	NY	WPP06.02040	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Bromomethane
Certified	Yes	NY	WPP06.02050	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Carbon tetrachloride
Certified	Yes	NY	WPP06.02060	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Chlorobenzene
Certified	Yes	NY	WPP06.02070	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Chloroethane
Certified	Yes	NY	WPP06.02080	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Chloroethyl vinyl ether (2-)
Certified	Yes	NY	WPP06.02090	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Chloroform
Certified	Yes	NY	WPP06.02100	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Chloromethane
Certified	Yes	NY	WPP06.02110	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Dibromochloromethane
Certified	Yes	NY	WPP06.02120	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Dichlorobenzene (1,2-)
Certified	Yes	NY	WPP06.02130	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Dichlorobenzene (1,3-)
Certified	Yes	NY	WPP06.02140	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Dichlorobenzene (1,4-)
Certified	Yes	NY	WPP06.02145	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Dichlorodifluoromethane
Certified	Yes	NY	WPP06.02150	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Dichloroethane (1,1-)
Certified	Yes	NY	WPP06.02160	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Dichloroethane (1,2-)
Certified	Yes	NY	WPP06.02170	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Dichloroethene (1,1-)
Certified	Yes	NY	WPP06.02180	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Dichloroethene (trans-1,2-)
Certified	Yes	NY	WPP06.02190	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Dichloropropane (1,2-)
Certified	Yes	NY	WPP06.02200	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Dichloropropene (cis-1,3-)
Certified	Yes	NY	WPP06.02210	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Dichloropropene (trans-1,3-)
Certified	Yes	NY	WPP06.02220	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Ethylbenzene
Certified	Yes	NY	WPP06.02230	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Methylene chloride (Dichloromethane)
Certified	Yes	NY	WPP06.02240	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Tetrachloroethane (1,1,2,2-)
Certified	Yes	NY	WPP06.02250	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Tetrachloroethene
Certified	Yes	NY	WPP06.02260	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Toluene
Certified	Yes	NY	WPP06.02270	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Trichloroethane (1,1,1-)
Certified	Yes	NY	WPP06.02280	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Trichloroethane (1,1,2-)
Certified	Yes	NY	WPP06.02290	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Trichloroethene
Certified	Yes	NY	WPP06.02300	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Trichlorofluoromethane

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Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: WPP06 -- Organic Parameters, Chromatography/MS

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	WPP06.02310	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Vinyl chloride
Certified	Yes	NY	WPP06.02312	NPW	GC/MS, P & T, Capillary Column	[EPA 624]	Xylenes (total)
Certified	Yes	NY	WPP06.03010	NPW	Extract, GC/MS	[EPA 625]	Acenaphthene
Certified	Yes	NY	WPP06.03020	NPW	Extract, GC/MS	[EPA 625]	Acenaphthylene
Certified	Yes	NY	WPP06.03030	NPW	Extract, GC/MS	[EPA 625]	Anthracene
Certified	Yes	NY	WPP06.03040	NPW	Extract, GC/MS	[EPA 625]	Benzo(a)anthracene
Certified	Yes	NY	WPP06.03050	NPW	Extract, GC/MS	[EPA 625]	Benzo(b)fluoranthene
Certified	Yes	NY	WPP06.03060	NPW	Extract, GC/MS	[EPA 625]	Benzo(k)fluoranthene
Certified	Yes	NY	WPP06.03070	NPW	Extract, GC/MS	[EPA 625]	Benzo(a)pyrene
Certified	Yes	NY	WPP06.03080	NPW	Extract, GC/MS	[EPA 625]	Benzo(ghi)perylene
Certified	Yes	NY	WPP06.03090	NPW	Extract, GC/MS	[EPA 625]	Butyl benzyl phthalate
Certified	Yes	NY	WPP06.03100	NPW	Extract, GC/MS	[EPA 625]	Bis (2-chloroethyl) ether
Certified	Yes	NY	WPP06.03110	NPW	Extract, GC/MS	[EPA 625]	Bis (2-chloroethoxy) methane
Certified	Yes	NY	WPP06.03120	NPW	Extract, GC/MS	[EPA 625]	Bis (2-ethylhexyl) phthalate
Certified	Yes	NY	WPP06.03130	NPW	Extract, GC/MS	[EPA 625]	Bis (2-chloroisopropyl) ether
Certified	Yes	NY	WPP06.03140	NPW	Extract, GC/MS	[EPA 625]	Bromophenyl-phenyl ether (4-)
Certified	Yes	NY	WPP06.03150	NPW	Extract, GC/MS	[EPA 625]	Chloronaphthalene (2-)
Certified	Yes	NY	WPP06.03160	NPW	Extract, GC/MS	[EPA 625]	Chlorophenyl-phenyl ether (4-)
Certified	Yes	NY	WPP06.03170	NPW	Extract, GC/MS	[EPA 625]	Chrysene
Certified	Yes	NY	WPP06.03180	NPW	Extract, GC/MS	[EPA 625]	Dibenzo(a,h)anthracene
Certified	Yes	NY	WPP06.03190	NPW	Extract, GC/MS	[EPA 625]	Di-n-butyl phthalate
Certified	Yes	NY	WPP06.03200	NPW	Extract, GC/MS	[EPA 625]	Dichlorobenzene (1,3-)
Certified	Yes	NY	WPP06.03210	NPW	Extract, GC/MS	[EPA 625]	Dichlorobenzene (1,2-)
Certified	Yes	NY	WPP06.03220	NPW	Extract, GC/MS	[EPA 625]	Dichlorobenzene (1,4-)
Certified	Yes	NY	WPP06.03230	NPW	Extract, GC/MS	[EPA 625]	Dichlorobenzidine (3,3'-)
Certified	Yes	NY	WPP06.03240	NPW	Extract, GC/MS	[EPA 625]	Diethyl phthalate
Certified	Yes	NY	WPP06.03250	NPW	Extract, GC/MS	[EPA 625]	Dimethyl phthalate
Certified	Yes	NY	WPP06.03260	NPW	Extract, GC/MS	[EPA 625]	Dinitrotoluene (2,4-)
Certified	Yes	NY	WPP06.03270	NPW	Extract, GC/MS	[EPA 625]	Dinitrotoluene (2,6-)
Certified	Yes	NY	WPP06.03280	NPW	Extract, GC/MS	[EPA 625]	Di-n-octyl phthalate
Certified	Yes	NY	WPP06.03290	NPW	Extract, GC/MS	[EPA 625]	Fluoranthene
Certified	Yes	NY	WPP06.03300	NPW	Extract, GC/MS	[EPA 625]	Fluorene

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8 WALKUP DR
WESTBOROUGH, MA 01581

Category: WPP06 -- Organic Parameters, Chromatography/MS

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	WPP06.03310	NPW	Extract, GC/MS	[EPA 625]	Hexachlorobenzene
Certified	Yes	NY	WPP06.03320	NPW	Extract, GC/MS	[EPA 625]	Hexachlorobutadiene (1,3-)
Certified	Yes	NY	WPP06.03330	NPW	Extract, GC/MS	[EPA 625]	Hexachloroethane
Certified	Yes	NY	WPP06.03340	NPW	Extract, GC/MS	[EPA 625]	Indeno(1,2,3-cd)pyrene
Certified	Yes	NY	WPP06.03350	NPW	Extract, GC/MS	[EPA 625]	Isophorone
Certified	Yes	NY	WPP06.03360	NPW	Extract, GC/MS	[EPA 625]	Naphthalene
Certified	Yes	NY	WPP06.03370	NPW	Extract, GC/MS	[EPA 625]	Nitrobenzene
Certified	Yes	NY	WPP06.03380	NPW	Extract, GC/MS	[EPA 625]	N-Nitroso-di-n-propylamine
Certified	Yes	NY	WPP06.03390	NPW	Extract, GC/MS	[EPA 625]	Phenanthrene
Certified	Yes	NY	WPP06.03400	NPW	Extract, GC/MS	[EPA 625]	Pyrene
Certified	Yes	NY	WPP06.03410	NPW	Extract, GC/MS	[EPA 625]	Trichlorobenzene (1,2,4-)
Certified	Yes	NY	WPP06.03420	NPW	Extract, GC/MS	[EPA 625]	Methyl phenol (4-chloro-3-)
Certified	Yes	NY	WPP06.03430	NPW	Extract, GC/MS	[EPA 625]	Chlorophenol (2-)
Certified	Yes	NY	WPP06.03440	NPW	Extract, GC/MS	[EPA 625]	Dichlorophenol (2,4-)
Certified	Yes	NY	WPP06.03450	NPW	Extract, GC/MS	[EPA 625]	Dimethylphenol (2,4-)
Certified	Yes	NY	WPP06.03460	NPW	Extract, GC/MS	[EPA 625]	Dinitrophenol (2,4-)
Certified	Yes	NY	WPP06.03470	NPW	Extract, GC/MS	[EPA 625]	Dinitrophenol (2-methyl-4,6-)
Certified	Yes	NY	WPP06.03480	NPW	Extract, GC/MS	[EPA 625]	Nitrophenol (2-)
Certified	Yes	NY	WPP06.03490	NPW	Extract, GC/MS	[EPA 625]	Nitrophenol (4-)
Certified	Yes	NY	WPP06.03500	NPW	Extract, GC/MS	[EPA 625]	Pentachlorophenol
Certified	Yes	NY	WPP06.03510	NPW	Extract, GC/MS	[EPA 625]	Phenol
Certified	Yes	NY	WPP06.03518	NPW	Extract, GC/MS	[EPA 625]	Trichlorophenol (2,4,5-)
Certified	Yes	NY	WPP06.03520	NPW	Extract, GC/MS	[EPA 625]	Trichlorophenol (2,4,6-)
Certified	Yes	NY	WPP06.03580	NPW	Extract, GC/MS	[EPA 625]	Benzidine
Certified	Yes	NY	WPP06.03660	NPW	Extract, GC/MS	[EPA 625]	Hexachlorocyclopentadiene
Certified	Yes	NY	WPP06.03680	NPW	Extract, GC/MS	[EPA 625]	N-Nitrosodimethylamine
Certified	Yes	NY	WPP06.03690	NPW	Extract, GC/MS	[EPA 625]	N-Nitrosodiphenylamine
Certified	Yes	NY	WPP06.03720	NPW	Extract, GC/MS	[EPA 625]	Pyridine

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WESTBOROUGH, MA 01581

Category: WPP07 -- Organic Parameters, Individual Pesticide

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	WPP07.23000	NPW	GC	[SM 6640 B]	D (2,4-)
Certified	Yes	NY	WPP07.83000	NPW	GC	[SM 6640 B]	T (2,4,5-)
Certified	Yes	NY	WPP07.84000	NPW	GC	[SM 6640 B]	TP (2,4,5-) (Silvex)

Category: SHW03 -- Analyze-Immediately Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW03.01000	NPW, SCM	Aqueous, Electrometric	[SW-846 9040B, Rev. 2, 1/95]	pH

Category: SHW04 -- Inorganic Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW04.06500	NPW, SCM	ICP	[SW-846 6010B, Rev. 2, 12/96]	Antimony
Certified	Yes	NY	SHW04.09000	NPW, SCM	ICP	[SW-846 6010B, Rev. 2 12/96]	Arsenic
Certified	Yes	NY	SHW04.11500	NPW, SCM	ICP	[SW-846 6010B, Rev. 2 12/96]	Barium
Certified	Yes	NY	SHW04.15500	NPW, SCM	ICP	[SW-846 6010B, Rev. 2 12/96]	Cadmium
Certified	Yes	NY	SHW04.18500	NPW, SCM	ICP	[SW-846 6010B, Rev. 2 12/96]	Chromium
Certified	Yes	NY	SHW04.27500	NPW, SCM	ICP	[SW-846 6010B, Rev. 2 12/96]	Lead
Certified	Yes	NY	SHW04.35500	NPW, SCM	ICP	[SW-846 6010B, Rev. 2, 12/96]	Nickel
Certified	Yes	NY	SHW04.39000	NPW, SCM	ICP	[SW-846 6010B, Rev. 2 12/96]	Selenium
Certified	Yes	NY	SHW04.41000	NPW, SCM	ICP	[SW-846 6010B, Rev. 2 12/96]	Silver

Category: SHW06 -- Organic Parameters, Chromatography

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW06.05010	NPW, SCM	GC, Direct Injection or P & T, PID-HECD	[SW-846 8021B, Rev. 2, 12/96]	Benzene
Certified	Yes	NY	SHW06.05030	NPW, SCM	GC, Direct Injection or P & T, PID-HECD	[SW-846 8021B, Rev. 2, 12/96]	Dichlorobenzene (1,2-)
Certified	Yes	NY	SHW06.05040	NPW, SCM	GC, Direct Injection or P & T, PID-HECD	[SW-846 8021B, Rev. 2, 12/96]	Dichlorobenzene (1,3-)

KEY: AE = Air and Emissions, BT = Biological Tissues, DW = Drinking Water, NPW = Non-Potable Water, SCM = Solid and Chemical Materials

New Jersey Department of Environmental Protection

National Environmental Laboratory Accreditation Program

ANNUAL CERTIFIED PARAMETER LIST AND CURRENT STATUS

Effective as of 07/01/2006 until 06/30/2007

Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: SHW06 -- Organic Parameters, Chromatography

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW06.05050	NPW, SCM	GC, Direct Injection or P & T, PID-HECD	[SW-846 8021B, Rev. 2, 12/96]	Dichlorobenzene (1,4-)
Certified	Yes	NY	SHW06.05060	NPW, SCM	GC, Direct Injection or P & T, PID-HECD	[SW-846 8021B, Rev. 2, 12/96]	Ethylbenzene
Certified	Yes	NY	SHW06.05070	NPW, SCM	GC, Direct Injection or P & T, PID-HECD	[SW-846 8021B, Rev. 2, 12/96]	Toluene
Certified	Yes	NY	SHW06.05080	NPW, SCM	GC, Direct Injection or P & T, PID-HECD	[SW-846 8021B, Rev. 2, 12/96]	Xylene (o-)
Certified	Yes	NY	SHW06.05090	NPW, SCM	GC, Direct Injection or P & T, PID-HECD	[SW-846 8021B, Rev. 2, 12/96]	Xylene (m-)
Certified	Yes	NY	SHW06.05100	NPW, SCM	GC, Direct Injection or P & T, PID-HECD	[SW-846 8021B, Rev. 2, 12/96]	Xylene (p-)
Certified	Yes	NY	SHW06.12010	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Aldrin
Certified	Yes	NY	SHW06.12020	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Alpha BHC
Certified	Yes	NY	SHW06.12030	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Beta BHC
Certified	Yes	NY	SHW06.12040	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Delta BHC
Certified	Yes	NY	SHW06.12050	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Lindane (gamma BHC)
Certified	Yes	NY	SHW06.12060	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Chlordane (technical)
Certified	Yes	NY	SHW06.12090	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	DDD (4,4'-)
Certified	Yes	NY	SHW06.12100	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	DDE (4,4'-)
Certified	Yes	NY	SHW06.12110	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	DDT (4,4'-)
Certified	Yes	NY	SHW06.12120	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Dieldrin
Certified	Yes	NY	SHW06.12130	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Endosulfan I
Certified	Yes	NY	SHW06.12140	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Endosulfan II
Certified	Yes	NY	SHW06.12150	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Endosulfan sulfate
Certified	Yes	NY	SHW06.12160	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Endrin
Certified	Yes	NY	SHW06.12170	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Endrin aldehyde
Certified	Yes	NY	SHW06.12190	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Heptachlor
Certified	Yes	NY	SHW06.12200	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Heptachlor epoxide
Certified	Yes	NY	SHW06.12210	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Methoxychlor
Certified	Yes	NY	SHW06.12220	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8081A, Rev. 1, 12/96]	Toxaphene
Certified	Yes	NY	SHW06.13110	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8082, Rev. 0, 12/96]	PCB 1016
Certified	Yes	NY	SHW06.13120	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8082, Rev. 0, 12/96]	PCB 1221
Certified	Yes	NY	SHW06.13130	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8082, Rev. 0, 12/96]	PCB 1232
Certified	Yes	NY	SHW06.13140	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8082, Rev. 0, 12/96]	PCB 1242
Certified	Yes	NY	SHW06.13150	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8082, Rev. 0, 12/96]	PCB 1248
Certified	Yes	NY	SHW06.13160	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8082, Rev. 0, 12/96]	PCB 1254
Certified	Yes	NY	SHW06.13170	NPW, SCM	GC, Extraction, ECD or HECD, Capillary	[SW-846 8082, Rev. 0, 12/96]	PCB 1260

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New Jersey Department of Environmental Protection

National Environmental Laboratory Accreditation Program

ANNUAL CERTIFIED PARAMETER LIST AND CURRENT STATUS

Effective as of 07/01/2006 until 06/30/2007

Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: SHW06 -- Organic Parameters, Chromatography

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW06.28010	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	HMX
Certified	Yes	NY	SHW06.28020	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	RDX
Certified	Yes	NY	SHW06.28030	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	Trinitrobenzene (1,3,5-)
Certified	Yes	NY	SHW06 28040	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	Dinitrobenzene (1,3-)
Certified	Yes	NY	SHW06.28050	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	Tetryl
Certified	Yes	NY	SHW06.28060	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	Nitrobenzene
Certified	Yes	NY	SHW06.28070	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	Trinitrotoluene (2,4,6-)
Certified	Yes	NY	SHW06.28080	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	Dinitrotoluene (4-amino-2,6-)
Certified	Yes	NY	SHW06.28090	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	Dinitrotoluene (2-amino-4,6-)
Certified	Yes	NY	SHW06 28100	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	Dinitrotoluene (2,4-)
Certified	Yes	NY	SHW06.28110	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	Dinitrotoluene (2,6-)
Certified	Yes	NY	SHW06.28120	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	Nitrotoluene (2-)
Certified	Yes	NY	SHW06.28130	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	Nitrotoluene (3-)
Certified	Yes	NY	SHW06.28140	NPW, SCM	HPLC, UV Detector	[SW-846 8330, Rev. 0, 9/94]	Nitrotoluene (4-)

Category: SHW07 -- Organic Parameters, Chromatography/MS

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW07.04010	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Benzene
Certified	Yes	NY	SHW07.04020	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Chlorobenzene
Certified	Yes	NY	SHW07.04030	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Dichlorobenzene (1,2-)
Certified	Yes	NY	SHW07.04040	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Dichlorobenzene (1,3-)
Certified	Yes	NY	SHW07.04050	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Dichlorobenzene (1,4-)
Certified	Yes	NY	SHW07.04060	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Ethylbenzene
Certified	Yes	NY	SHW07.04070	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Toluene
Certified	Yes	NY	SHW07.04080	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Xylenes (total)
Certified	Yes	NY	SHW07.04090	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Bromodichloromethane
Certified	Yes	NY	SHW07.04100	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Bromoform
Certified	Yes	NY	SHW07.04110	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Bromomethane
Certified	Yes	NY	SHW07.04120	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Carbon tetrachloride

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New Jersey Department of Environmental Protection

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ANNUAL CERTIFIED PARAMETER LIST AND CURRENT STATUS

Effective as of 07/01/2006 until 06/30/2007

Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: SHW07 -- Organic Parameters, Chromatography/MS

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW07.04130	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Chloroethane
Certified	Yes	NY	SHW07.04150	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Chloroform
Certified	Yes	NY	SHW07.04160	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Chloromethane
Certified	Yes	NY	SHW07.04170	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Dichloropropene (trans-1,3-)
Certified	Yes	NY	SHW07.04180	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Dibromochloromethane
Certified	Yes	NY	SHW07.04190	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Dichlorodifluoromethane
Certified	Yes	NY	SHW07.04200	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Dichloroethane (1,1-)
Certified	Yes	NY	SHW07.04210	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Dichloroethane (1,2-)
Certified	Yes	NY	SHW07.04220	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Dichloroethene (1,1-)
Certified	Yes	NY	SHW07.04240	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Dichloropropane (1,2-)
Certified	Yes	NY	SHW07.04250	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Dichloropropene (cis-1,3-)
Certified	Yes	NY	SHW07.04260	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Methylene chloride (Dichloromethane)
Certified	Yes	NY	SHW07.04270	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Tetrachloroethane (1,1,2,2-)
Certified	Yes	NY	SHW07.04280	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Tetrachloroethene
Certified	Yes	NY	SHW07.04290	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Trichloroethane (1,1,1-)
Certified	Yes	NY	SHW07.04300	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Trichloroethane (1,1,2-)
Certified	Yes	NY	SHW07.04310	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Trichloroethene
Certified	Yes	NY	SHW07.04320	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Trichlorofluoromethane
Certified	Yes	NY	SHW07.04330	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Vinyl chloride
Certified	Yes	NY	SHW07.04400	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Acrolein
Certified	Yes	NY	SHW07.04410	NPW, SCM	GC/MS, P & T or Direct Injection, Capillary	[SW-846 8260B, Rev. 2, 12/96]	Acrylonitrile
Certified	Yes	NY	SHW07.05070	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Chloronaphthalene (2-)
Certified	Yes	NY	SHW07.05080	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Hexachlorobenzene
Certified	Yes	NY	SHW07.05110	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Hexachloroethane
Certified	Yes	NY	SHW07.05120	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Trichlorobenzene (1,2,4-)
Certified	Yes	NY	SHW07.05130	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Bis (2-chloroethoxy) methane
Certified	Yes	NY	SHW07.05140	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev 3, 12/96]	Bis (2-chloroisopropyl) ether
Certified	Yes	NY	SHW07.05170	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Dinitrotoluene (2,4-)
Certified	Yes	NY	SHW07.05180	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Dinitrotoluene (2,6-)
Certified	Yes	NY	SHW07.05190	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Isophorone
Certified	Yes	NY	SHW07.05200	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Nitrobenzene
Certified	Yes	NY	SHW07.05210	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Butyl benzyl phthalate

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8 WALKUP DR
WESTBOROUGH, MA 01581

Category: SHW07 -- Organic Parameters, Chromatography/MS

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW07.05220	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Bis (2-ethylhexyl) phthalate
Certified	Yes	NY	SHW07.05230	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Diethyl phthalate
Certified	Yes	NY	SHW07.05240	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Dimethyl phthalate
Certified	Yes	NY	SHW07.05250	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Di-n-butyl phthalate
Certified	Yes	NY	SHW07.05260	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Di-n-octyl phthalate
Certified	Yes	NY	SHW07.05270	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Acenaphthene
Certified	Yes	NY	SHW07.05280	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Anthracene
Certified	Yes	NY	SHW07.05290	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Acenaphthylene
Certified	Yes	NY	SHW07.05300	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Benzo(a)anthracene
Certified	Yes	NY	SHW07.05310	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Benzo(a)pyrene
Certified	Yes	NY	SHW07.05320	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Benzo(b)fluoranthene
Certified	Yes	NY	SHW07.05330	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Benzo(ghi)perylene
Certified	Yes	NY	SHW07.05350	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Chrysene
Certified	Yes	NY	SHW07.05360	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Dibenzo(a,h)anthracene
Certified	Yes	NY	SHW07.05370	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Fluoranthene
Certified	Yes	NY	SHW07.05380	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Fluorene
Certified	Yes	NY	SHW07.05390	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Indeno(1,2,3-cd)pyrene
Certified	Yes	NY	SHW07.05410	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Naphthalene
Certified	Yes	NY	SHW07.05420	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Phenanthrene
Certified	Yes	NY	SHW07.05430	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Pyrene
Certified	Yes	NY	SHW07.05440	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Methyl phenol (4-chloro-3-)
Certified	Yes	NY	SHW07.05450	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Chlorophenol (2-)
Certified	Yes	NY	SHW07.05470	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Dimethylphenol (2,4-)
Certified	Yes	NY	SHW07.05480	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Dinitrophenol (2,4-)
Certified	Yes	NY	SHW07.05490	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Dinitrophenol (2-methyl-4,6-)
Certified	Yes	NY	SHW07.05520	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Nitrophenol (2-)
Certified	Yes	NY	SHW07.05530	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Nitrophenol (4-)
Certified	Yes	NY	SHW07.05540	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Pentachlorophenol
Certified	Yes	NY	SHW07.05550	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Phenol
Certified	Yes	NY	SHW07.05570	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Trichlorophenol (2,4,6-)
Applied	No	NY	SHW07.05590	NPW, SCM	GC/MS, Extract or Dir Inj, Capillary	[SW-846 8270C, Rev. 3, 12/96]	Methylphenol (3-)

KEY: AE = Air and Emissions, BT = Biological Tissues, DW = Drinking Water, NPW = Non-Potable Water, SCM = Solid and Chemical Materials

New Jersey Department of Environmental Protection

National Environmental Laboratory Accreditation Program

ANNUAL CERTIFIED PARAMETER LIST AND CURRENT STATUS

Effective as of 07/01/2006 until 06/30/2007

Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: SHW09 -- Miscellaneous Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Applied	No	NY	SHW09.05000	NPW, SCM	Colorimetric, Automated	[SW-846 9012A, Rev. 1, 12/96]	Cyanide
Certified	Yes	NY	SHW09.09000	NPW, SCM	Redox Titration	[SW-846 9030B, Rev. 2, 12/96]	Sulfides, acid sol. & insol.
Certified	Yes	NY	SHW09.14000	NPW, SCM	Electrometric	[SW-846 9040B, Rev. 2, 1/95]	pH - waste, >20% water

Category: SHW02 -- Characteristics of Hazardous Waste

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW02.01000	SCM	Pensky Martens	[SW-846 1010, Rev. 0, 9/86]	Ignitability
Certified	Yes	NY	SHW02.03000	SCM	Aqueous Waste, Potentiometric	[SW-846 9040B, Rev. 2, 1/95]	Corrosivity - pH waste, >20% water

Category: SHW04 -- Inorganic Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW04.01000	SCM	Acid Digestion/Surface and Groundwater, ICP, FLAA	[SW-846 3005A, Rev. 1, 7/92]	Metals, Total Rec and Dissolved
Certified	Yes	NJ	SHW04.03500	SCM	Microwave Acid Digest: Soil Sediment & Sludge	[SW-846 3051, Rev. 0, 9/94]	Metals
Certified	Yes	NY	SHW04.33500	SCM	AA, Manual Cold Vapor	[SW-846 7471A, Rev. 1, 9/94]	Mercury - solid waste

Category: SHW05 -- Organic Parameters, Prep. / Screening

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NJ	SHW05.05000	SCM	Ultrasonic Extraction	[SW-846 3550B, Rev. 2, 12/96]	Semivolatile organics
Applied	No	NJ	SHW05.06000	SCM	Waste Dilution	[SW-846 3580A, Rev. 1, 7/92]	Organics
Applied	No	NY	SHW05.12000	SCM	Cleanup-Florisil	[SW-846 3620B, Rev. 2, 12/96]	Semivolatile organics
Applied	No	NY	SHW05.15000	SCM	Cleanup-Acid/Base Partition	[SW-846 3650B, Rev. 2, 12/96]	Semivolatile organics
Applied	No	NY	SHW05.16000	SCM	Cleanup-Sulfur Removal	[SW-846 3660B, Rev. 2, 12/96]	Semivolatile organics

KEY: AE = Air and Emissions, BT = Biological Tissues, DW = Drinking Water, NPW = Non-Potable Water, SCM = Solid and Chemical Materials

New Jersey Department of Environmental Protection

National Environmental Laboratory Accreditation Program

ANNUAL CERTIFIED PARAMETER LIST AND CURRENT STATUS

Effective as of 07/01/2006 until 06/30/2007

Laboratory Name: ALPHA WOODS HOLE LABS Laboratory Number: MA935 Activity ID: NLC060002
8 WALKUP DR
WESTBOROUGH, MA 01581

Category: SHW06 -- Organic Parameters, Chromatography

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW06.05020	SCM	GC, Direct Injection or P & T, PID-HECD	[SW-846 8021B, Rev. 2, 12/96]	Chlorobenzene

Category: SHW09 -- Miscellaneous Parameters

Status	Eligible to Report NJ Data	State	Code	Matrix	Technique Description	Approved Method	Parameter Description
Certified	Yes	NY	SHW09.16000	SCM	Mix with Water or Calcium Chloride	[SW-846 9045C, Rev. 3, 1/95]	pH - soil and waste
Certified	Yes	NY	SHW09.17000	SCM	Wheatstone Bridge	[SW-846 9050A, Rev. 1, 12/96]	Specific conductance
Certified	Yes	NY	SHW09.21000	SCM	Colorimetric, Man, 4AAP Distillation	[SW-846 9065, Rev. 0, 9/86]	Phenols

Joseph F. Aiello, Chief

KEY: AE = Air and Emissions, BT = Biological Tissues, DW = Drinking Water, NPW = Non-Potable Water, SCM = Solid and Chemical Materials

State of Maine

Laboratory Certification Program

Awards Certification To

Alpha Woods Hole Labs

Located at

Eight Walkup Drive, Westborough, MA 01581

For the demonstration of capability of performing the analyses listed on the attached certified analytes list(s) as required by 22 M.R.S.A., Chapter 157-A.

Certificate Number: 2007027
Date of Issue: 5/16/2007
Expiration Date: 5/16/2009

Certification Officer

This certificate must be displayed with the corresponding analyte list.
This certificate supersedes all previously issued certificates.
Continuing certification status is dependent on successful ongoing participation in the program.
Customers may verify the laboratory's current certification status by calling (207) 287-1929.

Maine Department of Health and Human Services

Maine Center for Disease Control and Prevention
(Formerly Bureau of Health)
286 Water Street
11 State House Station
Augusta, ME 04333-0011

John Elias Baldacci
Governor

Laboratory ID: MA0086 Date of Issue: 5/30/2007 Expiration Date: 5/16/2009

Alpha Woods Hole Labs (508) 898-9220

Eight Walkup Drive Westborough MA 01581

Certificate Number: 2007027

Has demonstrated the capability to analyze DRINKING WATER analytes as defined by the 22 M.R.S.A., Chapter 157-A and the rules for Comprehensive Environmental Laboratory Certification and the Safe Drinking Water Act is hereby granted CERTIFICATION FOR:

Heterotrophic Plate Count	SM 9215 B	Full Certification
Fecal Coliform	SM 9221 E	Full Certification
Total Coliform	SM 9222 B	Full Certification
Fecal Coliform	SM 9222 D	Full Certification
E. Coli	SM 9223 B	Full Certification
Total Coliform	SM 9223 B	Full Certification
pH	EPA 150.1	Full Certification
Turbidity	EPA 180.1	Full Certification
Fluoride	EPA 300.0	Full Certification
Nitrogen, Nitrate	EPA 300.0	Full Certification
Nitrogen, Nitrite	EPA 300.0	Full Certification
Nitrogen, Nitrate	EPA 353.2	Full Certification
Nitrogen, Nitrate/Nitrite	EPA 353.2	Full Certification
Nitrogen, Nitrite	EPA 353.2	Full Certification
Turbidity	SM 2130 B	Full Certification
Alkalinity	SM 2320 B	Full Certification
Chlorine, Total	SM 4500 (Cl) D	Full Certification
Cyanide (Prilimnary Distillation Step)	SM 4500 (CN-) C	Full Certification
Cyanide	SM 4500 (CN-) E	Full Certification
Fluoride	SM 4500 (F-) C	Full Certification
pH	SM 4500 (H+) B	Full Certification
Nitrogen, Nitrate	SM 4500 (NO3-) F	Full Certification
Nitrogen, Nitrate/Nitrite	SM 4500 (NO3-) F	Full Certification
Barium	EPA 200.7	Full Certification
Beryllium	EPA 200.7	Full Certification
Cadmium	EPA 200.7	Full Certification
Calcium	EPA 200.7	Full Certification
Chromium	EPA 200.7	Full Certification
Copper	EPA 200.7	Full Certification
Nickel	EPA 200.7	Full Certification
Sodium	EPA 200.7	Full Certification
Antimony	EPA 200.8	Full Certification
Arsenic	EPA 200.8	Full Certification
Barium	EPA 200.8	Full Certification
Beryllium	EPA 200.8	Full Certification
Cadmium	EPA 200.8	Full Certification
Chromium	EPA 200.8	Full Certification
Copper	EPA 200.8	Full Certification

This analyte list supercedes all previously issued.

Matthew J. Sica, Certification Officer

DISPLAY IN A PROMINENT POSITION

Maine Department of Health and Human Services

Maine Center for Disease Control and Prevention
(Formerly Bureau of Health)
286 Water Street
11 State House Station
Augusta, ME 04333-0011

John Elias Baldacci
Governor

Laboratory ID: MA0086 Date of Issue: 5/30/2007 Expiration Date: 5/16/2009

Alpha Woods Hole Labs (508) 898-9220

Eight Walkup Drive Westborough MA 01581

Certificate Number: 2007027

Has demonstrated the capability to analyze DRINKING WATER analytes as defined by the 22 M.R.S.A., Chapter 157-A and the rules for Comprehensive Environmental Laboratory Certification and the Safe Drinking Water Act is hereby granted CERTIFICATION FOR:

Lead	EPA 200.8	Full Certification
Nickel	EPA 200.8	Full Certification
Selenium	EPA 200.8	Full Certification
Thallium	EPA 200.8	Full Certification
Mercury	EPA 245.1	Full Certification
Dibromochloropropane (DBCP)	EPA 504.1	Full Certification
Ethylene dibromide (EDB)	EPA 504.1	Full Certification
Benzene	EPA 524.2	Full Certification
Carbon Tetrachloride	EPA 524.2	Full Certification
Chlorobenzene	EPA 524.2	Full Certification
Dichlorobenzene, 1,2-	EPA 524.2	Full Certification
Dichlorobenzene, 1,4-	EPA 524.2	Full Certification
Dichloroethane, 1,2-	EPA 524.2	Full Certification
Dichloroethylene, 1,1-	EPA 524.2	Full Certification
Dichloroethylene, cis-	EPA 524.2	Full Certification
Dichloroethylene, trans-	EPA 524.2	Full Certification
Dichloromethane	EPA 524.2	Full Certification
Dichloropropane, 1,2-	EPA 524.2	Full Certification
Ethylbenzene	EPA 524.2	Full Certification
Styrene	EPA 524.2	Full Certification
Tetrachloroethylene	EPA 524.2	Full Certification
Toluene	EPA 524.2	Full Certification
Total Trihalomethanes	EPA 524.2	Full Certification
Trichlorobenzene, 1,2,4-	EPA 524.2	Full Certification
Trichloroethane, 1,1,1-	EPA 524.2	Full Certification
Trichloroethane, 1,1,2-	EPA 524.2	Full Certification
Trichloroethylene	EPA 524.2	Full Certification
Vinyl Chloride	EPA 524.2	Full Certification
Dibromoacetic Acid	SM 6251 B	Full Certification
Dichloroacetic Acid	SM 6251 B	Full Certification
Haloacetic Acids (HAA5)	SM 6251 B	Full Certification
Monobromoacetic Acid	SM 6251 B	Full Certification
Monochloroacetic Acid	SM 6251 B	Full Certification
Trichloroacetic Acid	SM 6251 B	Full Certification

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Matthew J. Sica, Certification Officer

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Laboratory ID: MA0086 Date of Issue: 5/30/2007 Expiration Date: 5/16/2009

Alpha Woods Hole Labs (508) 898-9220

Eight Walkup Drive Westborough MA 01581

Certificate Number: 2007027

Has demonstrated the capability to analyze WASTEWATER analytes as defined by the National Pollution Discharge Elimination System and as required by 22 M.R.S.A., Chapter 157-A and the rules for Comprehensive Environmental Laboratory Certification and is hereby granted CERTIFICATION FOR:

Specific Conductance	EPA 120.1	Full Certification
Oil & Grease	EPA 1664 A	Full Certification
Nitrogen, Ammonia	EPA 350.1	Full Certification
Nitrogen, Total Kjeldahl	EPA 351.1	Full Certification
Nitrogen, Nitrate/Nitrite	EPA 353.2	Full Certification
Chemical Oxygen Demand	EPA 410.4	Full Certification
Phenols	EPA 420.1	Full Certification
Nitrogen, Ammonia	Latchat 10-107-06-1-B	Full Certification
Alkalinity	SM 2320 B	Full Certification
Hardness, Total by Calculation	SM 2340 B / EPA 200.7	Full Certification
Specific Conductance	SM 2510 B	Full Certification
Specific Conductance	SM 2510 B	Full Certification
Residue, Filterable (TDS)	SM 2540 C	Full Certification
Residue, Non-filterable (TSS)	SM 2540 D	Full Certification
Sulfate	SM 426C	Full Certification
Chlorine, Total Residual	SM 4500 (Cl) D	Full Certification
Chloride	SM 4500 (Cl-) E	Full Certification
Cyanide, Total	SM 4500 (CN-) C	Full Certification
Cyanide, Total	SM 4500 (CN-) E	Full Certification
Fluoride (manual distillation)	SM 4500 (F-) B	Full Certification
Fluoride	SM 4500 (F-) C	Full Certification
pH	SM 4500 (H+) B	Full Certification
Nitrogen, Total Kjeldahl	SM 4500 (N org) B	Full Certification
Nitrogen, Total Kjeldahl	SM 4500 (N org) C	Full Certification
Nitrogen, Ammonia	SM 4500 (NH3) B	Full Certification
Nitrogen, Ammonia	SM 4500 (NH3) G	Full Certification
Nitrogen, Ammonia	SM 4500 (NH3) H	Full Certification
Nitrogen, Nitrate/Nitrite	SM 4500 (NO3-) F	Full Certification
Phosphorus, Total	SM 4500 (P) B.5	Full Certification
Orthophosphate	SM 4500 (P) E	Full Certification
Phosphorus, Total	SM 4500 (P) E	Full Certification
Biochemical Oxygen Demand	SM 5210 B	Full Certification
Chemical Oxygen Demand	SM 5220 D	Full Certification
Total Organic Carbon	SM 5310 C	Full Certification
Aluminum	EPA 200.7	Full Certification
Antimony	EPA 200.7	Full Certification
Arsenic	EPA 200.7	Full Certification
Beryllium	EPA 200.7	Full Certification
Cadmium	EPA 200.7	Full Certification
Calcium	EPA 200.7	Full Certification
Chromium	EPA 200.7	Full Certification

This analyte list supercedes all previously issued.

Matthew J. Sica, Certification Officer

DISPLAY IN A PROMINENT POSITION

Maine Department of Health and Human Services

Maine Center for Disease Control and Prevention
(Formerly Bureau of Health)
286 Water Street
11 State House Station
Augusta, ME 04333-0011

John Elias Baldacci
Governor

Laboratory ID: MA0086 Date of Issue: 5/30/2007 Expiration Date: 5/16/2009

Alpha Woods Hole Labs (508) 898-9220

Eight Walkup Drive Westborough MA 01581

Certificate Number: 2007027

Has demonstrated the capability to analyze WASTEWATER analytes as defined by the National Pollution Discharge Elimination System and as required by 22 M.R.S.A., Chapter 157-A and the rules for Comprehensive Environmental Laboratory Certification and is hereby granted CERTIFICATION FOR:

Cobalt	EPA 200.7	Full Certification
Copper	EPA 200.7	Full Certification
Iron	EPA 200.7	Full Certification
Lead	EPA 200.7	Full Certification
Magnesium	EPA 200.7	Full Certification
Manganese	EPA 200.7	Full Certification
Molybdenum	EPA 200.7	Full Certification
Nickel	EPA 200.7	Full Certification
Potassium	EPA 200.7	Full Certification
Selenium	EPA 200.7	Full Certification
Silver	EPA 200.7	Full Certification
Sodium	EPA 200.7	Full Certification
Thallium	EPA 200.7	Full Certification
Vanadium	EPA 200.7	Full Certification
Zinc	EPA 200.7	Full Certification
Aluminum	EPA 200.8	Full Certification
Antimony	EPA 200.8	Full Certification
Arsenic	EPA 200.8	Full Certification
Beryllium	EPA 200.8	Full Certification
Cadmium	EPA 200.8	Full Certification
Chromium	EPA 200.8	Full Certification
Copper	EPA 200.8	Full Certification
Lead	EPA 200.8	Full Certification
Manganese	EPA 200.8	Full Certification
Nickel	EPA 200.8	Full Certification
Selenium	EPA 200.8	Full Certification
Silver	EPA 200.8	Full Certification
Thallium	EPA 200.8	Full Certification
Zinc	EPA 200.8	Full Certification
Mercury	EPA 245.1	Full Certification
Aldrin	EPA 608	Full Certification
Chlordane	EPA 608	Full Certification
DDD, 4,4'-	EPA 608	Full Certification
DDE, 4,4'-	EPA 608	Full Certification
DDT, 4,4'-	EPA 608	Full Certification
Dieldrin	EPA 608	Full Certification
Heptachlor	EPA 608	Full Certification
Heptachlor Epoxide	EPA 608	Full Certification
PCB 1016	EPA 608	Full Certification
PCB 1221	EPA 608	Full Certification
PCB 1232	EPA 608	Full Certification

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Matthew J. Sica, Certification Officer

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Governor

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Alpha Woods Hole Labs (508) 898-9220

Eight Walkup Drive Westborough MA 01581

Certificate Number: 2007027

Has demonstrated the capability to analyze WASTEWATER analytes as defined by the National Pollution Discharge Elimination System and as required by 22 M.R.S.A., Chapter 157-A and the rules for Comprehensive Environmental Laboratory Certification and is hereby granted CERTIFICATION FOR:

PCB 1242	EPA 608	Full Certification
PCB 1248	EPA 608	Full Certification
PCB 1254	EPA 608	Full Certification
PCB 1260	EPA 608	Full Certification
Acrolein	EPA 624	Full Certification
Acrylonitrile	EPA 624	Full Certification
Benzene	EPA 624	Full Certification
Bromodichloromethane	EPA 624	Full Certification
Bromoform	EPA 624	Full Certification
Bromomethane	EPA 624	Full Certification
Carbon Tetrachloride	EPA 624	Full Certification
Chlorobenzene	EPA 624	Full Certification
Chloroethane	EPA 624	Full Certification
Chloroethylvinyl ether, 2-	EPA 624	Full Certification
cis-1,3-Dichloropropene	EPA 624	Full Certification
Dibromochloromethane	EPA 624	Full Certification
Dichlorobenzene, 1,2-	EPA 624	Full Certification
Dichlorobenzene, 1,3-	EPA 624	Full Certification
Dichlorobenzene, 1,4-	EPA 624	Full Certification
Dichloroethane, 1,2-	EPA 624	Full Certification
Dichloroethene, 1,1-	EPA 624	Full Certification
Dichloropropane, 1,2-	EPA 624	Full Certification
Ethylbenzene	EPA 624	Full Certification
Methylene Chloride	EPA 624	Full Certification
Tetrachloroethane, 1,1,2,2-	EPA 624	Full Certification
Tetrachloroethene	EPA 624	Full Certification
Toluene	EPA 624	Full Certification
trans-1,3-Dichloropropene	EPA 624	Full Certification
Trichloroethene	EPA 624	Full Certification
Trichlorofluoromethane	EPA 624	Full Certification
Vinyl Chloride	EPA 624	Full Certification

This analyte list supercedes all previously issued.

Matthew J. Silva, Certification Officer

DISPLAY IN A PROMINENT POSITION

Maine Department of Health and Human Services

Maine Center for Disease Control and Prevention
(Formerly Bureau of Health)
286 Water Street
11 State House Station
Augusta, ME 04333-0011

John Elias Baldacci
Governor

Laboratory ID: MA0086 Date of Issue: 5/16/2007 Expires: 5/16/2009

Alpha Woods Hole Labs (508) 898-9220

Eight Walkup Drive Westborough MA 01581

Certificate Number: 2007027

Has demonstrated the capability to analyze water and/or soil as required by 22 R.R.S.A. Chapter 157-A and the rules for Comprehensive and Limited Environmental Laboratory Certification, Section G.4., DRO/GRO and is hereby granted

FULL CERTIFICATION FOR:

Diesel Range Organics (aqueous)	ME 4.1.25
Diesel Range Organics (solid)	ME 4.1.25
Gasoline Range Organics (aqueous)	ME 4.2.17
Gasoline Range Organics (solid)	ME 4.2.17

This analyte list supercedes all previously issued.

Matthew J. Sica, Certification Officer

DISPLAY IN A PROMINENT POSITION

State of Connecticut, Department of Public Health

Approved Environmental Laboratory

THIS IS TO CERTIFY THAT THE LABORATORY DESCRIBED BELOW HAS BEEN APPROVED BY THE STATE DEPARTMENT OF PUBLIC HEALTH PURSUANT TO APPLICABLE PROVISIONS OF THE PUBLIC HEALTH CODE AND GENERAL STATUTES OF CONNECTICUT, FOR MAKING THE EXAMINATIONS, DETERMINATIONS OR TESTS SPECIFIED BELOW WHICH HAVE BEEN AUTHORIZED IN WRITING BY THAT DEPARTMENT.

ALPHA WOODS HOLE LABS

LOCATED AT Eight WalkUp Drive IN Westborough, MA 01581

AND REGISTERED IN THE NAME OF Mark H. Woelfel

THIS CERTIFICATE IS ISSUED IN THE NAME OF Chris Wakefield- Chemistry Director WHO HAS BEEN DESIGNATED BY THE REGISTERED OWNER\AUTHORIZED AGENT TO BE IN CHARGE OF THE LABORATORY WORK COVERED BY THIS CERTIFICATE OF APPROVAL AS FOLLOWS:

DRINKING WATER, WASTEWATER/NON-POTABLE WATER, SOLID WASTE/SOIL

Examination For:

BACTERIA

INORGANIC CHEMICALS

ORGANIC CHEMICALS

SEE COMPUTER PRINT-OUT FOR SPECIFIC TESTS APPROVED

THIS CERTIFICATE EXPIRES March 31, 2008 AND IS REVOCABLE FOR CAUSE BY THE STATE DEPARTMENT OF PUBLIC HEALTH

DATED AT HARTFORD, CONNECTICUT, THIS 7TH DAY OF July 2007

Registration No.

PH - 0574

SUZANNE BLANCAFLOR, MS
CHIEF, ENVIRONMENTAL HEALTH SECTION

STATE OF CONNECTICUT

DEPARTMENT OF PUBLIC HEALTH
ENVIRONMENTAL HEALTH SECTION

ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM

APPROVED ANALYTES REPORT
FOR ALL MATRICES
Alpha Woods Hole Labs (Westborough)

CT-APP-NUM PH-0574

LOCATION

8 Walkup Drive

Westborough MA 01581-

PHONE (508)-898-9220

REGISTERED OWNER/
AUTHORIZED AGENT Mark H. Woelfel

DIRECTOR Christopher Wakefield

CO DIRECTOR(S)

APPROVED BY _____ DATE 08/28/2007 10:22:50 AM
JEFFREY C. CURRAN

LABORATORY APPROVAL EXPIRATION DATE 03/31/2008

LABORATORY STATUS APPROVED

ANY QUESTIONS CONCERNING THIS DOCUMENT SHOULD BE ADDRESSED TO
THE ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM AT (860) 509-7389

DRINKING WATER (SDWA)

STATUS REPORTED ON 08/28/2007

SOC: REGULATED SYNTHETIC ORGANIC CHEMICAL
WITH MINIMUM MDL REQUIREMENTS

ANALYTE NAME

MICROBIOLOGY/BACTERIA

TOT. COLIFORM - MF mENDO (SM9222B)
TOT COLIFORM - COLILERT (SM9223 P/A)
E. COLI - COLILERT (SM9223 P/A)
HPC - POUR PLATE (SM9215B)
FECAL COLIFORM - MF m-FC (SM9222D)
FECAL COLIFORM- EC Medium(SM9221E)

PHYSICALS

PH
TURBIDITY

MINERALS

ALKALINITY
CHLORINE, FREE RESIDUAL
FLUORIDE
SULFATE

NUTRIENTS

NITRATE
NITRITE

METALS

ALUMINUM
ANTIMONY
ARSENIC
BARIUM
BERYLLIUM
CADMIUM
CALCIUM
CHROMIUM
COPPER
LEAD
MERCURY
NICKEL
SELENIUM
SODIUM
THALLIUM

RESIDUE

TOTAL DISSOLVED SOLIDS

MISCELLANEOUS

CYANIDE (TOTAL)

INORGANIC DISINFECTION BY-PRODUCTS

PERCHLORATE

ORGANIC DISINFECTION BY-PRODUCTS

BROMOCHLOROACETIC ACID
DIBROMOACETIC ACID
DICHLOROACETIC ACID
MONOBROMOACETIC ACID
MONOCHLOROACETIC ACID
TRICHLOROACETIC ACID

VOLATILE ORGANICS

VOLATILE ORGANICS - 524.2 (SOC)
1,2 - DIBROMO-3-CHLOROPROPANE (DBCP) (SOC)
1,4-DIOXANE (Mod 8270)
TOTAL TRIHALOMETHANES 524.2 (SOC)
ETHYLENE DIBROMIDE (EDB) (SOC)

NON-POTABLE WATER/ WASTEWATER

STATUS REPORTED ON 08/28/2007

ANALYTE NAME

MICROBIOLOGY/BACTERIA

TOT. COLIFORM - MF mENDO (SM9222B)
TOT COLIFORM - MTF (SM9221B)
HPC - POUR PLATE (SM9215B)
FECAL COLIFORM - MF m-FC (SM9222D)
FECAL COLIFORM- A-1 Broth (SM9221E)

PHYSICALS

COLOR
PH
CONDUCTIVITY

MINERALS

ACIDITY
ALKALINITY
CHLORIDE
CHLORINE, TOTAL & FREE RESIDUAL
FLUORIDE
HARDNESS, TOTAL
HARDNESS, CALCIUM
SILICA
SULFATE
SULFIDE

NUTRIENTS

AMMONIA
KJELDAHL NITROGEN
NITRATE
NITRITE
O-PHOSPHATE
TOTAL PHOSPHOROUS

METALS

ALUMINUM
ANTIMONY
ARSENIC
BARIUM
BERYLLIUM
BORON
CADMIUM
CALCIUM
CHROMIUM
CHROMIUM - Hexavalent
COBALT
COPPER
IRON
LEAD
MAGNESIUM
MANGANESE
MERCURY
MOLYBDENUM
NICKEL
POTASSIUM
SELENIUM
SILVER
SODIUM
STRONTIUM
THALLIUM
TIN
TITANIUM
VANADIUM
ZINC

RESIDUE

TOTAL RESIDUE (SOLIDS)
TOTAL DISSOLVED SOLIDS
TOTAL SUSPENDED SOLIDS (non-filterable)

DEMANDS

BOD
COD
TOTAL ORGANIC CARBON

MISCELLANEOUS

CYANIDE (TOTAL)
PHENOLICS
FOAMING AGENTS (MBAS)

INORGANIC DISINFECTION BY-PRODUCTS

BROMIDE

PESTICIDES/ PCB's

POLYCHLORINATED BIPHENYLS

ORGANOCHLORINE PESTICIDES (Single Response)

CHLORDANE (TECHNICAL)

TOXAPHENE

SOLVENTS

OIL AND GREASE

EXTRACTABLE PETROLEUM HYDROCARBONS (ETPH)

HERBICIDES

2,4-D

2,4,5-T

2,4,5- TP (SILVEX)

ORGANICS

ACID EXTRACTABLES (PHENOLS)

BENZIDINES

PHTHALATE ESTERS

NITROSAMINES

NITROAROMATICS & ISOPHORONE

POLYNUCLEAR AROMATIC HYDROCARBONS

HALOETHERS

CHLORINATED HYDROCARBONS

VOLATILE ORGANICS

SOLID WASTE/SOIL

STATUS REPORTED ON 08/28/2007

ANALYTE NAME

ENVIRONMENTAL HEALTH & HOUSING

LEAD IN PAINT

PHYSICALS

PH

MINERALS

SULFIDE

METALS

ANTIMONY
ARSENIC
BARIUM
CADMIUM
CHROMIUM
CHROMIUM - Hexavalent
LEAD
MERCURY
NICKEL
SELENIUM
SILVER

MISCELLANEOUS

CYANIDE (TOTAL)
IGNITABILITY
CORROSIVITY
TCLP LEACH (1311)
REACTIVITY

PESTICIDES/ PCB's

POLYCHLORINATED BIPHENYLS
ORGANOCHLORINE PESTICIDES (Single Response)
CHLORDANE (TECHNICAL)
TOXAPHENE

SOLVENTS

EXTRACTABLE PETROLEUM HYDROCARBONS (ETPH)

SOLID WASTE ORGANICS

VOLATILE ORGANICS (SW)
ACID EXTRACTABLES (PHENOLS) (SW)
PHTHALATES (SW)
NITROAROMATICS & CYCLIC KETONES (SW)
PAH's (SW)
HALOETHERS (SW)
CHLORINATED HYDROCARBONS (SW)

END OF SECTION FOR Alpha Woods Hole Labs (Westborough)

REPORT PROFILE

Report Printed on: 08/28/2007 10:22:50 AM
Report Name: APPROVED TESTS_ALT_NEW
Printed by: jeff
Report published from: CERTIFICATION REPORTS screen #3

lab code = ID1132P
test code = *
matrix code = *
matrix selection = ALL OR SOME MATRICES SELECTED
certifications approved or provisional on 08/28/2007

THIS IS THE LAST PAGE OF THE REPORT

State of Rhode Island and Providence Plantations
DEPARTMENT OF HEALTH
Certifies

LAO00065

ALPHA WOODS HOLE LABS
8 WALKUP DRIVE
WESTBOROUGH MA 01581-1019
Laboratory Director: Scott McLean

for the analysis of: **Potable Water Microbiology - Potable Water Organic Chemistry - Potable Water Inorganic Chemistry - Non-potable Water Microbiology - Non-potable Water Organic Chemistry - Non-potable Water Inorganic Chemistry -**

This certificate is issued, pursuant to Rhode Island General Laws 23-16.2 and supersedes all previous Rhode Island certificates issued to this laboratory. Certification is no guarantee of the validity of the laboratory results.

This certificate is valid only when accompanied by the certificate and list of analytes and methods for which certification has been granted based upon the following out of state certification(s):

Certifying Authority	*Certification Number*	*Expiration Date*
MA	*M-MA086*	*06/30/2007*
NY	*NY11148*	*04/01/2007*

ALPHA WOODS HOLE LABS is responsible for maintaining each of the certifications listed above. Failure to notify the Laboratory Certification Officer of any change in the status of these certifications may result in the suspension or revocation of certification. Contact the Laboratory Certification Officer to verify the current certification status of this laboratory.

David R. Gifford, MD, MPH
Director of Health

Expires: 12/30/2007

THIS CERTIFICATE IS TO BE CONSPICUOUSLY DISPLAYED AT THE LABORATORY IN A LOCATION VISABLE TO THE PUBLIC

ATTACHMENT B-2

Laboratory SOPs for Analytical Methods

Inductively Coupled Plasma - Atomic Emission Spectrometry

Reference Method No.: **Method 6010B**

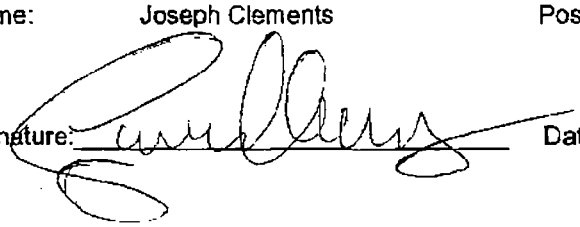
Reference: SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, 1997.

Copy No. _____

Alpha Woods Hole Labs
Uncontrolled Document

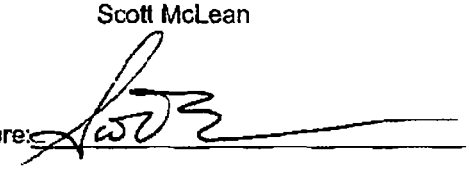
Prepared by:

Name: Joseph Clements Position: Inorganics Supervisor

Signature:  Date: 12/12/06

Authorized by:

Name: Scott McLean Position: Laboratory Director

Signature:  Date: 12/21/06

ISSUE AMENDMENTS

Changes since last issue:

Removed all references to PE Optima 3000DV Instrument.

Section 6.2: Clarified sample pH requirements

Section 8.12: Added Section for RL Standard

Section 9.2: Clarified standards used for calibration. Clarified curve verification.

Section 9.3.1.1: Redefined ICV acceptance criteria to ± 10%.

Section 9.4.1: Clarified curve verification.

Section 9.4.4.1: Edited Dilution test.

Section 10.9: Edited analytical sequence.

Section 12: Added paragraph for ICSA or ICSB corrective actions.

Table 1: Updated wavelengths.

Table 2: Updated precision and accuracy criteria.

Table 3: Updated reporting limits.

Inductively Coupled Plasma - Atomic Emission Spectrometry

Reference Method No.: **Method 6010B**

Reference: SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, 1997.

1. Scope and Application

Matrices: Digestate from all matrices.

Definitions: See Alpha Laboratories Quality Manual Appendix A

Inductively coupled plasma-atomic emission spectrometry (ICP-AES) determines trace elements, including metals, in solution. The method is applicable to all of the elements listed in Table 1. All matrices, excluding filtered groundwater samples but including ground water, aqueous samples, TCLP and EP extracts, industrial and organic wastes, soils, sludges, sediments, and other solid wastes, require digestion prior to analysis. Groundwater samples that have been prefiltered and acidified will not need acid digestion. Samples which are not digested must either use an internal standard or be matrix matched with the standards. Refer to Metals Preparation SOPs for the appropriate digestion procedures.

Table 1 lists the elements for which this method is applicable. Detection limits, sensitivity, and the optimum and linear concentration ranges of the elements can vary with the wavelength, spectrometer, matrix and operating conditions. Table 1 lists the recommended analytical wavelengths for the elements in clean aqueous matrices. Table 3 lists the Reported Detection Limits. The reported detection limit data may be used to estimate instrument and method performance for other sample matrices. Elements other than those listed in Table 1 may be analyzed by this method if performance at the concentration levels of interest (see Section 10) is demonstrated.

Users of the method should state the data quality objectives prior to analysis and must document and have on file the required initial demonstration performance data described in the following sections prior to using the method for analysis.

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is made by one of the following laboratory personnel before performing the modification: Area Supervisor, Metals Manager, Laboratory Services Manager, Laboratory Director, or Quality Assurance Officer.

Use of this method is restricted to spectroscopists who are knowledgeable in the correction of spectral, chemical, and physical interferences described in this method. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability, analyzing a proficiency test sample and completing the record of training.

After initial demonstration, ongoing demonstration is based on acceptable laboratory performance of at least a quarterly laboratory control sample or acceptable performance from an annual proficiency test sample. A major modification to this procedure requires demonstration of performance. The identification of major method modification requiring performance demonstration is directed by the QA Officer and Laboratory Director on a case-by-case basis.

2. Summary of Method

Prior to analysis, samples must be solubilized or digested using appropriate Sample Preparation Methods. When analyzing groundwater samples for dissolved constituents, acid digestion is not necessary if the samples are filtered and acid preserved prior to analysis.

This method describes multielemental determinations by ICP-AES using sequential or simultaneous optical systems and axial or radial viewing of the plasma. The instrument measures characteristic emission spectra by optical spectrometry. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element-specific emission spectra are produced by a radio-frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer, and the intensities of the emission lines are monitored by photosensitive devices. Background correction is required for trace element determination. Background must be measured adjacent to analyte lines on samples during analysis. The position selected for the background-intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. In one mode of analysis the position used must be as free as possible from spectral interference and must reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result. The possibility of additional interferences named in Section 4.0 must also be recognized and appropriate corrections made; tests for their presence are described in Section 9.4.4. Alternatively, users may choose multivariate calibration methods. In this case, point selections for background correction are superfluous since whole spectral regions are processed.

2.1 Method Modifications from Reference

None.

3. Detection Limits

The laboratory follows the procedure found in 40CFR Part 136 to determine the MDL on an annual basis. The method detection limits determined by the laboratory are on file for review.

4. Interferences

4.1 Spectral

Spectral interferences are caused by background emission from continuous or recombination phenomena, stray light from the line emission of high concentration elements, overlap of a spectral line from another element, or unresolved overlap of molecular band spectra.

4.1.1 Background emission and stray light can usually be compensated for by subtracting the background emission determined by measurements adjacent to the analyte wavelength peak. Spectral scans of samples or single element solutions in the analyte regions may indicate when alternate wavelengths are desirable because of severe spectral interference. These scans will also show whether the most appropriate estimate of the background emission is provided by an interpolation from measurements on both sides of the wavelength peak or by measured emission on only one side. The locations selected for the measurement of background intensity will be determined by the complexity of the spectrum adjacent to the wavelength peak. The locations used for routine measurement must be free of off-line spectral interference (interelement or molecular) or adequately corrected to reflect the same change in background intensity

as occurs at the wavelength peak. For multivariate methods using whole spectral regions, background scans must be included in the correction algorithm. Off-line spectral interferences are handled by including spectra on interfering species in the algorithm.

4.1.2 To determine the appropriate location for off-line background correction, the user must scan the area on either side adjacent to the wavelength and record the apparent emission intensity from all other method analytes. This spectral information must be documented and kept on file. The location selected for background correction must be either free of off-line interelement spectral interference or a computer routine must be used for automatic correction on all determinations. If a wavelength other than the recommended wavelength is used, the analyst must determine and document both the overlapping and nearby spectral interference effects from all method analytes and common elements and provide for their automatic correction on all analyses. Tests to determine spectral interference must be done using analyte concentrations that will adequately describe the interference. Normally, 100 mg/L single element solutions are sufficient; however, for analytes such as iron that may be found at high concentration, a more appropriate test would be to use a concentration near the upper analytical range limit.

4.1.3 Spectral overlaps may be avoided by using an alternate wavelength or can be compensated by equations that correct for interelement contributions. Instruments that use equations for interelement correction require the interfering elements be analyzed at the same time as the element of interest. When operative and uncorrected, interferences will produce false positive determinations and be reported as analyte concentrations. More extensive information on interferant effects at various wavelengths and resolutions is available in reference wavelength tables and books. Users may apply interelement correction equations determined on their instruments with tested concentration ranges to compensate (off line or on line) for the effects of interfering elements. For multivariate methods using whole spectral regions, spectral interferences are handled by including spectra of the interfering elements in the algorithm. The interferences listed are only those that occur between method analytes. Only interferences of a direct overlap nature are listed. These overlaps were observed with a single instrument having a working resolution of 0.035 nm.

4.1.4 When using interelement correction equations, the interference may be expressed as analyte concentration equivalents (i.e. false analyte concentrations) arising from 100 mg/L of the interference element. For example, assume that As is to be determined (at 193.696 nm) in a sample containing approximately 10 mg/L of Al. 100 mg/L of Al would yield a false signal for As equivalent to approximately 1.3 mg/L. Therefore, the presence of 10 mg/L of Al would result in a false signal for As equivalent to approximately 0.13 mg/L. The user is cautioned that each instrument may exhibit somewhat different levels of interference. The interference effects must be evaluated for each individual instrument since the intensities will vary.

Major known interferences are Fe, Al, Ca, Mg, V, Ni, Cu, and Cr. To minimize any of these interferences, every analyte is analyzed on each instrument at or near its linear range and corrected for these interferences. This is done on an annual basis, and data is kept on file.

4.1.5 Interelement corrections will vary for the same emission line among instruments because of differences in resolution, as determined by the grating, the entrance and exit slit widths, and by the order of dispersion. Interelement corrections will also vary depending upon the choice of background correction points. Selecting a background correction point where an interfering emission line may appear must be avoided when practical. Interelement corrections that constitute a major portion of an emission signal may not yield accurate data. Users must not forget that some samples may contain uncommon elements that could contribute spectral interferences.

4.1.6 The interference effects must be evaluated for each individual instrument whether configured as a sequential or simultaneous instrument. For each instrument, intensities will vary not only with optical resolution but also with operating conditions (such as power, viewing height and argon flow rate). When using the recommended wavelengths, the analyst is required to determine and document for each wavelength the effect from referenced interferences as well as any other suspected interferences that may be specific to the instrument or matrix. The analyst is encouraged to utilize a computer routine for automatic correction on all analyses.

4.1.7 The primary wavelength for each anaylte is based upon the instrument manufacturer's recommendations. An alternate wavelength is chosen if there is an indication of elevated background or overlap of another spectral wavelength. The wavelength for each analyte must be as free from interferences as possible.

4.1.8 If the correction routine is operating properly, the determined apparent analyte(s) concentration from analysis of each interference solution must fall within a specific concentration range around the calibration blank. The concentration range is calculated by multiplying the concentration of the interfering element by the value of the correction factor being tested and divided by 10. If after the subtraction of the calibration blank the apparent analyte concentration falls outside of this range in either a positive or negative direction, a change in the correction factor of more than 10% should be suspected. The cause of the change must be determined and corrected and the correction factor updated. The interference check solutions must be analyzed more than once to confirm a change has occurred. Adequate rinse time between solutions and before analysis of the calibration blank will assist in the confirmation.

4.1.9 When interelement corrections are applied, their accuracy must be verified, daily, by analyzing spectral interference check solutions. If the correction factor or multivariate correction matrices tested on a daily basis (by running a check solution on each analytical run) are found to be within 20% criteria for 5 consecutive days, analysis may be extended to a weekly basis. Also, if the nature of the samples analyzed is such that they do not contain concentrations of the interfering elements greatee than the reported detection limit, daily verification is not required. All interelement spectral correction factors or multivariate correction matrices are verified and updated on an annual basis or when an instrumentation change, such as in the torch, nebulizer, injector, or plasma conditions occurs. The standard solution must be inspected to ensure that there is no contamination that may be perceived as a spectral interference.

4.1.10 When interelement corrections are <u>not</u> used, verification of absence of interferences is required.

4.1.10.1 One method is to use a computer software routine for comparing the determinative data to limits, files for notifying the analyst when an interfering element is detected in the sample at a concentration that will produce either an apparent false positive concentration, (i.e., greater than) the analyte

instrument detection limit, or false negative analyte concentration, (i.e., less than the lower control limit of the calibration blank defined for a 99% confidence interval).

4.1.10.2 Another method is to analyze an Interference Check Solution(s) which contains similar concentrations of the major components of the samples (>10 mg/L) on a continuing basis to verify the absence of effects at the wavelengths selected. These data must be kept on file with the sample analysis data. If the check solution confirms an operative interference that is >20% of the analyte concentration, the analyte must be determined using (1) analytical and background correction wavelengths (or spectral regions) free of the interference, (2) by an alternative wavelength, or (3) by another documented test procedure.

4.2 Physical

Physical interferences are effects associated with the sample nebulization and transport processes. Changes in viscosity and surface tension can cause significant inaccuracies, especially in samples containing high dissolved solids or high acid concentrations. If physical interferences are present, they must be reduced by diluting the sample, using a peristaltic pump, use of an internal standard or by using a high solids nebulizer. Another problem that can occur with high dissolved solids is salt buildup at the tip of the nebulizer, affecting aerosol flow rate and causing instrumental drift. The problem can be controlled by wetting the argon prior to nebulization, using a tip washer, using a high solids nebulizer or diluting the sample. Also, it has been reported that better control of the argon flow rate, especially to the nebulizer, improves instrument performance: this may be accomplished with the use of mass flow controllers. The test described in Section 9.4.4.1 will help determine if a physical interference is present.

4.3 Chemical

Chemical interferences include molecular compound formation, ionization effects, and solute vaporization effects. Normally, these effects are not significant with the ICP technique, but if observed, can be minimized by careful selection of operating conditions (incident power, observation position, and so forth), by buffering of the sample, by matrix matching, and by standard addition procedures. Chemical interferences are highly dependent on matrix type and the specific analyte element.

4.4 Memory

Memory interferences result when analytes in a previous sample contribute to the signals measured in a new sample. Memory effects can result from sample deposition on the uptake tubing to the nebulizer and from the build up of sample material in the plasma torch and spray chamber. The site where these effects occur is dependent on the element and can be minimized by flushing the system with a rinse blank between samples. The possibility of memory interferences must be recognized within an analytical run and suitable rinse times must be used to reduce them. The rinse times necessary for a particular element must be estimated prior to analysis. This may be achieved by aspirating a standard containing elements at a concentration ten times the usual amount or at the top of the linear dynamic range. The aspiration time for this sample must be the same as a normal sample analysis period, followed by analysis of the rinse blank at designated intervals. The length of time required to reduce analyte signals to within a factor of two of the method detection limit must be noted. Until the required rinse time is established, this method suggests a rinse period of at least 60 seconds between samples and standards. If a memory interference is suspected, the sample must be reanalyzed after a rinse period of sufficient length. Alternate rinse times may be established by the analyst based upon their DQOs.

4.5 Other Interferences

4.5.1 Users are advised that high salt concentrations can cause analyte signal suppressions and confuse interference tests. If the instrument does not display negative values, fortify the interference check solution with the elements of interest at 0.5 to 1 mg/L and measure the added standard concentration accordingly. Concentrations must be within 20% of the true spiked concentration or dilution of the samples will be necessary. In the absence of measurable analyte, overcorrection could go undetected if a negative value is reported as zero.

5. Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound must be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material data handling sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

6. Sample Collection, Preservation, and Handling

6.1 Sample Collection

Samples are collected in plastic bottles.

6.2 Sample Preservation

Samples for Total Metals are preserved with 1:1 Nitric acid to a pH of <2.

If samples are for Soluble Metals, they must not be preserved prior to filtration. They are preserved with 1:1 Nitric acid to a pH of <2 post-filter.

6.3 Sample Handling

Samples to be analyzed for soluble metals, that have not been filtered, must be filtered and preserved within 24 hours of sample collection.

Preserved samples have a hold time of 6 months, and are stored under refrigeration at 4°C.

7. Equipment and Supplies

7.1 Inductively coupled argon plasma emission spectrometer:

- **Thermo Jarrell Ash 61E Trace Analyzer (Vacuum)**
- **Thermo Jarrell Ash 61E Trace Analyzer (Purge)**

7.1.1 Computer-controlled emission spectrometer with background correction.

7.1.2 Radio-frequency generator compliant with FCC regulations.

7.1.3 Optional mass flow controller for argon nebulizer gas supply.

7.1.4 Optional peristaltic pump.

7.1.5 Optional Autosampler.

7.1.6 Argon gas supply - high purity.

7.2 Volumetric flasks of suitable precision and accuracy.

7.3 Volumetric pipets of suitable precision and accuracy.

8. Standards and Reagents

Reagent semiconductor and/or trace grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination. If the purity of a reagent is in question, analyze for contamination. If the concentration of the contamination is less than the MDL then the reagent is acceptable.

8.1 Hydrochloric acid (conc), HCl.

8.2 Hydrochloric acid (1:1), HCl. Add 500 mL concentrated HCl to 400 mL DI water and dilute to 1 liter in an appropriately sized beaker.

8.3 Nitric acid (conc), HNO_3.

8.4 Nitric acid (1:1), HNO_3. Add 500 mL concentrated HNO_3 to 400 mL DI water and dilute to 1 liter in an appropriately sized beaker.

8.5 Reagent Water. All references to water in the method refer to reagent water unless otherwise specified. Reagent water will be interference free. Refer to Chapter One for a definition of reagent water.

8.6 Standard stock solutions may be purchased or prepared from ultra- high purity grade chemicals or metals (99.99% pure or greater). All stock standards are ordered through ISO and American Association for Lab Accreditation vendors. All standards are in aqueous solutions and are at concentrations of 1000ppm and 10,000ppm.

8.7 Mixed calibration standard solutions

Prepare mixed calibration standard solutions by combining appropriate volumes of the stock solutions in volumetric flasks. Add the appropriate types and volumes of acids so that the standards are matrix matched with the sample digestates. Care must be taken when preparing the mixed standards to ensure that the elements are compatible and stable together. Transfer the mixed standard solutions to FEP fluorocarbon or previously unused polyethylene or polypropylene bottles for storage. Fresh mixed standards must be prepared, as needed, with the realization that concentration can change on aging.

NOTE: If the addition of silver to the recommended acid combination results in an initial precipitation, add 15 mL of water and warm the flask until the solution clears. Cool and dilute to 100 mL with water. For this acid combination, the silver concentration must be limited to 2 mg/L. Silver under these conditions is stable in a tap-water matrix for 30 days. Higher concentrations of silver require additional HCl.

8.8 Blanks

Two types of blanks are required for the analysis for samples prepared by any method other than 3040. The calibration blank is used in establishing the analytical curve, and the method blank is used to identify possible contamination resulting from varying amounts of the acids used in the sample processing.

8.8.1 The calibration blank is prepared by acidifying reagent water to the same concentrations of the acids found in the standards and samples. Prepare a sufficient quantity to flush the system between standards and samples. The calibration blank will also be used for all initial (ICB) and continuing calibration blank (CCB) determinations (see Sections 9.2 and 9.3). Refer to Section 9.3.1.2 for acceptance criteria and/or corrective actions.

8.8.2 The method blank must contain all of the reagents in the same volumes as used in the processing of the samples. The method blank must be carried through the complete procedure and contain the same acid concentration in the final solution as the sample solution used for analysis. Refer to Section 10.2 for acceptance criteria and/or corrective actions.

8.9 The Initial Calibration Verification Standard (ICV) and the Continuing Calibration Verification Standard (CCV)

These Standards are prepared by the analyst by combining compatible elements from a standard source different than that of the calibration standard and within the mid-point of the calibration curve.

8.10 Interference Check Solution

These solutions are prepared to contain known concentrations of interfering elements that will provide an adequate test of the correction factors. Spike the sample with the elements of interest. In the absence of measurable analyte, overcorrection could go undetected because a negative value could be reported as zero. If the particular instrument will display overcorrection as a negative number, this spiking procedure will not be necessary.

8.11 CRI

The CRI is an ICP standard that is analyzed at a concentration of 2 - 5 times each element's RDL. The CRI must be recovered within 80-120% of its true value. If the CRI does not meet these criteria, it is remade and reanalyzed. If the CRI fails a second time, the analysis is terminated, the problem determined and corrected. The instrument is then recalibrated.

CRI solutions are made for each type of instrument.

8.11.1 CRI Stock Standard Solution, for the TJA Trace instruments

To a 500mL volumetric flask, add 200mL DI water and 50mL of 1:1 HNO_3. Add the following volumes of each certified 1000ppm stock standard:

Pb	0.9 mL	Ni	1.6 mL
Se	0.2 mL	Ag	0.4 mL
Sb	2.0 mL	Tl	0.4 mL
As	0.4 mL	V	2.0 mL
Ba	0.8 mL	Zn	0.8 mL
Be	0.2 mL	Al	4.0 mL
Cd	0.2 mL	Ca	4.0 mL
Co	2.0 mL	Mg	4.0 mL
Cr	0.4 mL	B	2.0 mL
Cu	1.0 mL	Sr	0.4 mL
Fe	4.0 mL	Ti	0.4 mL
Mn	0.6 mL	Sn	0.4 mL
Mo	2.0 mL		

And the following volumes of each certified 10000ppm stock standard:

K	4.0 mL
Na	4.0 mL
Si	2.0 mL

Bring to volume of 500mL with DI water. This solution expires one month after the date of preparation.

8.11.1.1 CRI Working Standard Solution

To a 1L volumetric flask, add 25mL of CRI Stock Standard Solution (Section 8.11.1). Bring to volume with DI water. This solution will contain elements in the following concentrations:

Pb	0.045 ppm	Ag	0.02 ppm
Se	0.01 ppm	Tl	0.02 ppm
Sb	0.10 ppm	V	0.10 ppm
As	0.02 ppm	Zn	0.04 ppm
Ba	0.04 ppm	Al	0.20 ppm
Be	0.01 ppm	Ca	0.20 ppm
Cd	0.01 ppm	Mg	0.20 ppm
Co	0.10 ppm	B	0.10 ppm
Cr	0.02 ppm	Sr	0.02 ppm
Cu	0.05 ppm	Ti	0.02 ppm
Fe	0.20 ppm	Sn	0.02 ppm
Mn	0.03 ppm	K	2.0 ppm
Mo	0.10 ppm	Na	2.0 ppm
Ni	0.08 ppm	Si	1.0 ppm

8.12 Reporting Limit (RL) Standard

The RL standard consists of a series of standards that are analyzed after the CRI. The following standards are analyzed. This standard does not have to be a second source. Typically the ICV Standard is serially diluted.

0.0025 mg/L Cd,Be

0.005 mg/L As,Ag,Tl

0.010 mg/L Pb,Se,Ba,Co,Cr,Cu,Mn,Mo,Ni,V,Sr,Ti,B

0.050 mg/L Al,Sb,Fe,Zn,Sn,Ca,Mg,Si

If the Al does not pass, then run a 0.1 mg/L standard.

The RL standard for K and Na are included in the CRI Standard.

9. Procedure

9.1 SET-UP

9.1.1 Sample Preparation

Preliminary treatment of most matrices is necessary because of the complexity and variability of sample matrices. Groundwater samples which have been prefiltered and acidified will not need acid digestion. Samples which are not digested must either use an internal standard or be matrix matched with the standards. Solubilization and digestion procedures are presented in Sample Preparation Methods (Chapter Three, Inorganic Analytes).

9.1.2 Instrument Set-Up

Set up the instrument with proper operating parameters established as detailed below. The instrument must be allowed to become thermally stable before beginning (usually requiring at least 30 minutes of operation prior to calibration).

Startup Procedures

For the TJA Trace 61E Vacuum and Purge ICP's

- Turn on the main power switch
- Turn on the power to the chillers
- Push the re-set switch on the front of the spectrometers
- Turn on the computer
- Click on the "Thermo-Spec" software icon
- Click on "Set-Up"
- Choose "Plasma Control Panel"
- Click on F1. This is the automated start-up sequence.
- Escape back to the Main Menu and move the cursor over to "Operations" and type in (ALL02) in the method box. This will automatically set up the instrument with the correct method Parameters.
- Wait 30 minutes for the instrument to come to equilibrium
- Enter F5 then F3 (Profile)
- Profile instrument with 1.0 mg/L As standard. When acceptable profile has been performed, enter profile intensity in instrument logbook, and press F9. This will bring you back to the Main Menu.
- Select " Auto Sampler Set-up"
- Input batch #s and sample ID's
- Select "Analyze"

9.1.2.1 Specific wavelengths are listed in Table 1. Other wavelengths may be substituted if they can provide the needed sensitivity and are corrected for spectral interference. The instrument and operating conditions utilized for determination must be capable of providing data of acceptable quality to the program and data user.

Operating conditions for axial plasma will vary from 1100 – 1500 wats forward power, 15-19 Liters/min argon coolant flow, 0.5 – 0.7 L/min argon nebulizer flow, 140 – 200 rpm pump rate and a 1 minute preflush time and 10 second measurement time is recommended for all simultaneous instruments.

9.1.2.2 The plasma operating conditions need to be optimized prior to use of the instrument. This routine is not required on a daily basis, but only when first setting up a new instrument or following a change in operating conditions. The following procedure is recommended or follow manufacturer's recommendations. The purpose of plasma optimization is to provide a maximum signal to background ratio for some of the least sensitive elements in the analytical array. The use of a mass flow controller to regulate the nebulizer gas flow or source optimization software greatly facilitates the procedure.

9.1.2.2.2 The TJA ICP's use a Meinhard Nebulizer. The nebulizer flow for each instrument is listed below:

- TJA Trace (Vacuum): 0.52 L/min
- TJA Trace (Purge): 0.65 L/min

9.1.2.2.3 Profiles on the TJA Trace ICP's use a 1.0mg/L solution of Arsenic. Peak position on the TJA instruments have a tolerance of 0.1. If the tolerance is not met, the computer program automatically corrects and re-profiles. Profile intensity is recorded in the instrument notebook. Dramatic loss of intensity must be a signal that there is a problem with the instrument. Usually this entails checking and cleaning the nebulizer, and making sure that the nebulizer flows are correct.

9.1.2.2.4 The instrument operating condition finally selected as being optimum must provide the lowest reliable instrument detection limits and method detection limits.

9.1.2.2.5 If either the instrument operating conditions, such as incident power or nebulizer gas flow rate are changed, or a new torch injector tube with a different orifice internal diameter is installed, the plasma and viewing height must be reoptimized.

9.1.2.2.6 After completing the initial optimization of operating conditions, but before analyzing samples, the laboratory must establish and initially verify an interelement spectral interference correction routine to be used during sample analysis. A general description concerning spectral interference and the analytical requirements for background correction in particular are discussed in the section on interferences. Criteria for determining an interelement spectral interference is an apparent positive or negative concentration for the analyte that falls within ± the RDL. The upper control limit is the analyte instrument detection limit. Once established, the entire routine is periodically verified annually. In between that time, IEC's are done on a need be basis per analyte. Only a portion of the correction routine

must be verified more frequently or on a daily basis. Initial and periodic verification of the routine must be kept on file. Special cases where continual verification is required are described elsewhere.

9.1.2.3 Sensitivity, instrumental detection limit, precision, linear dynamic range, and interference effects must be established for each individual analyte line on each particular instrument. All measurements must be within the instrument linear range where the correction equations are valid.

9.1.2.4.1 Method detection limits must be established for all wavelengths utilized for each type of matrix commonly analyzed. The matrix used for the MDL calculation must contain analytes of known concentrations within 3-5 times the anticipated detection limit.

9.1.2.4.2 Determination of limits using reagent water MDLs represent a best case situation and do not represent possible matrix effects of real world samples.

9.1.2.4.3 If additional confirmation is desired, reanalyze the seven replicate aliquots on two more non-consecutive days and again calculate the method detection limit values for each day. An average of the three values for each analyte may provide for a more appropriate estimate.

9.1.2.4.4 The upper limit of the linear dynamic range must be established for each wavelength utilized by determining the signal responses from a minimum for three, preferably five, different concentration standards across the range. One of these must be near the upper limit of the range. The ranges which may be used for the analysis of samples must be judged by the analyst from the resulting data. The data, calculations and rationale for the choice of range made must be documented and kept on file. The upper range limit must be an observed signal no more than 10% below the level extrapolated from lower standards. Determined analyte concentrations that are above the upper range limit must be diluted and reanalyzed. The analyst must also be aware that if an interelement correction from an analyte above the linear range exists, a second analyte where the interelement correction has been applied may be inaccurately reported. New dynamic ranges must be determined whenever there is a significant change in instrument response. The linear dynamic range is checked on an annual basis. For those analytes that are known interferences, and are present at above the linear range, the analyst must ensure that the interelement correction has not been inaccurately applied.

> **NOTE:** Many of the alkali and alkaline earth metals have non-linear response curves due to ionization and self-absorption effects. These curves may be used if the instrument allows; however the effective range must be checked and the second order curve fit must have a correlation coefficient of 0.995 or better. Third order fits are not acceptable. These non-linear response curves must be revalidated and recalculated every six months. These curves are much more sensitive to changes in operating conditions than the linear lines and must be checked whenever there have been moderate equipment changes.

9.1.2.5 The analyst must (1) verify that the instrument configuration and operating conditions satisfy the analytical requirements and (2) maintain quality control data confirming instrument performance and analytical results.

9.2 Initial Calibration

Profile and calibrate the instrument according to the instrument manufacturer's recommended procedures, using the typical mixed calibration standard solutions described in Section 8.7. Flush the system with the calibration blank (Section 8.8.1) between each standard or as the manufacturer recommends. (Use the average intensity of multiple exposures for both standardization and sample analysis to reduce random error.) The calibration curve consists of a calibration blank and a high level standard. Calibration curve verification is accomplished through the analysis of the ICV and CRI standards.

9.3 Calibration Verification

9.3.1 Verify calibration with the Continuing Calibration Verification (CCV) Standard (Section 8.9) immediately following daily calibration, after every ten samples, and at the end of an analytical run. Check calibration with an ICV following the initial calibration (Section 8.9). At the laboratory's discretion, an ICV may be used in lieu of the continuing calibration verifications. If used in this manner, the ICV must be at a concentration near the mid-point of the calibration curve. Use a calibration blank (Section 8.8.1) immediately following daily calibration, after every 10 samples and at the end of the analytical run.

A CRI (Section 8.11) must be analyzed after the ICB. The concentration of the CRI is 2 – 5 times that of each element's RDL. The linearity of the instrument is determined on an annual basis by linear ranges.

9.3.1.1 The results of the ICV are to agree within 10% of the expected value, and CCVs are to agree within 10% of the expected value; if not, terminate the analysis, correct the problem, and recalibrate the instrument.

9.3.1.2 The results of the calibration blank are to agree within three times the IDL. If not, repeat the analysis two more times and average the results. If the average is not within three standard deviations of the background mean, terminate the analysis, correct the problem, recalibrate, and reanalyze the previous 10 samples. If the blank is less than 1/10 the concentration of the action level of interest, and no sample is within ten percent of the action limit, analyses need not be rerun and recalibration need not be performed before continuation of the run.

9.3.1.3 The results of the CRI must be within 20% of the true value. If they are not, correct the problem and recalibrate the instrument. (Any element may be analyzed on a different ICP that has passsed the CRI.)

9.3.2 Verify the interelement and background correction factors at the beginning of each analytical run. Do this by analyzing the interference check sample (Section 8.10). Results must be within 80 – 120% of the true value.

9.3.3 When low-level sensitivity is required, a check standard at the requested limit of quantitation is analyzed to confirm the reported detection limit (RDL). This is performed on a project-by-project basis.

9.4 Equipment Operation and Sample Analysis

9.4.1 For all analytes and determinations, the laboratory must analyze an ICV (Section 8.9), and a calibration blank (ICB, Section 8.8.1), immediately following daily calibration.

A calibration blank (CCB, Section 8.8.1) and a calibration verification standard (CCV, Section 8.9) must be analyzed after every tenth sample and at the end of the sample run. Analysis of the calibration verification (CCV) must verify that the instrument is within 10% of the calibration with the relative standard deviation < 5% from replicate (minimum of two) integrations.

If the calibration cannot be verified within the specified limits, the sample analysis must be discontinued, the cause determined and the instrument recalibrated. All samples following the last acceptable ICB, ICV, CRI, CCV or CCB must be reanalyzed. The analysis data for the calibration blank, check standard, and ICV or CCV must be kept on file with the sample analysis data.

9.4.2 Rinse the system with the calibration blank solution (Section 8.8.1) before the analysis of each sample. The rinse time will be one minute. Each laboratory may establish a reduction in this rinse time through a suitable demonstration.

9.4.3 Dilute and reanalyze samples that exceed the linear calibration range or use an alternate, less sensitive line for which quality control data is already established.

9.4.4 A series of tests is performed prior to reporting concentration data for analyte elements. These tests, as outlined in Sections 9.4.4.1 and 9.4.4.2, will ensure that neither positive nor negative interferences are operating on any of the analyte elements to distort the accuracy of the reported values.

9.4.4.1 Dilution Test: If the analyte concentration is sufficiently high (minimally, a factor of 50 above the detection limit before dilution), an analysis of a 1:5 dilution must agree within ± 10% of the original determination. If not, a chemical or physical interference effect must be suspected.

9.4.4.2 Post Digestion Spike Addition: An analyte spike added to a portion of a prepared sample, or its dilution, must be recovered to within 75% to 125% of the known value. The spike addition must produce a minimum level of 10 times and a maximum of 100 times the instrumental detection limit. If the spike is not recovered within the specified limits, a matrix effect must be suspected.

9.4.5 **CAUTION:** If spectral overlap is suspected, use of computerized compensation, an alternate wavelength, or comparison with an alternate method is recommended.

9.5 Preventative Maintenance

Whenever instrument maintenance is performed, it is noted in the instrument's Maintenance Logbook.

9.5.1 Daily

Change the nebulizer pump tubing from the Autosampler to the Nebulizer.

9.5.2 Monthly or as needed

Remove the torch, nebulizer and spray chamber. Clean each with 10% Nitric Acid and 5% Hydrochloric Acid. Soak the torch and spray chamber for one hour, then rinse well with DI water. Soak the nebulizer in an ultrasonic bath for 30 minutes, then rinse with DI water.

9.5.3 Every 6 months

Preventive Maintenance is performed by the Vendor as follows:

- clean the lenses
- check/replace the power tube
- check the cooling system
- refill the chiller with distilled water
- clean the instrument to regain intensity
- clean/replace air filters on the rear of the instruments.

9.6 Calculations

9.6.1 If dilutions were performed, the appropriate factors must be applied to sample values. All results must be reported with up to three significant figures.

9.6.2 Soil samples

Soil samples are calculated as follows:

$$A = \frac{\text{Sample weight (grams)}}{\text{Final Volume (mL)}}$$

$$B \text{ (concentration in mg/Kg)} = \frac{\text{Concentration of analyte (mg/L)}}{A}$$

9.6.2.1 Dry weight correction

The LIMS calculates the dry weight correction, however it is calculated as follows:

$$\text{Final concentration in mg/Kg dry weight} = \frac{B}{\text{\% Solids}}$$

9.6.3 Liquid samples

Liquid samples are calculated as follows:

$$\text{Dilution Factor} = \frac{\text{Final Volume (mL)}}{\text{Sample Volume (mL)}}$$

Final concentration in mg/L = Concentration of analyte (mg/L) x Dilution Factor

10. Quality Control and Data Assessment

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method. When results of sample spikes indicate atypical method performance, a calibration verification standard is used to confirm the measurements were performed in an in-control mode of operation.

10.1 Demonstration of Capability

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method. Each time a method modification is made, the analyst is required to repeat the procedure.

When one or more of the parameters tested fail at least one of the acceptance criteria, the analyst must locate and correct the source of the problem and repeat the test for failed parameters of the method.

Repeated failure confirms a general problem with the measurement system or analytical technique of the analyst. If the failure repeats, locate and correct the source of the problem and repeat the test for all parameters listed in the method.

Before using this procedure to analyze samples, there must be data available documenting initial demonstration of performance. The required data documents the selection criteria of background correction points; analytical dynamic ranges, the applicable equations, and the upper limits of those ranges; the method and instrument detection limits; and the determination and verification of interelement correction equations or other routines for correcting spectral interferences. This data must be generated using the same instrument, operating conditions and calibration routine to be used for sample analysis. These documented data must be kept on file and be available for review by the data user or auditor.

10.2 Method Blank

Employ a minimum of one method blank per sample batch to determine if contamination or any memory effects are occurring. A method blank is a volume of reagent water carried through the same preparation process as a sample.

The method blank results must be less than the reported detection limit (RDL) for all analytes of concern. If the results of the method blank exceed the RDL for any analyte, perform re-analysis of a new aliquot of the method blank.

If the results continue to exceed the RDL, proceed as follows:

If all of the samples for the analyte are non-detected, and the method blank is at or above the RDL, no action is required.

If one or more associated samples for that analyte have positive results at or above the RDL, those samples must be considered to be out of control, and are re-digested and reanalyzed.

10.3 Laboratory Control Samples (LCS)

Analyze one LCSW/LCSS per sample batch. A LCS/LCSW sample is a spiked volume of reagent water that is brought through the entire preparation and analytical process. The LCSW must have a % Recovery of ± 20% within the actual value or within the documented historical limits for each matrix.

If the LCSW % Recovery is outside the acceptable limits as stated in Table 2, or outside any historical documentation, the failed analytes are re-prepped and re-analyzed. Otherwise, a nonconformance report form is raised to document the exact problem and this form is then authorized by the QA/QC Director and/or the Laboratory Manager(s).

10.4 Interference Check Standards

A check solution is analyzed twice per each calibration curve. One solution has only elevated concentrations of Fe, Al, Ca, Mg to ensure no interferences occur. The other check solution is the same solution spiked with a known amount of each analyte. These solutions are analyzed at the beginning and at the end of each analytical run.

If the Interference Check Solution falls outside the acceptable limits of 80 – 120% of the true value, the failed analytes are re-analyzed. Otherwise, a Nonconformance Report form is raised to document the exact problem and this form is then forwarded to the Department Supervisor and/or the QA Department.

10.5 Reporting Limit (RL) Standard

The RL standard is actually a series of standards that are analyzed after the CRI. The lowest of the RL standards may be used to evaluate the sensitivity of reportable elements under method 6010. This may be a low level client-specific analysis, or it may be the standard reporting limits for an aqueous sample or a soil/solid material. The standards must have a % Recovery of 70-130%. If an element fails the acceptance criteria, the RL standard may be re-analyzed. If the element failure continues, then either re-calibrate the instrument or analyze the sample on another instrument.

10.6 Matrix Spike

Analyze matrix spike samples at a frequency of one per matrix batch. A matrix spike sample is a sample brought through the entire sample preparation and analytical process.

10.6.1 The percent recovery is to be calculated as follows:

$$\% \text{ Recovery} = \frac{MS - S}{C} \times 100$$

where:

MS = Matix Spike value
S = Sample value.
C = Concentration of the Spiking solution.

10.6.2 If the Matrix Spike falls outside of the limits as stated in Table 2, or outside any historical documentation, the failed analytes are either re-prepped and re-analyzed, or a post analytical spike is performed. The acceptable % Recovery of the post analytical spike is 75 – 125%. A nonconformance report form is raised and is attached to the data package. This form is then authorized by the QA/QC Director and/or the Laboratory Manager.

10.7 Duplicates

A duplicate sample is analyzed once per matrix batch. This sample is brought through the entire sample preparation and analytical process.

10.7.1 The relative percent difference between duplicate determinations is to be calculated as follows:

$$RPD = \frac{|D_1 - D_2|}{(|D_1 + D_2|)/2} \times 100$$

where:

RPD = relative percent difference.
D_1 = first sample value.
D_2 = second sample value (replicate).

10.7.2 If the Duplicate falls outside of the limits as stated in Table 2, or outside any historical documentation, the failed analytes are re-prepped and re-analyzed. A nonconformance report form is raised and is attached to the data package. This form is then authorized by the QA/QC Director and/or the Laboratory Manager.

If re-digestion is not available or applicable, a nonconformance report form is raised and is attached to the data package. This form is then authorized by the QA/QC Director and/or the Laboratory Manager.

10.8 Control Limits

The laboratory maintains performance records to document the quality of data that is generated. Method accuracy for samples is assessed and records maintained. After the analysis of 20 spiked samples, and 20 laboratory control samples, calculate the average percent recovery (R) and the standard deviation of the percent recovery (S).

Control limits for the method parameters are generated by the QC staff and distributed to the analysts. The control limits are calculated based on in-house performance data. The limits are compared to the control limits found in the reference method.

10.9 Analytical Sequence

- Calibration of instrument
- Initial Calibration Verification Standard
- Initial Calibration Blank
- Interference Check Solution A
- Interference Check Solution AB
- CRI
- RL Check Standards
- Continuing Calibration Verification Standard
- Continuing Calibration Blank
- 10 samples
- Continuing Calibration Verification Standard
- Continuing Calibration Blank

11. Method Performance

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations were obtained using reagent water. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects.

Method performance data is on file in the laboratory QC department. Comparison of method performance data for the laboratory to the reference method criteria occurs when laboratory in-house acceptance limits are generated. In-house generated data must be within the specifications of the reference method or the analysis is not continued until corrective action is completed.

12. Corrective Actions

Holding time exceedence, improper preservation and observed sample headspace are noted on the nonconformance report form.

Perform routine preventative maintenance on both of the TJA Trace ICP's according to Section 9.5. Record all maintenance in the instrument logbooks. Evaluate the notes in the maintenance logbook to determine whether further maintenance is necessary on the instrument, e.g. dropping or low intensities when profiling. Notify the Department Manager when these types of trends occur.

Review of standards, blanks and LCS for acceptable performance occurs for each batch of samples. If any part of batch quality control does not meet acceptance criteria, the Department Manager is notified. If enough sample remains and holding time has not expired, then the batch is redigested and reanalyzed. If there is not sufficient sample remaining to allow redigestion, then the analysis is repeated and both sets of data are reported, with the nonconformance narrated on the final report.

If either the CVV/CCB, LCS or Method Blank recovery falls outside the designated acceptance range, the laboratory performance for that parameter is judged to be out of control, and the problem must be immediately identified and corrected. The analytical result in the unspiked samples is suspect and is only reported for regulatory compliance purposes with the appropriate nonconformance action form.

If the ICSA or ICSAB is outside of the 80 – 120% recovery window, then the standard is reanalyzed. If the standard failure continues, the the IECs for the element/elements in question are reviewed and recalculated if necessary.

Immediate corrective action for a failing CCV/CCB includes reanalyzing the failing standard. If the standard passes the second time then the analysis may be continued. The raw data is noted. If the standard fails again, the problem must be found and corrected. The CCV/CCB standard is remade and reanalyzed. If the standard passes, then the data that had failed up to the previous passing standard is reanalyzed. The raw data is noted and all data associated with the failing standard must have one line drawn through the data, indicating its unusability.

If the standard fails after instrument maintenance, the instrument is recalibrated. A new ICV/ICB is performed, and all previous data that had failed up to the previous passing CCV/CCB is reanalyzed.

The procedure outline above is also conducted for a failing LCS or Method Blank.

If the Matrix Spike does not meet acceptance criteria, an analytical spike is performed. The recovery must be within 80-120% of the true value for aqueous samples and within 75-125% of the true value for soil samples. If this criteria is met, then the Matrix Spike data is reported, with the post spike narrated on the final report. If the post spike fails the acceptance criteria, the Department Manager is notified to determine what type of matrix interferent is present, and whether a serial dilution must be perfomed.

If sample Duplicates are outside of the acceptance criteria, the analyst examines the sample for homogeneity. If the sample is not homogenous, this is narrated on the final report. Clean, homogenous samples are redistilled and reanalyzed within holding time.

Sample nonconformance regarding a Matrix Spike recovery or a duplicate %RSD is narrated on the final report along with the corrective action(s) taken.

If the ICSA or the ICSAB are outside of the 80-120% window then the standard in question must be re-analyzed. If the standard failure continues, then check the IECs for the element(s) in question and re-calculate and recalibrate the instrument. The ICSA and the ICSAB are then re-analyzed. If the standard failure repeats, then a fresh standard is prepared and re-analyzed. If failure continues notify the Department Supervisor.

The RL standards must have a % Recovery of 70-130%. If an element fails the acceptance criteria, the RL standard may be re-analyzed if the element must be included in the analytical event. If the element failure continues, then either re-calibrate the instrument or analyze the sample on another instrument.

If the CRI (low level check standard), is recovered oustide of the 80-120% window, the standard may be re-analyzed if the element must be included in the analytical event. If the element failure continues, then either re-calibrate the instrument or analyze the sample on another instrument.

13. Pollution Prevention

See Chemical Hygiene Plan for pollution prevention operations.

14. Waste Management

See Chemical Hygiene Plan for waste handling and disposal.

15. Attachments

TABLE 1: Element Wavelengths

TABLE 2: Precision and Accuracy Acceptance Criteria

TABLE 3: Reporting Limits

TABLE 1
ELEMENT WAVELENGTHS

Element	Trace 3 wavelength (nm)	Trace 2 wavelength (nm)
Pb	220.3	220.3
Se	196.0	196.0
Sb	206.8	206.8
As	189.0	189.0
Ba	493.4	493.4
Be	313.0	313.0
Cd	226.5	226.5
Co	228.6	228.6
Cu	324.7	324.7
Cr	267.7	267.7
Fe	271.4	271.4
Mn	257.6	257.6
Mo	202.0	202.0
Ni	231.6	231.6
Ag	328.0	328.0
Tl	190.8	190.8
V	292.4	292.4
Zn	213.8	206.2
Al	308.2	308.2
Ca	317.9	317.9
Mg	279.0	279.0
B	249.6	--
Si	288.1	--
Sn	189.9	--
Sr	421.5	--
Ti	337.2	--
Bi	223.0	--
Na	330.2	330.2
K	766.4	766.4

TABLE 2
PRECISION AND ACCURACY ACCEPTANCE CRITERIA

	Aqueous % Recovery LCS		Aqueous % Recovery MS		TCLP and Soil % Recovery LCS / MS		Duplicate	
Element	Lower Control Limit	Upper Control Limit	Lower Control Limit	Upper Control Limit	Lower Control Limit	Upper Control Limit	Aqueous %RPD	Soil %RPD
Aluminum	80	120	75	125	75	125	20	35
Antimony	80	120	75	125	75	125	20	35
Arsenic	80	120	75	125	75	125	20	35
Barium	80	120	75	125	75	125	20	35
Berylium	80	120	75	125	75	125	20	35
Boron	80	120	75	125	75	125	20	35
Cadmium	80	120	75	125	75	125	20	35
Calcium	80	120	75	125	75	125	20	35
Chromium	80	120	75	125	75	125	20	35
Cobalt	80	120	75	125	75	125	20	35
Copper	80	120	75	125	75	125	20	35
Iron	80	120	75	125	75	125	20	35
Lead	80	120	75	125	75	125	20	35
Lithium	80	120	75	125	75	125	20	35
Magnesium	80	120	75	125	75	125	20	35
Manganese	80	120	75	125	75	125	20	35
Molybdenum	80	120	75	125	75	125	20	35
Nickel	80	120	75	125	75	125	20	35
Phosphorus	80	120	75	125	75	125	20	35
Potassium	80	120	75	125	75	125	20	35
Selenium	80	120	75	125	75	125	20	35
Silica (SiO_2)	80	120	75	125	75	125	20	35
Silver	80	120	75	125	75	125	20	35
Sodium	80	120	75	125	75	125	20	35
Strontium	80	120	75	125	75	125	20	35
Thallium	80	120	75	125	75	125	20	35
Tin	80	120	75	125	75	125	20	35
Titanium	80	120	75	125	75	125	20	35
Vanadium	80	120	75	125	75	125	20	35
Zinc	80	120	75	125	75	125	20	35

TABLE 3
REPORTING LIMITS

Element	Aqueous (mg/L)	Soil (mg/Kg)
ALUMINUM	0.10	4.0
ANTIMONY	0.05	2.0
ARSENIC	0.005	0.40
BARIUM	0.01	0.40
BERYLLIUM	0.005	0.20
BORON	0.03	1.2
CADMIUM	0.005	0.40
CALCIUM	0.10	4.0
CHROMIUM	0.01	0.40
COBALT	0.02	0.80
COPPER	0.01	0.40
IRON	0.05	2.0
LEAD	0.01	2.0
MAGNESIUM	0.10	4.0
MANGANESE	0.01	0.40
MOLYBDENUM	0.05	2.0
NICKEL	0.025	1.0
POTASSIUM	2.5	100
SELENIUM	0.01	0.80
SILICON	0.50	20
SILVER	0.007	0.40
SODIUM	2.0	80
STRONTIUM	0.01	2.0
THALLIUM	0.02	0.80
TIN	0.05	4.0
TITANIUM	0.01	0.40
VANADIUM	0.01	0.40
ZINC	0.05	2.0

Project Specific SOP Addendum

SOP No.: SOP/06-01 **Method 6010B**, Issue 8, December 21, 2006-

Reference Document: MA DEP BWSC WSC-CAM-III A, Revision 5, May 28, 2004.

Client: Various

Project Name: All Massachusetts Contingency Plan Projects

Project No.: Various

The following modifications need to be made to the referenced SOP for all samples applicable to this project:

Section 9.3.1: Verify calibration with the Continuing Calibration Verification (CCV) Standard (Section 8.9) immediately following daily calibration, after every ten samples, and at the end of an analytical run. Check calibration with an ICV following the initial calibration (Section 8.9). At the laboratory's discretion, an ICV may be used in lieu of the continuing calibration verifications. If used in this manner, the ICV must be at a concentration near the mid-point of the calibration curve. Analyze an ICB after the ICV, and analyze a CCB after the CCV and at the end of the analytical run. Results must be less than the RL.

A CRI (Section 8.11) must be analyzed after the ICB. The concentration of the CRI is 2 – 5 times that of each element's RDL. The linearity of the instrument is determined on an annual basis by linear ranges.

Section 9.3.1.2: The results of the ICB must be less than the RL for that analyte. If the results are greater than the RL for that analyte, terminate the analysis, correct the problem, and recalibrate the instrument.

Section 9.3.3: When low-level sensitivity is required, a low-level check standard is analyzed to confirm the reported detection limit (RDL). % Recovery for this standard must be within 70 – 130% of the true value. If % Recovery is outside of acceptance criteria, a narrative is included for the final report.

Section 10.3: **Laboratory Control Sample (LCS) / Laboratory Control Sample Duplicate (LCSD)**

Analyze one LCS/LCSD pair per sample batch. The LCS/LCSD samples are a spiked volume of reagent water that is brought through the entire preparation and analytical process. The LCS samples must have a % Recovery of ± 20% (aqueous) and a % Recovery of ± 25% (soil) of the actual value.

If the LCS or LCSD % Recovery is outside the acceptable limits, the failed analytes are re-prepped and re-analyzed. A narrative is included on the final report.

In addition to meeting the % Recovery requirements for the LCS, the LCSD must have a calculated RPD (relative percent difference) of $\leq$ 20% (aqueous) and $\leq$ 30% (soil) from the LCS.

If the LCSD acceptance criteria is not met, the RPD is recalculated. If the LCSD still fails, the source of the non-conformance must be found and corrected before other sample batches are processed. A narrative is included on the final report.

Section 10.6.2: The Matrix Spike must be recovered within 75 – 125% of the true value for all matrices. If the MS recovery is ≥30%, and the LCS recovery is valid, no corrective action is taken. If the MS recovery is < 30%, a analytical post spike (APS) is performed. The acceptable % Recovery of the APS is 75 – 125%. If the APS fails this criterion, both the sample and MS are redigested and reanalyzed. A nonconformance report form is raised and is attached to the data package. This form is then authorized by the QA/QC Director and/or the Laboratory Manager.

Section 10.7: Duplicates

A duplicate sample is analyzed once per matrix batch of 20 samples or less. This sample is brought through the entire sample preparation and analytical process.

Section 10.7.2: For Aqueous samples, the %RPD must be ≤ 20% if the sample results are greater than 5 times the RL for the analyte. If the results are less than 5 times the RL for the analyte, the difference between the sample results and its duplicate results must be ≤ the RL for the analyte.

For soil samples, the %RPD must be ≤ 35% if the sample results are greater than 5 times the RL for the analyte. If the results are less than 5 times the RL for the analyte, the difference between the sample results and its duplicate results must be ≤ 2 times the RL for the analyte.

If the % RPD is outside the control limits, and the LCS recovery is acceptable for the analyte, a narrative is raised and is attached to the data package. This form is then authorized by the QA/QC Director and/or the Laboratory Manager.

If the %RPD is ouside the control limits and the LCS recovery is not acceptable for the analyte, the failed analyte is re-prepped and re-analyzed. A narrative is raised and is attached to the data package. This form is then authorized by the QA/QC Director and/or the Laboratory Manager.

If re-digestion is not available or applicable, a narrative is raised and is attached to the data package. This form is then authorized by the QA/QC Director and/or the Laboratory Manager.

Section 10.8: Linear Dynamic Range Determination

The linear dynamic range analysis of the instrument is performed on an annual basis. The LDR is determined utilizing 3 – 5 concentrations across the high end of the calibration curve for each analyte. When a standard falls below 90% recovery, that is the point where the LDR is defined.

Section 10.9: Control Limits

The laboratory maintains performance records to document the quality of data that is generated. Method accuracy for samples is assessed and records maintained. After the analysis of 20 spiked samples, and 20 laboratory control samples, calculate the average percent recovery (R) and the standard deviation of the percent recovery (S).

Section 10.10: Analytical Sequence

- Calibration of instrument
- Initial Calibration Verification Standard
- Initial Calibration Blank
- CRI
- Blank (to check for carry-over)
- Interference Check Solution A
- Interference Check Solution AB
- Continuing Calibration Verification Standard
- Continuing Calibration Blank
- 10 samples
- Continuing Calibration Verification Standard
- Continuing Calibration Blank

TABLE 2
PRECISION AND ACCURACY ACCEPTANCE CRITERIA

	Aqueous % Recovery LCS		Aqueous % Recovery MS		Soil % Recovery LCS / MS		Duplicate	
Element	Lower Control Limit	Upper Control Limit	Lower Control Limit	Upper Control Limit	Lower Control Limit	Upper Control Limit	Aqueous %RPD	Soil %RPD
Aluminum	80	120	75	125	75	125	20	35
Antimony	80	120	75	125	75	125	20	35
Arsenic	80	120	75	125	75	125	20	35
Barium	80	120	75	125	75	125	20	35
Berylium	80	120	75	125	75	125	20	35
Boron	80	120	75	125	75	125	20	35
Cadmium	80	120	75	125	75	125	20	35
Calcium	80	120	75	125	75	125	20	35
Chromium	80	120	75	125	75	125	20	35
Cobalt	80	120	75	125	75	125	20	35
Copper	80	120	75	125	75	125	20	35
Iron	80	120	75	125	75	125	20	35
Lead	80	120	75	125	75	125	20	35
Lithium	80	120	75	125	75	125	20	35
Magnesium	80	120	75	125	75	125	20	35
Manganese	80	120	75	125	75	125	20	35
Molybdenum	80	120	75	125	75	125	20	35
Nickel	80	120	75	125	75	125	20	35
Phosphorus	80	120	75	125	75	125	20	35
Potassium	80	120	75	125	75	125	20	35
Selenium	80	120	75	125	75	125	20	35
Silica (SiO_2)	80	120	75	125	75	125	20	35
Silver	80	120	75	125	75	125	20	35
Sodium	80	120	75	125	75	125	20	35
Strontium	80	120	75	125	75	125	20	35
Thallium	80	120	75	125	75	125	20	35
Tin	80	120	75	125	75	125	20	35
Titanium	80	120	75	125	75	125	20	35
Vanadium	80	120	75	125	75	125	20	35
Zinc	80	120	75	125	75	125	20	35

TABLE 3
REPORTING LIMITS

Element	Aqueous (mg/L)	Soil (mg/Kg)
ALUMINUM	0.10	4.0
ANTIMONY	0.05	2.0
ARSENIC	0.005	0.40
BARIUM	0.01	0.40
BERYLLIUM	0.005	0.20
BORON	0.03	1.2
CADMIUM	0.004	0.40
CALCIUM	0.10	4.0
CHROMIUM	0.01	0.40
COBALT	0.02	0.80
COPPER	0.01	0.40
IRON	0.05	2.0
LEAD	0.01	2.0
MAGNESIUM	0.10	4.0
MANGANESE	0.01	0.40
MOLYBDENUM	0.05	2.0
NICKEL	0.025	1.0
POTASSIUM	2.5	100
SELENIUM	0.005	0.80
SILICON	0.50	20
SILVER	0.007	0.40
SODIUM	2.0	80
STRONTIUM	0.01	2.0
THALLIUM	0.02	0.40
TIN	0.05	4.0
TITANIUM	0.01	0.40
VANADIUM	0.01	0.40
ZINC	0.05	2.0

Approved: Arin Jones **(Signature)** **Date:** 4/3/07

ARIN JONES **(Printed Name)**

Hot Block Digestion
for Aqueous Samples

Reference Methods: **EPA 200.7**, Code of Federal Regulations 40, Part 136, Appendix C, July 1, 1999 edition; **EPA 200.8**, Environmental Monitoring Systems Laboratory Office of Research and Development U.S. EPA Cincinnati, OH Rev 5.4; **EPA 200.9**, Code of Federal Regulations 40, Part 136, Appendix C, July 1, 1999 edition; **Method 3005A**, SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update I, 1992.

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Prepared by:

Name: Elena Dayn Position: Inorganics Department Manager

Signature: E. Day Date: 12/16/08

Authorized by:

Name: Christopher Wakefield Position: Laboratory/Technical Director

Signature: _____ Date: 12/15/08

ISSUE AMENDMENTS

Changes since last issue:

Section 9.3.2: Added rinsing of condensate on the watch glass cover back into the digestate. Added that samples are allowed to cool to room temperature after removal from Hot Block.

Hot Block Digestion
for Aqueous Samples

Reference Methods: **EPA 200.7,** Code of Federal Regulations 40, Part 136, Appendix C, July 1, 1999 edition; **EPA 200.8,** Environmental Monitoring Systems Laboratory Office of Research and Development U.S. EPA Cincinnati, OH Rev 5.4; **EPA 200.9,** Code of Federal Regulations 40, Part 136, Appendix C, July 1, 1999 edition; **Method 3005A,** SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update I, 1992.

1. Scope and Application

Matrices: This method is appropriate for the digestion of all influents, effluents, surface waters, monitoring wells, liquids, drinking waters, furnace metals and soluble metals.

Definitions: See Alpha Laboratories Quality Manual Appendix A.

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one of the following laboratory personnel before performing the modification: Area Supervisor, Metals Manager, Laboratory Services Manager, Laboratory Director, or Quality Assurance Officer.

This method is restricted to use by or under the supervision of trained analysts. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability, analyzing a proficiency test sample and completing the record of training.

After initial demonstration, ongoing demonstration is based on acceptable laboratory performance of at least a quarterly laboratory control sample or acceptable performance from an annual proficiency test sample. A major modification to this procedure requires demonstration of performance. The identification of major method modification requiring performance demonstration is directed by the QA Officer and Laboratory Director on a case-by-case basis.

2. Summary of Method

Aqueous samples and appropriate QC samples are poured into 50mL digestion cups. Acid is added to the cup and the samples are reduced to 25mL at 96.5 °C for approximately 5 hours. The samples are then brought up to a final volume of 50mL, and are ready for analysis by ICP or ICP-MS.

2.1 Method Modifications from Reference

None.

3. Detection Limits

The laboratory follows the procedure found in 40CFR Part 136 to determine the MDL on an annual basis. The method detection limits determined by the laboratory are on file for review.

4. Interferences

Potential interferences that may be encountered during analysis are discussed in the individual analytical methods.

5. Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material data handling sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents. This includes wearing personal protective equipment such as a labcoat, safety glasses, gloves and respirator (as necessary).

6. Sample Collection, Preservation, and Handling

6.1 Sample Collection

Samples are collected in plastic bottles.

6.2 Sample Preservation

If samples are for soluble metals analysis, filtration must take place prior to preservation with 1:1 HNO_3 to a pH < 2.

Samples for total metals analysis are preserved with 1:1 HNO_3 to a pH < 2.

6.3 Sample Handling

Samples are stored under refrigeration at 4 ± 2 °C. Samples for soluble metals analysis should be filtered and preserved within 24 hours of collection.

7. Equipment and Supplies

7.1 Hot Block Apparatus: Set to 96.5 °C, with sample cup rack

7.2 Digestion cups: 50mL volume, polypropylene

7.3 Watch Glass: Ribbed, polypropylene to cover the digestion cups during digestion

7.4 Threaded Caps: To cover digestate following digestion

7.5 Volumetric Glassware: Various sizes of volumetric flasks and pipets, as needed

7.6 Filter Mate Push Plunger Filter

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8. Standards and Reagents

8.1 Analytical Standards: All standards shall be prepared according to the appropriate method of analysis.

8.2 1:1 Hydrochloric Acid

8.3 Concentrated Nitric Acid ($cHNO_3$)

8.3.1 Trace-grade $cHNO_3$: For all samples to be analyzed by EPA Method 200.8, Trace-grade cHNO3 is utilized for the digestion.

8.4 Concentrated Hydrochloric Acid (cHCl)

8.4.1 Trace-grade cHCl: For all samples to be analyzed by EPA Method 200.8, Trace-grade cHHCl is utilized for the digestion.

8.5 2:1 mixture of trace HNO3:HCl: Combine Trace-grade $cHNO_3$ and Trace-grade cHCl in a ratio of 2:1 to be utilized for digestion of all samples to be analyzed by EPA Method 200.8.

8.6 Deionized Water (DI)

8.7 Standard Spiking Solutions

8.7.1 IPS: Containing Sb, Ba, Be, Cd, Cr, Cu, Ni, Ag, Zn, Fe, Mn, Al, Co, V.

8.7.2 FPS: Containing As, Pb, Se, Tl.

8.7.3 MIX: Containing B, Ca, Mg, Mo, K, Na, Ti.

8.7.4 1000ppm Standards of individual metals

9. Procedure

9.1 Set-Up

9.1.1 Inspect all samples and determine QC duplicate (dp) and spike (ms). This decision is normally based upon client sample content history and analytes requested. The ideal sample for QC is one that has both ample volume and the most requested analytes of all the samples in the batch.

9.1.2 Samples of an overly cloudy nature or those with pH and preservation issues should be avoided. Do not prep samples requesting Na and K with samples requesting B, Si, Ca, Ti, Sn, unless the analyst approves the digestion.

9.1.3 One spike and one duplicate must be performed per batch of 20 samples or less.

9.1.4 Each batch must have a Prep Blank Water (PBW) and a Laboratory Control Sample Water (LCSW).

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9.2 Sample Preparation for Digestion

9.2.1 Obtain on 50mL polypropylene digestion cup for each sample and QC sample to be digested. Label the cups with the sample number across the top 1/3 of the cup and at the bottom write "TOT" for total metals, "SOL" for soluble metals, and/or "DW" for a drinking water. Additionally, if the sample is being re-prepped, note this with a "II" on the cup.

9.2.2 Using the Hot Block lab notebook, begin writing up the batch as follows:

9.2.2.1 The heading includes the date, prep chemist's initials, the digestion being performed, and the time of prep.

9.2.2.2 Evenly spaced columns are created with the following headings, left to right: Sample Number, Amount (mLs), 2:1 HNO_3:HCl, V_f (final volume), Color, Clarity.

9.2.3 Place all samples on the lab bench in a chosen order from left to right. Place the appropriately labeled cup in front of each sample, and another cup for the QC samples (dp and ms).

9.2.4 Shake and pour 50mL of each sample into the appropriate cup. 50mL of DI water is used for the Blank (PBW) and LCSW.

9.2.5 Note the Color and Clarity of each sample in the appropriate columns in the laboratory notebook. Clarity is used to describe any sediment the sample may contain.

9.2.6 Hardness

If samples require Hardness analysis then perform the following:

9.2.6.1 Determine if there is any sediment in the sample. If there is none, then simply decant the sample into the cup without shaking.

9.2.6.2 If the sample does contain sediment and the only requested analyte is Hardness, then let the sample settle and decant only the top layer, avoiding the sedimentary layer.

9.2.6.3 If other analytes are requested on the sample, first decant 50mL off the top layer into a tube marked with the sample number and "Ha" below. Then shake the sample and pour it into a second tube labeled with the sample number. The first tube will be used for the Hardness analysis, and the second tube will be used for the analysis of the other analytes requested.

9.2.7 Any sample dilutions must be performed based upon initial knowledge of sample concentration or if the sample is either soapy or foamy. Dilutions up to 10x are prepared directly in the digestion cup, utilizing the graduated markings as a guide. Otherwise, for dilutions >10x, volumetric glassware is used.

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9.2.8 Spike the samples based upon the analytes requested and the final volume desired. All Hot Block samples are brought up to a 50mL final volume. The metals analysis commonly uses 0.5mL each of any or all of the 3 stock spiking solutions (Section 8.5).

50µL of the individual 1000ppm metal standard is used, if the requested metal is not included in the other spike mixes.

9.2.9 Once spiked, the sample cups can be placed in a clear hot block rack and then 2.5mL of $cHNO_3$ is added to each sample cup.

NOTE: If EPA Method 200.8 is requested, and Sb and Ag are required, then 2.5mL of a 2:1 mixture of trace HNO_3 and HCl (Section 8.5) must be used instead of $cHNO_3$.

9.2.9.1 Drinking Water Samples

Only 2mL of $cHNO_3$ is added to each sample cup.

9.3 Sample Digestion

9.3.1 The sample cups are placed on the hot block set to a temperature of 96.5 °C. Each cup is covered with a ribbed polypropylene watch glass and remains on the hot block until it reduces 50% or 5 hours, whichever occurs first. Record in the laboratory notebook the time sample digestion began and the time the samples are taken off the Hot Block unit.

9.3.1.1 Drinking Water Samples

After the samples have reduced by about 20 – 25mL, add another 2mL of $cHNO_3$.

After the samples have reduced another 12mL, add 5mL of 1:1 HCl. Keep samples on the hot block for an additional 20 minutes.

NOTE: Omit the addition of 1:1 HCl for all drinking water samples to be analyzed by EPA Method 200.8.

9.3.2 Upon completion of the digestion, the samples are removed from the hot block and allowed to cool to room temperature. For each tube, the ribbed watch glass cover must be rinsed with a small amount of DI water to incorporate any condensate back into the digestate. Samples are then brought up to a final volume of 50mL using DI water.

All digestates that are sediment-free are capped and are ready for instrumental analysis. If any samples contain sediment, they are filtered using a filter mate push plunger filter. The filter is clipped onto the plunger and then pushed into the tube gently, but with enough force to move it downward throught the tube. The sample is then capped and is ready for instrumental analysis.

9.4 Preventative Maintenance

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The Hot Block temperature is calibrated on an annual basis by an instrument service company. Certificates are kept on file.

10. Quality Control and Data Assessment

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

10.1 Demonstration of Capability

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method. Each time a method modification is made, the analyst is required to repeat the procedure.

When one or more of the parameters tested fail at least one of the acceptance criteria, the analyst must locate and correct the source of the problem and repeat the test for failed parameters of the method.

Repeated failure confirms a general problem with the measurement system or analytical technique of the analyst. If the failure repeats, locate and correct the source of the problem and repeat the test for all parameters listed in the method.

10.2 Blank

A minimum of one blank must be analyzed for every batch or 20 samples, whichever comes first.

10.3 Matrix Spike

A matrix spike is performed for each sample matrix. A minimum of one matrix spike must be analyzed for each batch.

10.4 Duplicates

Each batch of 20 or less samples will include a duplicate sample.

10.5 Digestion Sequence

- Determine which samples will be used for batch QC.
- Pour 50mL sample into a digestion cup
- Add spike solution to samples, as appropriate
- Place digestion cups into a hot block rack
- Add 2.5mL cHNO3 (2mL for DW samples). However, if Sb and Ag are to be analyzed, use 2.5mL 2:1 mixture of trace HNO_3 and HCl (for Method 200.8 samples)
- Heat on hot block until reduced by half, or 5 hours
    - If DW sample: After reduced by half, add another 2.0mL cHNO3. After reduced another ¼, add 5mL of 1:1 HCl. Heat on Hot Block for additional 20 mins.
        - Do not add 1:1 HCl to DW samples to be analyzed by EPA Method 200.8.

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- Bring samples to 50mL volume with DI water. Filter any digestates containing sediment.

11. Method Performance

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations were obtained using reagent water. Similar results were achieved using representative wastewaters. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects.

Method performance data is on file in the laboratory QC department. Comparison of method performance data for the laboratory to the reference method criteria occurs when laboratory in-house acceptance limits are generated. In-house generated data must be within the specifications of the reference method or the analysis is not continued until corrective action is completed.

12. Corrective Actions

Holding time exceedence and improper preservation are noted on the nonconformance report form.

Perform routine preventative maintenance following manufacturer's specification. Record all maintenance in the instrument logbook.

Review of standards, blanks and standard response for acceptable performance occurs for each batch of samples. Record any trends or unusual performance on a nonconformance action form.

If the CV or LCS recovery of any parameter falls outside the designated acceptance range, the laboratory performance for that parameter is judged to be out of control, and the problem must be immediately identified and corrected. The analytical result for that parameter in the unspiked samples is suspect and is only reported for regulatory compliance purposes with the appropriate nonconformance action form. Immediate corrective action includes reanalyzing all affected samples by using any retained sample before the expiration of the holding time.

13. Pollution Prevention

See Chemical Hygiene Plan for pollution prevention operations.

14. Waste Management

See Chemical Hygiene Plan for waste handling and disposal.

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Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)

References.: **Method 8260 B**, SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, December 1996.

Method 5035, Closed System Purge &Trap and Extraction for Volatile Organics in Soil and Waste Samples. SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, December, 1996.

Method 5030B, Purge & Trap for Aqueous Samples. SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, December, 1996.

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ISSUE AMENDMENTS

Changes since last issue:

Removed references to Tekmar 2016 throughout.

Section 6.1.1: Clarified sample pH.

Section 6.1.2.1: Added reference to calculation of soil moisture content.

Section 8.4.5, Section 9.4.1.5, Section 10.6.1, Table 2, Table 4: Removed Extraction Surrogate information.

Section 9.2.1.1: Clarified curve generation on Archon.

Section 9.2.1.2: Clarified curve generation on Solatek.

Section 9.6: Added Section to reference LIMS methanol correction and % solids determination.

Table 1: Changed Acrylonitrile RL. Changed Hexachlorobutadiene liquid RL.

Table 5: Added Table of 8260 Volatile Internal Standards with Corresponding Target Compounds and Surrogates Assigned for Quantitation.

Table 6: Added Table of quantitation ions.

Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)

References.: **Method 8260 B**, SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, December 1996.

Method 5035, Closed System Purge &Trap and Extraction for Volatile Organics in Soil and Waste Samples. SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, December, 1996.

Method 5030B, Purge & Trap for Aqueous Samples. SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, December, 1996.

1. Scope and Application

Matrices:

Method 8260 is used to determine volatile organic compounds in a variety of solid waste matrices. This method is applicable to nearly all types of samples, regardless of water content, including various air sampling trapping media, ground and surface water, aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments. The following compounds can be determined by this method:

8260B LIST OF ANALYTES		
dichlorodifluoromethane	carbon tetrachloride	isopropylbenzene
chloromethane	1,2-dichloroethane	1,4-dichloro-2-butane
vinyl chloride	benzene	1,1,2,2-tetrachloroethane
chloroethane	trichloroethene	trans-1,4-dichloro-2-butene
bromomethane	1,2-dichloropropane	1,2,3-trichloropropane
trichlorofluoromethane	bromodichloromethane	n-propylbenzene
ethyl ether	dibromomethane	bromobenzene
acrolein	4-methyl-2-pentanone	2-chlorotoluene
acetone	cis-1,3-dichloropropene	1,3,5-trimethylbenzene
1,1-dichloroethene	toluene	4-chlorotoluene
iodomethane	trans-1,3-dichloropropene	tert-butylbenzene
carbon disulfide	ethyl-methacrylate	1,2,4-trimethylbenzene
methylene chloride	1,1,2-trichloroethane	sec-butylbenzene
acrylonitrile	2-hexanone	p-isopropyltoluene
methyl-tert-butyl ether	1,3-dichloropropane	1,3-dichlorobenzene
trans-1,2-dichloroethene	tetrachloroethene	1,4-dichlorobenzene
1,1-dichloroethane	chlorodibromomethane	n-butylbenzene
vinyl acetate	1,2-dibromoethane	1,2-dichlorobenzene
2-butanone	chlorobenzene	1,2-dibromo-3-chloropropane
2,2-dichloropropane	1,1,1,2-tetrachloroethane	1,2,4-trichlorobenzene
cis-1,2-dichloroethene	ethyl benzene	hexachlorobutadiene
chloroform	p/m xylene	naphthalene
bromochloromethane	o xylene	1,2,3-trichlorobenzene
tetrahydrofuran	styrene	
1,1,1-trichloroethane	bromoform	
1,1-dichloropropene		

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There are various techniques by which these components may be introduced into the GC/MS system. Purge-and-trap, by Methods 5030 (aqueous samples) and 5035 (solid and waste oil samples), is the most commonly used technique for volatile organic analytes. However, other techniques are also appropriate and necessary for some analytes. One technique is direct injection of an aqueous sample (concentration permitting).

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one of the following laboratory personnel before performing the modification: Area Supervisor, Laboratory Services Manager, Laboratory Director, or Quality Assurance Officer. A major modification to this procedure requires demonstration of performance.

This method is restricted to use by or under the supervision of analysts experienced in the operation of the gas chromatograph/mass spectrometers and in the interpretation of mass spectra and their use as a quantitative tool. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability, analyzing a proficiency test sample and completing the record of training.

After initial demonstration, ongoing demonstration is based on acceptable laboratory performance of at least a quarterly laboratory control sample or acceptable performance from an annual proficiency test sample.

2. Summary of Method

The volatile compounds are introduced into the gas chromatograph by the purge-and-trap method or by direct injection. The analytes are introduced to a narrow-bore capillary column for analysis. The column is temperature-programmed to separate the analytes, which are then detected with a mass spectrometer (MS) interfaced to the gas chromatograph (GC).

Analytes eluted from the capillary column are introduced into the mass spectrometer via a direct connection. Identification of target analytes is accomplished by comparing their mass spectra with the electron impact (or electron impact-like) spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard, comparing sample response to the calibration standards.

2.1 Method Modifications from Reference

None.

3. Detection Limits

The laboratory follows the procedure found in 40CFR Part 136 to determine the MDL on an annual basis. The method detection limits determined by the laboratory are on file for review. Table 1 lists our typical reporting limits. Whenever MDL studies are performed, the MDL results are compared with our reporting limits to ensure that our calculated MDLs are equal to or below the reporting limits.

4. Interferences

4.1 Impurities in the purge gas, organic compounds out-gassing from the plumbing ahead of the trap, and solvent vapors in the laboratory account for the majority of contamination problems. The analytical system must be free from contamination under the conditions of the analysis. Running laboratory reagent blanks as described in Section 9.4 and 10.2 demonstrates the system is free of contamination. The use of non-Teflon plastic tubing, non-Teflon thread sealants, or flow controllers with rubber components in the purge and trap system must be avoided.

4.2 Sample contamination occurs by diffusion of volatile organics (particularly fluorocarbons and methylene chloride) through the septum seal into the sample during shipment and storage. A trip blank or a field reagent blank prepared from reagent water and carried through the sampling and handling protocol serves as a check on such contamination.

4.3 Contamination by carry-over can occur whenever high level and low level samples are sequentially analyzed. To reduce carry-over, the sample syringe must be rinsed with reagent water between sample analyses. Each autosampler position is also monitored for positive hits and subsequent sample analyses are checked for potential carry-over. If carry-over is suspected, the sample is rerun for confirmation. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross contamination. For samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds or high purgeable levels, it may be necessary to wash the purging device with a detergent solution, rinse it with reagent water, and then dry it in a 105°C oven between analyses. The trap and other parts of the system are subject to contamination; therefore, frequent bakeout and purging of the entire system may be required.

5. Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material data handling sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

The following method analytes have been tentatively classified as known or suspected human or mammalian carcinogens: benzene, carbon tetrachloride, 1,4-dichlorobenzene, 1,2-dichloroethane, hexachlorobutadiene, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, chloroform, 1,2-dibromoethane, tetrachloroethene, trichloroethene, and vinyl chloride. Pure standard materials and stock standard solutions of these compounds should be handled in a hood. A NIOSH/MESA approved toxic gas respirator should be worn when the analyst handles high concentrations of these toxic compounds.

5.1 Lab coats, safety glasses, and gloves must be worn when handling samples, standards, or solvents.

5.2 All standard preparation must be performed in the volatiles hood.

5.3 All expired standards must be placed into the waste bucket in the lab, for future disposal by the Health and Safety Officer. The container must be labeled properly with hazard warning labels indicating the container contents.

5.4 Bottles containing flammable solvents must be stored in the flammables cabinet.

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6. Sample Collection, Preservation, Shipping, and Handling

6.1 Sample Collection and Preservation

6.1.1 Aqueous Samples

Grab samples are collected in standard 40mL amber glass screw-cap vials with Teflon lined silicon septa (VOA vial). Two VOA vials are filled per sample location. EPA Method 8260 requires that samples be acidified to eliminate the possibility of biological degradation. Unless otherwise directed for project-specific reasons, all VOA vials are delivered to the client with approximately 2 – 4 drops of 1:1 HCl added to the vial, which is sufficient to adjust the pH of the sample to < 2. Prepared trip blanks are provided to the client to accompany field samples for QC purposes.

Fill the sample vial just to overflowing. Samples must be introduced into the vials gently to reduce agitation, which might drive off volatile compounds or cause loss of the HCl preservative.

Seal the bottle so that no air bubbles are in the VOA vial. If preservative has been added, shake vigorously for one minute. Invert the bottle and tap to check for air bubbles. Recollect the samples if any air bubbles are present.

Maintain the hermetic seal on the VOA vial until time of analysis.

Ice or refrigerate all samples from the time of collection until analysis, maintaining the sample temperature between 1 and 4 °C. Sample receiving personnel note on the sample delivery group form when samples received at the laboratory are not within the temperature criteria.

6.1.2 Soil Samples

The recommended sampling method for soil samples is EPA 5035. Method 5035 provides for two distinct sampling procedures, depending on the required reporting limits and suspected or known concentration levels of target analytes. These methods are referred to as the High Level and Low Level methods. Both are listed below, but depending on the samples only one of the methods may be required. If concentration levels are unknown, it is recommended that samples be collected using both procedures. The Lab will analyze the high level sample first, followed by the low level sample if the results from the high level analysis show that the sample is clean or contains analytes at low levels. The typical reporting levels of the two methods are listed in Table 1.

6.1.2.1 High Level Soil Samples

Collect sample in a standard 40mL amber glass screw-cap vial with Teflon lined silicon septa (VOA vial). The vial is provided containing 15mL of Purge and Trap Grade methanol, and is labeled and weighed prior to addition of sample. Record the weight of the vial with methanol on the vial label. Prepared trip blanks are provided to the client to accompany field samples for QC purposes.

Approximately 15g of soil is added to the vial in the field, making sure that the sample is completely covered by the methanol.

Maintain the hermetic seal on the VOA vial until the time of analysis.

Ice or refrigerate all samples from the time of collection until analysis, maintaining the sample temperature between 1 and 4 °C. Sample receiving personnel note on the nonconformance report form when samples received at the laboratory are not within the temperature criteria.

An additional sample of the soil must also be obtained (without methanol) to be used for the determination of soil moisture content to allow for the calculation of the dry weight results, and to calculate the methanol dilution effect. (See Section 9.6)

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6.1.2.2 Low Level Soil Samples

Collect sample in a standard 40mL amber glass screw-cap vials with Teflon lined silicon septa (VOA vial). Two samples should be taken per sample location. Vials are provided containing a magnetic stirring bar and 5 mL of either 200g/L sodium bisulfate solution or water, prepared by a certified vendor. These vials are labeled and weighed prior to addition of sample. Record the weight of the vial with the stirring bar and preservative on the vial label.

Approximately 5g of soil is added to the vial in the field, making sure that the sample is completely covered by the sodium bisulfate solution or water.

Maintain the hermetic seal on the VOA until the time of analysis.

Ice or refrigerate samples preserved with sodium bisulfate from the time of collection until analysis, maintaining the sample temperature between 1 and 4°C. Samples preserved with water are to be immediately frozen after sampling. Sample receiving personnel note on the nonconformance report form when samples received at the laboratory are not within the temperature criteria.

6.2 Sample Shipping

Samples requiring shipment to the laboratory are shipped in ice-packed coolers via an overnight delivery service in accordance with applicable Department of Transportation regulations.

6.3 Sample Handling

Upon receipt of samples at the laboratory, sample receiving personnel label the vials with the Alpha sample number, and store the samples in the volatiles refrigerator. If more than one vial is received for a sample the vials are stored in separate refrigerators. Storing the vials apart provides a useful check if laboratory contamination of a sample is suspected. Samples must be analyzed within 14 days of collection. Unpreserved samples requiring aromatic analysis must be analyzed within 7 days of collection.

Document client specific sample handling, preservation and collection criteria in the project file. The laboratory Log-in staff documents sample temperature at the time of receipt.

Record deviations from this SOP or client specific criteria on the chain of custody form.

Record holding time exceedence, improper preservation and observed sample headspace on the nonconformance report form.

7. Equipment and Supplies

7.1 Purge and Trap System (For Aqueous samples and High Level Soils): The purge-and-trap system consists of two separate pieces of equipment: a purging device coupled to the desorber (Tekmar 2000/3000).

7.1.1 Purge gas = Helium, analytical grade (99.999%).

7.1.2 The purging device is configured with 25 mL sample purge tubes, and the helium purge gas is introduced at the bottom of the water column as finely divided bubbles

7.1.3 The trap used in the desorber is typically a Supelco "K" trap. Different traps may be used if equivalent performance is demonstrated.

7.1.4 The desorber is capable of rapidly heating the trap to 260°C. The trap is not heated above manufacturer's specifications

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7.2. Purge and Trap System (For Low Level Soil Samples): The purge and trap system consists of two separate pieces of equipment: a purging device coupled to the desorber (Varian Archon or Tekmar Solatek, with Tekmar 2000/3000, or equivalents).

7.2.1. Purge gas = Helium, analytical grade (99.999%).

7.2.2. The Archon or Tekmar Solatek purging device is a closed system, designed to accept the 40mL VOA vials. The VOA vial, containing the soil sample, sodium bisulfate, and stirring bar is placed into the Archon tray. The instrument automatically adds reagent water, internal standards, and surrogates to the unopened VOA vial. The vial is heated to 40 °C, and the helium purge gas is introduced into the aqueous portion to purge the volatile components onto the trap.

7.2.3. The trap used in the desorber is typically a Supelco "K" trap. Different traps may be used if equivalent performance is demonstrated.

7.2.4. The desorber is capable of rapidly heating the trap to 260 °C. The trap is not heated above manufacturer specifications.

7.3 Gas Chromatography/Mass Spectrometer/Data System:

7.3.1 Gas Chromatograph, Hewlett Packard 5890/6890 or equivalent: An analytical system complete with a temperature-programmable gas chromatograph with appropriate interface for sample introduction device. The system includes all required accessories, including syringes, analytical columns, and gases. The capillary column is directly coupled to the source of the GC/MS system.

7.3.2 Gas Chromatographic Columns:

7.3.2.1 Column 1: Restek 502.2, 40 meter, 0.18mm ID, or equivalent.

7.3.2.2 Column 2: Restek 502.2, 60 meter, 0.25mm ID, or equivalent.

7.3.3 Mass Spectrometer, Hewlett Packard 5973 or equivalent: Scanning from 35 to 300 amu every 2 seconds or less, using 70 volts (nominal) electron energy in the electron impact ionization mode. The mass spectrometer must be capable of producing a mass spectrum for 4-Bromofluorobenzene (BFB) which meets all of the criteria in Table 3, when 50ng of the GC/MS tuning standard (BFB) are injected through the GC.

7.3.4 Data System: Hewlett-Packard EnviroQuant software is used for data acquisition, and allows the continuous acquisition and storage on machine-readable media of all mass spectra obtained throughout the duration of the chromatographic program.

Thruput Target 4.12 software is used for data processing, and allows searching of any GC/MS data file for ions of a specified mass, and plotting such ion abundances versus time or scan-number.

The most recent version of the EPA/NIST Mass Spectral Library is loaded onto the Target data system.

7.4 Wiretrol or Microsyringes: 10µL - 1,000µL.

7.5 Syringes: 5mL, 10mL, or 25mL, glass with Luerlock tip.

7.6 Balances: Top-loading, capable of weighing 0.1g.

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7.7 Vials: 2mL, 4mL.

7.8 Disposable Pipets.

7.9 Volumetric Flasks: Class A, appropriate sizes, with ground-glass stoppers.

8. Standards and Reagents

Reagent grade inorganic chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all inorganic reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

Great care must be taken to maintain the integrity of all standard solutions. Standards in methanol are stored at –10°C or less, in amber vials with PTFE-lined screw-caps.

8.1 Organic-free Reagent Water:

All references to water in this method refer to organic-free reagent water, which is tap water passed through activated carbon.

8.2 Methanol:

Purge and Trap Grade or equivalent, demonstrated to be free of volatile analytes. Store in flammables cabinet.

8.3 Stock Solutions:

All stock standard solutions are purchased from commercial vendors as ampulated certified solutions. When an ampulated stock solution is opened, it is transferred to a labeled amber screw-cap vial with minimal headspace. The expiration date of the stock solution is either the vendor specified expiration date or 6 months from the date the ampule was opened, whichever is sooner. Typical stock standard concentrations are listed in Table 4.

8.4 Intermediate Standards: Intermediate standards are prepared volumetrically by diluting the appropriate stock standard(s) with methanol. Initial Calibration solutions expire 1 month from the date of preparation. If the Intermediate Standards are used as a second source to verify a valid Initial Calibration solution, there is no expiration date.

8.4.1 Internal Standard Solutions:

The internal standards are fluorobenzene, chlorobenzene-d_5, and 1,4-dichlorobenzene-d_4. The intermediate I.S. solution is prepared by diluting the stock solution(s) with methanol to a concentration of 100 µg/mL. The appropriate amount of I.S. solution is added to the water or soil sample or QC sample to achieve a final concentration of 100 ng/sample or standard. Internal standard is added at the same concentration to all standards, samples, and QC samples.

8.4.2 Surrogate Standard Solutions:

The surrogate standards are dibromofluoromethane, 1,2-dichloroethane-d_4, Toluene-d_8, and 4-bromofluorobenzene. The intermediate surrogate solutions is prepared by diluting the stock solution(s) with methanol to a concentration of 100 µg/mL. The appropriate amount of surrogate solution is added to the water or soil sample or QC sample to achieve a final concentration of 100 ng/sample.

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8.4.3 Target Compound Solutions:

The target analytes routinely reported by this method are listed in Table 4. The intermediate target compound solutions are prepared by diluting the stock solution(s) with methanol. This set of solutions, at concentrations of 200 µg/mL, is used for preparation of the calibration standards at the concentrations listed in Table 4.

8.4.4 4-Bromofluorobenzene (BFB) Tune solution:

A solution containing BFB at a concentration of 25 µg/mL is prepared by volumetrically diluting the BFB stock solution. 2 µL of this solution is direct-injected or purged into the GC/MS system to verify system performance prior to any standard or sample analysis.

8.5 Calibration Standards:

There are two types of calibration standards used for this method – initial calibration standards and calibration verification standards.

8.5.1 Initial Calibration Standards:

Initial calibration standards are prepared at the levels listed in Table 4. Prepare these solutions in organic-fee reagent water. The standards correspond to the range of concentrations found in typical samples and do not exceed the working range of the GC/MS system. Initial calibration should be mixed from fresh stock standards and dilution standards when generating an initial calibration curve.

8.5.2 Continuing Calibration Verification Standards:

The continuing calibration verification standard, or calibration check standard, is at the same concentrations as the level 3 initial calibration standard. This standard is run daily, following the BFB tune standard, to verify system performance. This standard is made from a second source than the Initial Calibration Standards.

9. Procedure

9.1 Instrument Set-up Conditions: Typical instrument operating conditions are listed below. Alternate conditions are allowed, as long as method performance criteria can be met.

9.1.1 GC Conditions:

Temperature 1:	35°C
Hold Time 1:	4 minutes
Ramp 1:	6°C/minute
Temperature 2:	150°C
Hold Time 2:	0 minutes
Ramp 2:	8°C/minute
Temperature 3:	220°C
Final Time:	1 minute

Carrier gas:	Helium, 99.999%
Carrier mode:	Constant flow
Carrier flow:	1 mL/minute

9.1.2 MS Conditions:

Mass scan range:	35 – 260 amu
Scan time:	0.5 minutes/scan
Source temperature:	230°C

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9.1.3 Purge and Trap Conditions:

Purge time:	11 minutes
Dry purge:	4 minutes
Desorb preheat:	245°C
Desorb temp:	250°C
Desorb time:	4 minutes
Bake temp:	260°C
Bake time:	15 minutes

9.2 Initial Calibration

9.2.1 The initial calibration is performed at the 7 concentration levels listed in Table 4. The calibration is performed using instrument conditions listed in Section 9.1. BFB must be analyzed prior to analysis of the initial calibration standards, and must pass the criteria listed in Table 3.

9.2.1.1 Low Level/High Level Soil Curve on Archon: To prepare a calibration standard, add the appropriate volume of standard solution(s) to a 100mL volumetric flask using a microsyringe. Remove the needle quickly and mix by inverting the flask 3 times. Pour several mLs of the aqueous standard into the waste vessel, then gently fill a 5mL syringe with standard and transfer to a 40mL VOA vial containing a magnetic stir bar. Load the vial onto Archon Autosampler.

9.2.1.2 Aqueous/High Level Soil Curve on Solatek: To prepare a calibration standard, add the appropriate volume of standard solution(s) to a 100mL volumetric flask using a microsyringe. Remove the needle quickly and mix by inverting the flask 3 times. Pour several mLs of the aqueous standard into the waste vessel, then gently fill a 40mL VOA vial to the top. Load the vial onto the Solatek Autosampler.

9.2.2 Establish the GC operating conditions by loading the appropriate GC method. Typical instrument conditions are listed in Section 9.1. The same operating conditions are used for calibration and sample analyses. Create the analytical sequence using the HP Enviroquant data acquisition software.

Relative Response Factors: The internal standard calibration technique is used. In each calibration standard, calculate the relative response factor for each analyte and the relative standard deviation (RSD) of the response factors using the Target data processing software. The response factors are calculated using the areas of the characteristic (quantitation) ion for each target analyte and internal standard. The calculations are performed automatically using the Target software, using the formulae listed in Alpha's Quality Manual.

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9.2.3 Initial Calibration Criteria: The following sections outline the method acceptance criteria for an initial calibration curve. All criteria must be met for the calibration to be deemed acceptable, and for sample analysis to proceed.

9.2.3.1 System performance check compounds (SPCCs):

Five compounds (the System Performance Check Compounds, or SPCCs) must meet minimum response factor criteria. These compounds are: chloromethane, 1,1-dichloroethane, bromoform, chlorobenzene, and 1,1,2,2-tetrachloroethane. These compounds are monitored to demonstrate system performance. Possible causes of low response for these analytes are listed below.

Chloromethane response may be low if the purge flow is too fast.

Bromoform response may be low if the purge flow is too slow. Cold spots and/or active sites in the transfer lines may adversely affect response as well.

1,1,2,2-Tetrachloroethane and 1,1-dichloroethane response may be low in there are contaminated transfer lines in the purge-and-trap system, or the trap may need to be replaced.

The minimum mean response factors for the volatile SPCCs are as follows:

Chloromethane	0.10
1,1-Dichloroethane	0.10
Bromoform	0.10
Chlorobenzene	0.30
1,1,2,2-Tetrachloroethane	0.30

9.2.3.2 Relative Standard Deviation Criteria: If the RSD for each target analyte is less than or equal to 15%, then the response for this compound is considered linear over the calibration range and the mean calibration factor can be used to quantitate sample results. If the 15% RSD criterion is not met for an analyte, linear regression may be used if $r^2 \geq 0.995$. The calibration may be repeated for any compounds that fail, or a calibration curve must be generated for this compound and used for sample quantitation.

Six of the target analytes are designated as Calibration Check Compounds (CCCs). For these compounds, listed below, the %RSD must be below 30%. If this criterion is not met for all 6 compounds, the calibration curve is invalid and cannot be used. If the %RSD is less than of equal to 15%, the mean RF is used for sample quantitation. It the %RSD is between 15 and 30%, linear regression may be used for sample quantitation. The CCCs are:

1,1-Dichloroethene	Toluene
Chloroform	Ethylbenzene
1,2-Dichloropropane	Vinyl chloride

If an RSD of greater than 30% is measured for any CCC, then corrective action to eliminate a system leak and/or column reactive sites is necessary before reattempting calibration.

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9.2.4 Evaluation of Retention Times: The relative retention times used for identification of target analytes are +/- 0.06 RRT (Relative Retention Time) units, based on the most recent standard run. It has been determined that these limits work well, being wide enough to eliminate false-negative results while being tight enough to eliminate false positive results. Due to the selectivity of the mass spectrometer, compound identification is more definitive than when using a less selective detector.

9.3 Continuing Calibration Verification

Calibration verification consists of three steps that are performed at the beginning of each 12-hour analytical shift.

9.3.1 Prior to the analysis of samples or calibration standards, inject or purge 2 µL (50 ng) of the 4-bromofluorobenzene standard (Section 8.4.4) into the GC/MS system. The resultant mass spectra for the BFB must meet the criteria given in Table 3 before sample analysis begins.

9.3.2 The initial calibration curve for each compound of interest must be verified once every 12 hours prior to sample analysis. This is accomplished by analyzing the continuing calibration check standard (Section 8.5.2). The results from the calibration standard analysis must meet the verification acceptance criteria provided in Sections 9.3.4 through 9.3.7.

9.3.3 A method blank must be analyzed prior to any samples, typically immediately following the continuing calibration check standard, to ensure that the analytical system is free of contaminants. The method blank must not contain any target analytes at or above the required compound reporting limits.

9.3.4 System Performance Check Compounds (SPCCs):

9.3.4.1 The relative response factors for the 5 SPCC compounds must meet the minimum response factor criteria listed in Section 9.2.3.1.

9.3.4.2 If the minimum response factors are not met, the system must be evaluated, and corrective action must be taken before sample analysis begins. Possible problems include standard mixture degradation, injection port inlet contamination, contamination at the front end of the analytical column, and active sites in the column or chromatographic system.

9.3.5 Calibration Check Compounds (CCCs):

9.3.5.1 The percent difference or drift for each CCC listed in Section 9.2.3.2 must be less than or equal to 20%. If the criterion is not met for any one CCC, (i.e., greater than 20% difference or drift), then corrective action must be taken prior to the analysis of samples. All other analytes should also meet the 25%D criteria. An allowance is made to fail 10% of the compounds with > 25% D. If any samples have a hit of an analyte with >25% D, these results should be considered and estimate or rerun to verify.

9.3.5.2 Analytical system problems similar to those that affect the SPCC response can also cause problems with the CCCs. If the problem cannot be corrected by performing system maintenance, a new seven-point initial calibration must be generated.

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9.3.6 Internal Standard Retention Time:

The retention times of the internal standards in the calibration verification standard are evaluated after data acquisition. If the retention time for any internal standard changes by more than 30 seconds from that in the mid-point standard level of the most recent initial calibration sequence, then the chromatographic system must be inspected for malfunctions and corrections must be made, as required. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is required.

9.3.7 Internal Standard Response:

If the EICP area for any of the internal standards in the calibration verification standard changes by a factor of two (-50% to +100%) from that in the mid-point standard level of the most recent initial calibration sequence, the mass spectrometer must be inspected for malfunctions and corrections must be made, as appropriate. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is required.

9.4 Sample Analysis and Data Processing

The same GC, MS, and Purge and Trap conditions used for the initial calibration must be employed for sample analysis. After verification of system performance by analysis of BFB, the continuing calibration standard, and method blank, samples are analyzed and processed as described below.

9.4.1 Analysis of Samples

Retrieve sample VOA vials from the sample bank refrigerator just prior to loading onto the purge and trap system. High level soil samples must be shaken for 1 – 2 minutes to extract the volatile components into the methanol. Let sample settle prior to taking methanol aliquot. Low level soil sample should be shaken briefly to ensure that the stir bar is loose, and will spin on the Archon unit.

9.4.1.1 Low level soil samples: (Archon)
Take the low level VOA vial and place directly into the rack of the Archon sampling unit. Surrogate and internal standards are added automatically by the Archon prior to sample purging.

9.4.1.2 Aqueous samples: (Solatek)
Load the VOA vial directly on the sampling rack. Dilutions may be prepared volumetrically and poured into VOA vials ensuring there is no headspace left in the vial. The Solatek will then sample 10mL from the VOA vial.

9.4.1.3 High level soil samples: (Archon/Solatek)

Shake for 2 minutes, ensuring the methanol has completely penetrated the soil in the vial.

9.4.1.3.1 Through liquid path
Load 430µL of the methanol into a half-full VOA vial. Fill the VOA vial up to the top with water and cap with no headspace. Allow the autosampler to sample 10mL out of the VOA vial which would be equivalent to injecting 100µL of the methanol extract. Prepare dilutions accordingly.

9.4.1.3.2 Through soil path
Into a VOA vial with a stir bar added, load 4.9mL of water plus 100 µL of methanol extract from a 5mL luerlock syringe. Cap the vial and load onto the autosampler.

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9.4.2 Qualitative Analysis:

9.4.2.1 The qualitative identification of each compound is based on retention time and on comparison of the sample mass spectrum with the reference mass spectrum. The reference mass spectrum must be generated by the laboratory on the same GC/MS system. The characteristic ions from the reference mass spectrum are defined to be the three ions of greatest relative intensity, or any ions over 30% relative intensity if less than three such ions occur in the reference spectrum. Compounds are identified as present when the following criteria are met:

9.4.2.1.1 The intensities of the characteristic ions of a compound maximize in the same scan or within one scan of each other. The Target data system is configured to make this check.

9.4.2.1.2 The relative retention time (RRT) of the sample component is within ±0.06 RRT units of the RRT of the standard component.

9.4.2.1.3 The relative intensities of the characteristic ions agree within 30% of the relative intensities of these ions in the reference spectrum. (Example: For an ion with an abundance of 50% in the reference spectrum, the corresponding abundance in a sample spectrum can range between 20% and 80%.)

9.4.2.1.4 Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is less than 25% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs (i.e., m and p-xylene).

9.4.2.1.5 Identification is hampered when sample components are not resolved chromatographically and produce mass spectra containing ions contributed by more than one analyte. When gas chromatographic peaks obviously represent more than one sample component (i.e., a broadened peak with shoulder(s) or a valley between two or more maxima), appropriate selection of analyte spectra and background spectra is important.

9.4.2.1.6 Examination of extracted ion current profiles of appropriate ions can aid in the selection of spectra, and in qualitative identification of compounds. When analytes coelute (i.e., only one chromatographic peak is apparent), the identification criteria may be met, but each analyte spectrum will contain extraneous ions contributed by the coeluting compound.

9.4.2.2 For samples containing non-target analytes, a library search will be performed at client request. Compound identification will be classified as "tentative", and the concentration will be reported as an estimate as no quantitative standards are run for these compounds.

1) Relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) should be present in the sample spectrum.

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2) The relative intensities of the major ions should agree within ±20%. (Example: For an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance must be between 30 and 70%.)

3) Molecular ions present in the reference spectrum should be present in the sample spectrum.

4) Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of coeluting compounds.

5) Ions present in the reference spectrum but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or coeluting peaks.

9.4.3 Quantitative Analysis:

9.4.3.1 Quantitation of a target compound detected in a sample is performed automatically by the Target data processing software, using the formulae found in Alpha's Quality Manual. Either the average response factor or calibration curve will be used for sample quantitation, depending on how the particular analyte was processed in the initial calibration curve.

9.4.3.2 If non-target compounds are to be reported, the quantitation is performed automatically by the Target software using the total area of the compound and the nearest internal standard, and assuming a relative response factor of 1.0.

9.5 Maintenance

Routine preventive maintenance should be performed on the analytical system. This includes replacement of GC septa and periodic rinsing or replacement of purge and trap tubes and sparge needles. The trap should be replaced every six months, or sooner if performance criteria cannot be met. Periodic cleaning (typically twice per year) of the mass spectrometer ion source is required. More frequent source cleaning may be needed, especially if dirty samples are analyzed. In addition, semi-annual preventive maintenance is provided by the instrument manufacturer as part of our service agreement.

If system performance deteriorates, additional maintenance may be required. This includes replacement of injector ports and seals, clipping several inches off of the front end of the GC column, or in extreme cases the replacement of the GC column. Flushing or replacement of purge and trap lines may be necessary if they become contaminated or develop active sites.

9.6 Data Reporting

LIMS Data Corrections

Please note that the Laboratory Information Management System (LIMS) automatically adjusts soil sample results to account for the % Total Solids of the sample (as determined per Alpha SOP/07-38) and the methanol preservation dilution effect.

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10. Quality Control and Data Assessment

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

10.1 Demonstration of Capability

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method. Each time a method modification is made, the analyst is required to repeat the procedure.

Prepare a Level 3 QC check standard according to the specifications in Section 8.5.

Analyze four 5mL aliquots of the well-mixed QC check standard.

Calculate the result for each aliquot in µg/L, the relative standard deviation of the four results in µg/L, the average result for the four aliquots in µg/L, and the percent recovery for each parameter of interest using the four results.

For each parameter, compare the average percent recovery of the four results. All parameters of interest must meet the acceptance criteria before actual sample analysis begins. If any individual parameter exceeds the precision limit or any individual falls outside the range for accuracy, the system performance is unacceptable for that parameter. Recovery must be 70 – 130% of the true value.

10.2 Method Blank

Analyze a reagent water blank each day prior to sample analysis to demonstrate that interferences from the analytical system are under control. The reagent blank must contain the internal standards and surrogates.

Analyze the reagent water blank from the same lot of water used for preparing the standards, QC samples and making sample dilutions. The method blank must not contain any target analytes at or above the compound reporting limits.

10.3 Laboratory Control Sample (LCS)

A laboratory control sample is analyzed at the beginning of each analytical sequence. Since the LCS contains the same compounds at the same concentrations as the continuing calibration check standard, the same analysis is used to satisfy both QC elements. The LCS must meet the QC criteria listed in Table 2.

10.4 Matrix Spike/Matrix Spike Duplicates (MS/MSD)

A matrix spike/matrix spike duplicate pair is analyzed with each batch of 20 or less samples. The MS/MSD are sample aliquots spiked with the target compounds at the same concentration as the continuing calibration standard. The MS/MSD must meet the QC criteria listed in Table 2. If the MS/MSD does not meet the criteria, but the LCD does, the failure may be attributed to sample matrix. Report the MS/MSD, including a narrative sheet for inclusion with the client report.

NOTE: A matrix spike/matrix spike duplicate pair is only analyzed upon client request for Low Level Soil samples. A sample duplicate is analyzed instead.

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10.5 Internal Standards

Area counts of the internal standard peaks in all samples and QC samples must be between 50-200% of the areas of the internal standards in the QC check standard.

If any individual percent recovery falls outside the range, that parameter has failed the acceptance criteria. For calibration standards, CV or blanks the internal standard must be within the range for data to be reported to the clients. For samples, matrix spikes and duplicates: if the data is not within the range, the sample is rerun to confirm that the failure is due to sample matrix. A nonconformance report form is completed to ensure client notification and reporting if matrix effect is confirmed.

10.6 Surrogates

Surrogates are added to each field sample and QC sample. The laboratory must evaluate surrogate recovery data from individual samples versus the surrogate control limits developed by the laboratory. The surrogate acceptance criteria are listed in Table 2.

10.7 Control Limits

The laboratory maintains performance records to document the quality of data that is generated. Method accuracy for samples is assessed and records maintained.

Control limits for the method parameters are generated by the QC staff and distributed to the analysts. The control limits are calculated based on in-house performance data. The limits are compared to the control limits found in the reference method.

10.8 Analytical Sequence

In a 12-hour period, the typical analytical sequence is as follows:

BFB
QC Check Standard/Laboratory Control Sample
Method Blank
Samples
MS (as required)
MSD (as required)

11. Method Performance

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations were obtained using reagent water. Similar results were achieved using representative wastewaters. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects.

Method performance data is on file in the laboratory QC department. Comparison of method performance data for the laboratory to the reference method criteria occurs when laboratory in-house acceptance limits are generated. In-house generated data must be within the specifications of the reference method or the analysis is not continued until corrective action is completed.

The performance of this method is evaluated on an on-going basis by the QC criteria listed throughout this SOP. Specifically, Initial Calibration criteria, Continuing Calibration Check criteria, surrogates, blanks, LCSs, and MS/MSDs are all used to ensure that the method is producing results of consistently high quality. In addition, Alpha participates in several blind and double blind PE studies annually to demonstrate the ability of this method to produce accurate and reproducible data.

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12. Corrective Actions

Holding time exceedence, improper preservation and observed sample headspace are noted on the nonconformance report form.

Perform routine preventative maintenance as described throughout this SOP. Record all maintenance in the instrument logbook.

Review of internal standard, surrogates and QC check standard response for acceptable performance occurs for each batch of samples. Record any trends or unusual performance on a nonconformance action form.

All batch and sample specific QC criteria outlined in section 10 are evaluated by the analyst prior to approval of the data. When any QC criteria fail, the cause for the failure must be identified and corrected. This may include instrument recalibration followed by sample reanalysis, sample cleanup, or sample re-extraction. If it is determined that the failure is due to sample matrix effects, a project narrative report is written by the analyst for inclusion in the data report. If there is insufficient sample volume to perform the re-analysis for confirmation, this is also noted in the narrative and included in the client report.

13. Pollution Prevention

See Chemical Hygiene Plan for pollution prevention operations.

14. Waste Management

See Chemical Hygiene Plan for waste handling and disposal.

15. Attachments

TABLE 1: 8260 REPORTING LIMITS

TABLE 2: 8260 QC ACCEPTANCE CRITERIA

TABLE 3: BFB TUNING CRITERIA

TABLE 4: STANDARD SOLUTIONS

TABLE 5: 8260B Volatile Internal Standards with Corresponding Target Compounds and Surrogates Assigned for Quantitation

TABLE 6: 8260B Quantitation Ions

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Table 1

Standard Reported Detection Limits

US EPA METHOD 8260B and 5035/8260B

Analyte	RDL (µg/L)	RDL(µg/KG)[1]	RDL (µg/KG)[2]
Acetone	5.0	10.0	500
Acrolein	12.5	25.0	1250
Acrylonitrile	2.0	4.0	200
Benzene	0.5	1.0	50
Bromobenzene	2.5	5.0	250
Bromochloromethane	2.5	5.0	250
Bromodichloromethane	0.5	1.0	50
Bromoform	2.0	4.0	200
Bromomethane	1.0	2.0	100
2-Butanone	5.0	10.0	500
n-Butyl benzene	0.5	1.0	50
sec-Butyl benzene	0.5	1.0	50
tert-Butyl benzene	2.5	5.0	250
Carbon disulfide	5.0	10.0	500
Carbon tetrachloride	0.5	1.0	50
Chlorobenzene	0.5	1.0	50
Chloroethane	1.0	2.0	100
Chloroform	0.75	1.5	75
Chloromethane	2.5	5.0	250
o-Chlorotoluene	2.5	5.0	250
p-Chlorotoluene	2.5	5.0	250
Dibromochloromethane	0.5	1.0	50
1,2-Dibromo-3-chloropropane	2.5	5.0	250
1,2-Dibromoethane	2.5	5.0	250
Dibromomethane	5.0	10.0	500
1,2-Dichlorobenzene	2.5	5.0	250
1,3-Dichlorobenzene	2.5	5.0	250
1,4-Dichlorobenzene	2.5	5.0	250
1,4-Dichlorobutane	5.0	10.0	500
trans-1,4-Dichloro-2-butene	2.5	5.0	250
Dichlorodifluoromethane	5.0	10.0	500
1,1-Dichloroethane	0.75	1.5	75
1,2-Dichloroethane	0.75	1.5	75
1,1-Dichloroethene	0.75	1.5	75
cis-1,2-Dichloroethene	0.5	1.0	50
trans-1,2-Dichloroethene	0.75	1.5	75

Table 1 (continued)

Standard Reported Detection Limits

US EPA METHOD 8260B and 5035/8260B

Analyte	RDL (µg/L)	RDL(µg/KG)[1]	RDL (µg/KG)[2]
1,2-Dichloropropane	1.75	3.5	175
1,3-Dichloropropane	2.5	5.0	250
2,2-Dichloropropane	2.5	5.0	250
1,1-Dichloropropene	12.5	25.0	1250
cis-1,3-Dichloropropene	0.5	1.0	50
trans-1,3-Dichloropropene	0.5	1.0	50
Ethylbenzene	0.5	1.0	50
Ethyl ether	12.5	25.0	1250
Ethyl methacrylate	5.0	10.0	500
Hexachlorobutadiene	0.6	5.0	250
2-Hexanone	5.0	10.0	500
Iodomethane	5.0	10.0	500
Isopropylbenzene	0.5	1.0	50
p-Isopropyltoluene	0.5	1.0	50
Methylene chloride	2.5	5.0	250
4-Methyl-2-pentanone	5.0	10.0	500
Methyl-tert-butyl-ether	1.0	2.0	100
Naphthalene	2.5	5.0	250
n-Propylbenzene	0.5	1.0	50
Styrene	1.0	2.0	100
1,1,1,2-Tetrachloroethane	2.5	5.0	250
1,1,2,2-Tetrachloroethane	0.5	1.0	50
Tetrachloroethene	0.75	1.5	75
Tetrahydrofuran	10.0	20.0	1000
Toluene	0.75	1.5	75
1,2,3-Trichlorobenzene	2.5	5.0	250
1,2,4-Trichlorobenzene	2.5	5.0	250
1,1,1-Trichloroethane	0.5	1.0	50
1,1,2-Trichloroethane	0.75	1.5	75
Trichloroethene	0.5	1.0	50
Trichlorofluoromethane	2.5	5.0	250
1,2,3-Trichloropropane	5.0	10.0	500
1,2,4-Trimethylbenzene	2.5	5.0	250
1,3,5-Trimethylbenzene	2.5	5.0	250
Vinyl acetate	5.0	10.0	500
Vinyl chloride	1.0	2.0	100
m/p-Xylenes	1.0	2.0	100
o-Xylene	1.0	2.0	100

(1) Detection Limits are for Low-level Sodium Bisulfate preserved samples.
(2) Detection Limits are for High-level Methanol preserved samples.

Table 2

QUALITY CONTROL ACCEPTANCE CRITERIA

Surrogate Spike Percent Recovery	Aqueous Limits		Soil Limits	
	Lower Control Limit	Upper Control Limit	Lower Control Limit	Upper Control Limit
1,2-Dichloroethane-d_4	70%	130%	70%	130%
4-Bromofluorobenzene	70%	130%	70%	130%
Toluene-d_8	70%	130%	70%	130%
Dibromofluoromethane	70%	130%	70%	130%

MS/MSD and LCS Percent Recovery	Aqueous Limits		Soil Limits	
	Lower Control Limit	Upper Control Limit	Lower Control Limit	Upper Control Limit
1,1-Dichloroethene	61%	145%	59%	172%
Trichloroethene	71%	120%	62%	137%
Chlorobenzene	75%	130%	60%	133%
Benzene	76%	127%	66%	142%
Toluene	76%	125%	59%	139%

MS/MSD Relative Percent Difference	Aqueous Limits	Soil Limits
All Target Compounds	20%	30%

Table 3

BFB (4-BROMOFLUOROBENZENE) MASS INTENSITY CRITERIA

m/z	Required Intensity (relative abundance)
50	15 to 40% of m/z 95
75	30 to 60% of m/z 95
95	Base peak, 100% relative abundance
96	5 to 9% of m/z 95
173	Less than 2% of m/z 174
174	Greater than 50% of m/z 95
175	5 to 9% of m/z 174
176	Greater than 95% but less than 101% of m/z 174
177	5 to 9% of m/z 176

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Table 4

Stock Standard Concentrations and Calibration Concentration Levels

Target Compounds	Stock (µg/mL)	Level 1 (µg/L)	Level 2 (µg/L)	Level 3 (µg/L)	Level 4 (µg/L)	Level 5 (µg/L)	Level 6 (µg/L)	Level 7 (µg/L)
Acetone	2000	0.5	2	10	20	30	50	100
Acrolein	2000	0.5	2	10	20	30	50	100
Acrylonitrile	2000	0.5	2	10	20	30	50	100
Benzene	2000	0.5	2	10	20	30	50	100
Bromobenzene	2000	0.5	2	10	20	30	50	100
Bromochloromethane	2000	0.5	2	10	20	30	50	100
Bromodichloromethane	2000	0.5	2	10	20	30	50	100
Bromoform	2000	0.5	2	10	20	30	50	100
Bromomethane	2000	0.5	2	10	20	30	50	100
2-Butanone	2000	0.5	2	10	20	30	50	100
n-Butyl benzene	2000	0.5	2	10	20	30	50	100
sec-Butyl benzene	2000	0.5	2	10	20	30	50	100
tert-Butyl benzene	2000	0.5	2	10	20	30	50	100
Carbon disulfide	2000	0.5	2	10	20	30	50	100
Carbon tetrachloride	2000	0.5	2	10	20	30	50	100
Chlorobenzene	2000	0.5	2	10	20	30	50	100
Chloroethane	2000	0.5	2	10	20	30	50	100
Chloroform	2000	0.5	2	10	20	30	50	100
Chloromethane	2000	0.5	2	10	20	30	50	100
o-Chlorotoluene	2000	0.5	2	10	20	30	50	100
p-Chlorotoluene	2000	0.5	2	10	20	30	50	100
Dibromochloromethane	2000	0.5	2	10	20	30	50	100
1,2-Dibromo-3-chloropropane	2000	0.5	2	10	20	30	50	100
1,2-Dibromoethane	2000	0.5	2	10	20	30	50	100
Dibromomethane	2000	0.5	2	10	20	30	50	100
1,2-Dichlorobenzene	2000	0.5	2	10	20	30	50	100
1,3-Dichlorobenzene	2000	0.5	2	10	20	30	50	100
1,4-Dichlorobenzene	2000	0.5	2	10	20	30	50	100
1,4-Dichlorobutane	2000	0.5	2	10	20	30	50	100
trans-1,4-Dichloro-2-butene	2000	0.5	2	10	20	30	50	100
Dichlorodifluoromethane	2000	0.5	2	10	20	30	50	100
1,1-Dichloroethane	2000	0.5	2	10	20	30	50	100
1,2-Dichloroethane	2000	0.5	2	10	20	30	50	100
1,1-Dichloroethene	2000	0.5	2	10	20	30	50	100
cis-1,2-Dichloroethene	2000	0.5	2	10	20	30	50	100
trans-1,2-Dichloroethene	2000	0.5	2	10	20	30	50	100
1,2-Dichloropropane	2000	0.5	2	10	20	30	50	100
1,3-Dichloropropane	2000	0.5	2	10	20	30	50	100

Table 4 (continued)

Stock Standard Concentrations and Calibration Concentration Levels

Target Compounds	Stock (µg/mL)	Level 1 (µg/L)	Level 2 (µg/L)	Level 3 (µg/L)	Level 4 (µg/L)	Level 5 (µg/L)	Level 6 (µg/L)	Level 7 (µg/L)
2,2-Dichloropropane	2000	0.5	2	10	20	30	50	100
1,1-Dichloropropene	2000	0.5	2	10	20	30	50	100
cis-1,3-Dichloropropene	2000	0.5	2	10	20	30	50	100
trans-1,3-Dichloropropene	2000	0.5	2	10	20	30	50	100
Ethylbenzene	2000	0.5	2	10	20	30	50	100
Ethyl ether	2000	0.5	2	10	20	30	50	100
Ethyl methacrylate	2000	0.5	2	10	20	30	50	100
Hexachlorobutadiene	2000	0.5	2	10	20	30	50	100
2-Hexanone	2000	0.5	2	10	20	30	50	100
Iodomethane	2000	0.5	2	10	20	30	50	100
Isopropylbenzene	2000	0.5	2	10	20	30	50	100
p-Isopropyltoluene	2000	0.5	2	10	20	30	50	100
Methylene chloride	2000	0.5	2	10	20	30	50	100
4-Methyl-2-pentanone	2000	0.5	2	10	20	30	50	100
Methyl-tert-butyl-ether	2000	0.5	2	10	20	30	50	100
Naphthalene	2000	0.5	2	10	20	30	50	100
n-Propylbenzene	2000	0.5	2	10	20	30	50	100
Styrene	4000	1	4	20	40	60	100	200
1,1,1,2-Tetrachloroethane	2000	0.5	2	10	20	30	50	100
1,1,2,2-Tetrachloroethane	2000	0.5	2	10	20	30	50	100
Tetrachloroethene	2000	0.5	2	10	20	30	50	100
Tetrahydrofuran	2000	0.5	2	10	20	30	50	100
Toluene	2000	0.5	2	10	20	30	50	100
1,2,3-Trichlorobenzene	2000	0.5	2	10	20	30	50	100
1,2,4-Trichlorobenzene	2000	0.5	2	10	20	30	50	100
1,1,1-Trichloroethane	2000	0.5	2	10	20	30	50	100
1,1,2-Trichloroethane	2000	0.5	2	10	20	30	50	100
Trichloroethene	2000	0.5	2	10	20	30	50	100
Trichlorofluoromethane	2000	0.5	2	10	20	30	50	100
1,2,3-Trichloropropane	2000	0.5	2	10	20	30	50	100
1,2,4-Trimethylbenzene	2000	0.5	2	10	20	30	50	100
1,3,5-Trimethylbenzene	2000	0.5	2	10	20	30	50	100
Vinyl acetate	2000	0.5	2	10	20	30	50	100
Vinyl chloride	2000	0.5	2	10	20	30	50	100
m/p-Xylenes	4000	1	4	20	40	60	100	200
o-Xylene	4000	1	4	20	40	60	100	200

Table 4 (continued)

Stock Standard Concentrations and Calibration Concentration Levels

Target Compounds	Stock (µg/mL)	Level 1 (µg/L)	Level 2 (µg/L)	Level 3 (µg/L)	Level 4 (µg/L)	Level 5 (µg/L)	Level 6 (µg/L)	Level 7 (µg/L)
Internal Standards								
Fluorobenzene	2500	10	10	10	10	10	10	10
Chlorobenzene-d5	2500	10	10	10	10	10	10	10
1,4-Dichlorobenzene-d4	2500	10	10	10	10	10	10	10
Surrogates								
Dibromofluoromethane	2500	10	10	10	10	10	10	10
1,2-Dichloroethane-d4	2500	10	10	10	10	10	10	10
Toluene-d8	2500	10	10	10	10	10	10	10
4-Bromofluorobenzene	2500	10	10	10	10	10	10	10

- For Low Level Soil analysis, the calibration levels are the same in µg/Kg units.
- For High Level Soil analysis, the calibration levels are at 50X the levels listed due to sample preparation requirements.

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TABLE 5

8260B Volatile Internal Standards with Corresponding Target Compounds and Surrogates Assigned for Quantitation

Fluorobenzene	Chlorobenzene-d5	1,4-Dichlorobenzene-d4
dichlorodifluoromethane	toluene-d8 surr	bromoform
chloromethane	toluene	1,1,2,2,-tetrachloroethane
vinyl chloride	trans-1,3-dichloropropene	4-bromofluorobenzene surr
bromomethane	1,1,2-trichloroethane	1,2,3-trichloropropane
chloroethane	2-hexanone	trans-1,4-dichloro-2-butene
trichlorofluoromethane	1,3-dichloropropane	n-propylbenzene
ethyl ether	tetrachloroethene	bromobenzene
Freon 113	chlorodibromomethane	1,3,5-trimethybenzene
acetone	1,2-dibromoethane	2-chlorotoluene
1,1,-dichloroethene	chlorobenzene	4-chorotoluene
carbon disulfide	1,1,1,2-tetrachloroethane	tert-butylbenzene
methylene chloride	ethyl benzene	1,2,4-trimethylbenzene
acrylonitrile	p/m xylene	sec-butylbenzene
methyl tert butyl ether	o xylene	p-isopropyltoluene
Hexane	styrene	1,3-dichlorobenzene
trans-1,2-dichloroethene	isopropylbenzene	1,4-dichlorobenzene
Diisopropyl Ether		n-butylbenzene
1,1-dichloroethane		1,2-dichlorobenzene
Ethyl-Tert-Butyl-Ether		1,2-dibromo-3-chloropropane
2-butanone		1,2,4-trichlorobenzene
2,2-dichloropropane		hexachlorobutadiene
cis-1,2-dichloroethene		naphthalene
chloroform		1,2,3-trichlorobenzene
bromochloromethane		
tetrahydrofuran		
dibromofluoromethane		
1,1,1-trichloroethane		
1,1-dichloropropene		
carbon tetrachloride		
Tertiary-Amyl Methyl Ether		
1,2-dichloroethane-d4 surr		
1,2-dichloroethane		
benzene		
trichloroethene		
1,2-dichloropropane		
bromodichloromethane		
1,4-Dioxane		
dibromomethane		

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TABLE 6

8260B Quantitation Ions

Compound	Quantitation Ion	Compound	Quantitation Ion
Dichlorodifluoromethane	85	ethyl-methacrylate	69
Chloromethane	50	1,1,2-trichloroethane	83
Vinyl Chloride	62	2-hexanone	43
Bromomethane	94	1,3-dichloropropane	76
Chloroethane	64	tetrachloroethene	166
Trichlorofluoromethane	101	chlorodibromomethane	129
Ethyl ether	74	1,2-dibromoethane	107
Acrolein	56	chlorobenzene	112
Acetone	43	1,1,1,2-tetrachloroethane	131
1,1-Dichloroethene	96	ethyl benzene	91
Iodomethane	142	p/m xylene	106
Methylene Chloride	84	o xylene	106
Carbon disulfide	76	styrene	104
Acrylonitrile	53	bromoform	173
Methyl tert butyl ether	73	isopropylbenzene	105
Trans-1,2-dichloroethene	96	1,4-dichloro-2-butane	55
Vinyl acetate	43	1,1,2,2-tetrachloroethane	83
1,1-dichloroethane	63	trans-1,4-dichloro-2-butene	53
2-butanone	43	1,2,3-trichloropropane	75
2,2-dichloropropene	77	n-propylbenzene	91
Cis-1,2-dichloroethene	96	bromobenzene	156
Chloroform	83	2-chlorotoluene	91
bromochloromethane	128	1,3,5-trimethylbenzene	105
tetrahydrofuran	42	4-chlorotoluene	91
1,1,1-trichloroethane	97	tert-butylbenzene	119
1,1-dichloropropene	75	1,2,4-trimethylbenzene	105
carbon tetrachloride	117	sec-butylbenzene	105
1,2-dichloroethane	62	p-isopropyltoluene	119
benzene	78	1,3-dichlorobenzene	146
trichloroethene	95	1,4-dichlorobenzene	146
1,2-dichloropropane	63	n-butylbenzene	91
bromodichloromethane	83	1,2-dichlorobenzene	146
dibromomethane	93	1,2-dibromo-3-chloropropane	75
4-methyl-2-pentanone	58	1,2,4-trichlorobenzene	180
cis-1,3-dichloropropene	75	hexachlorobutadiene	225
toluene	92	naphthalene	128
trans-1,3-dichloropropene	75	1,2,3-trichlorobenzene	180

Alpha Analytical Laboratories
Project Specific SOP Addendum

SOP No.: SOP/03-03. Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Issue 9, February 2, 2007.

Reference Documents:

Method 8260 B, SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, December 1996.

Method 5035, Closed System Purge &Trap and Extraction for Volatile Organics in Soil and Waste Samples. SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, December, 1996.

Method 5030B, Purge & Trap for Aqueous Samples. SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, EPA SW-846, Update III, December, 1996.

Client: Various

Project Name: All Massachusetts Contingency Plan Projects

Project No.: Various

The following modifications need to be made to the referenced SOP for all samples applicable to this project:

Section 1. The following compounds can be determined by this method:

8260B MCP LIST OF ANALYTES		
dichlorodifluoromethane	benzene	1,2,3-trichloropropane
chloromethane	trichloroethene	n-propylbenzene
vinyl chloride	1,2-dichloropropane	bromobenzene
chloroethane	bromodichloromethane	2-chlorotoluene
bromomethane	dibromomethane	1,3,5-trimethylbenzene
trichlorofluoromethane	4-methyl-2-pentanone	4-chlorotoluene
ethyl ether	cis-1,3-dichloropropene	tert-butylbenzene
acetone	toluene	1,2,4-trimethylbenzene
1,1-dichloroethene	trans-1,3-dichloropropene	sec-butylbenzene
carbon disulfide	1,1,2-trichloroethane	p-isopropyltoluene
methylene chloride	2-hexanone	1,3-dichlorobenzene
methyl-tert-butyl ether	1,3-dichloropropane	1,4-dichlorobenzene
trans-1,2-dichloroethene	tetrachloroethene	n-butylbenzene
1,1-dichloroethane	chlorodibromomethane	1,2-dichlorobenzene
2-butanone	1,2-dibromoethane	1,2-dibromo-3-chloropropane
2,2-dichloropropane	chlorobenzene	1,2,4-trichlorobenzene
cis-1,2-dichloroethene	1,1,1,2-tetrachloroethane	hexachlorobutadiene

chloroform	ethyl benzene	naphthalene
bromochloromethane	p/m xylene	1,2,3-trichlorobenzene
tetrahydrofuran	o xylene	Diisopropyl Ether
1,1,1-trichloroethane	styrene	Ethyl-tert-butyl-ether
1,1-dichloropropene	bromoform	Tertiary-amyl methyl ether
carbon tetrachloride	isopropylbenzene	1,4-Dioxane
1,2-dichloroethane	1,1,2,2-tetrachloroethane	

Section 9.3.5.1 The percent difference or drift for each CCC listed in Section 9.2.3.2 must be less than or equal to 20%. If the criterion is not met for any one CCC, (i.e., greater than 20% difference or drift), then corrective action must be taken prior to the analysis of samples. All other analytes should meet a 30% D criteria. An allowance is made to fail 10% of the compounds with > 30%. If any samples have a hit of an analyte with > 30% D, these results should be considered an estimate or rerun to verify.

Section 10.3 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

A laboratory control sample is analyzed at the beginning of each analytical sequence. Since the LCS contains the same compounds at the same concentrations as the continuing calibration check standard, the same analysis is used to satisfy both QC elements. A laboratory control sample duplicate is also analyzed in every analytical sequence, usually following the LCS.

Recoveries for all analytes in the LCS and LCSD must be 70 – 130%, with an allowance for up to 10% of analytes > 130%. Also, an allowance is made for difficult analytes listed in Table 7. These analytes may have < 70% recovery. Any target hits of an analyte with >30% D in the LCS must be qualified as an estimate or rerun. RPDs calculated between the LCS and LCSD must be $\leq$ 30% for all analytes, or $\leq$ 50% for difficult analytes.

Section 10.4 Matrix Spike/Matrix Spike Duplicates (MS/MSD)

A MS/MSD is not performed unless requested by a client. Recovery must be within 70 – 130%. RPD must be less than 30% for both liquid and soil samples. Any exceedence of these limits is narrated if the analytes that failed were successfully recovered in the LCS.

Table 1: Standard Reported Detection Limits MCP Method 8260B

Analyte	RDL (µg/L)	RDL(µg/KG)[1]	RDL (µg/KG)[2]
Acetone	5.0	10.0	500
Benzene	0.5	1.0	50
Bromobenzene	2.5	5.0	250
Bromochloromethane	2.5	5.0	250
Bromodichloromethane	0.5	1.0	50
Bromoform	2.0	4.0	200
Bromomethane	1.0	2.0	100
2-Butanone	5.0	10.0	500
n-Butyl benzene	0.5	1.0	50
sec-Butyl benzene	0.5	1.0	50
tert-Butyl benzene	2.5	5.0	250
Carbon disulfide	5.0	10.0	500
Carbon tetrachloride	0.5	1.0	50
Chlorobenzene	0.5	1.0	50
Chloroethane	1.0	2.0	100
Chloroform	0.75	1.5	75
Chloromethane	2.5	5.0	250
o-Chlorotoluene	2.5	5.0	250
p-Chlorotoluene	2.5	5.0	250
Dibromochloromethane	0.5	1.0	50
1,2-Dibromo-3-chloropropane	2.5	5.0	250
1,2-Dibromoethane	2.5	5.0	250
Dibromomethane	5.0	10.0	500
1,2-Dichlorobenzene	2.5	5.0	250
1,3-Dichlorobenzene	2.5	5.0	250
1,4-Dichlorobenzene	2.5	5.0	250
Dichlorodifluoromethane	5.0	10.0	500
1,1-Dichloroethane	0.75	1.5	75
1,2-Dichloroethane	0.75	1.5	75
1,1-Dichloroethene	0.75	1.5	75
cis-1,2-Dichloroethene	0.5	1.0	50
trans-1,2-Dichloroethene	0.75	1.5	75
1,2-Dichloropropane	1.75	3.5	175
1,3-Dichloropropane	2.5	5.0	250
2,2-Dichloropropane	2.5	5.0	250
1,1-Dichloropropene	12.5	25.0	1250

Table 1 (continued): Standard Reported Detection Limits MCP Method 8260B

Analyte	RDL (µg/L)	RDL(µg/KG)(1)	RDL (µg/KG)(2)
cis-1,3-Dichloropropene	0.5	1.0	50
trans-1,3-Dichloropropene	0.5	1.0	50
Ethylbenzene	0.5	1.0	50
Ethyl ether	12.5	25.0	1250
Hexachlorobutadiene	2.5	5.0	250
2-Hexanone	5.0	10.0	500
Isopropylbenzene	0.5	1.0	50
p-Isopropyltoluene		1.0	50
Methylene chloride	2.5	5.0	250
4-Methyl-2-pentanone	5.0	10.0	500
Methyl-tert-butyl-ether	1.0	2.0	100
Naphthalene	2.5	5.0	250
n-Propylbenzene	0.5	1.0	50
Styrene		1.0	50
1,1,1,2-Tetrachloroethane	2.5	5.0	250
1,1,2,2-Tetrachloroethane	0.5	1.0	50
Tetrachloroethene	0.75	1.5	75
Tetrahydrofuran	10.0	20.0	1000
Toluene	0.75	1.5	75
1,2,3-Trichlorobenzene	2.5	5.0	250
1,2,4-Trichlorobenzene	2.5	5.0	250
1,1,1-Trichloroethane	0.5	1.0	50
1,1,2-Trichloroethane	0.75	1.5	75
Trichloroethene	0.5	1.0	50
Trichlorofluoromethane	2.5	5.0	250
1,2,3-Trichloropropane	5.0	10.0	500
1,2,4-Trimethylbenzene	2.5	5.0	250
1,3,5-Trimethylbenzene	2.5	5.0	250
Vinyl chloride	1.0	2.0	100
m/p-Xylenes	0.5	1.0	50
o-Xylene	0.5	1.0	50
Diisopropyl Ether	2.5	5	250
Ethyl-tert-butyl Ether	20	4	200
Tertiary-Amyl Methyl Ether	20	4	200
1,4-Dioxane	250	500	25000

(1) Detection Limits are for Low-level Sodium Bisulfate preserved samples.
(2) Detection Limits are for High-level Methanol preserved samples.

Table 4: Stock Standard Concentrations and Calibration Concentration Levels

Target Compounds	Stock (µg/mL)	Level 1 (ug/L)	Level 2 (ug/L)	Level 3 (ug/L)	Level 4 (ug/L)	Level 5 (ug/L)	Level 6 (ug/L)	Level 7 (ug/L)
Acetone	2000	0.5	2	10	20	30	50	100
Benzene	2000	0.5	2	10	20	30	50	100
Bromobenzene	2000	0.5	2	10	20	30	50	100
Bromochloromethane	2000	0.5	2	10	20	30	50	100
Bromodichloromethane	2000	0.5	2	10	20	30	50	100
Bromoform	2000	0.5	2	10	20	30	50	100
Bromomethane	2000	0.5	2	10	20	30	50	100
2-Butanone	2000	0.5	2	10	20	30	50	100
n-Butyl benzene	2000	0.5	2	10	20	30	50	100
sec-Butyl benzene	2000	0.5	2	10	20	30	50	100
tert-Butyl benzene	2000	0.5	2	10	20	30	50	100
Carbon disulfide	2000	0.5	2	10	20	30	50	100
Carbon tetrachloride	2000	0.5	2	10	20	30	50	100
Chlorobenzene	2000	0.5	2	10	20	30	50	100
Chloroethane	2000	0.5	2	10	20	30	50	100
Chloroform	2000	0.5	2	10	20	30	50	100
Chloromethane	2000	0.5	2	10	20	30	50	100
o-Chlorotoluene	2000	0.5	2	10	20	30	50	100
p-Chlorotoluene	2000	0.5	2	10	20	30	50	100
Dibromochloromethane.	2000	0.5	2	10	20	30	50	100
1,2-Dibromo-3-chloropropane	2000	0.5	2	10	20	30	50	100
1,2-Dibromoethane	2000	0.5	2	10	20	30	50	100
Dibromomethane	2000	0.5	2	10	20	30	50	100
1,2-Dichlorobenzene	2000	0.5	2	10	20	30	50	100
1,3-Dichlorobenzene	2000	0.5	2	10	20	30	50	100
1,4-Dichlorobenzene	2000	0.5	2	10	20	30	50	100
Dichlorodifluoromethane	2000	0.5	2	10	20	30	50	100
1,1-Dichloroethane	2000	0.5	2	10	20	30	50	100
1,2-Dichloroethane	2000	0.5	2	10	20	30	50	100
1,1-Dichloroethene	2000	0.5	2	10	20	30	50	100
cis-1,2-Dichloroethene	2000	0.5	2	10	20	30	50	100
trans-1,2-Dichloroethene	2000	0.5	2	10	20	30	50	100
1,2-Dichloropropane	2000	0.5	2	10	20	30	50	100
1,3-Dichloropropane	2000	0.5	2	10	20	30	50	100

Table 4 (continued): Stock Standard Concentrations and Calibration Concentration Levels

Target Compounds	Stock (µg/mL)	Level 1 (ug/L)	Level 2 (ug/L)	Level 3 (ug/L)	Level 4 (ug/L)	Level 5 (ug/L)	Level 6 (ug/L)	Level 7 (ug/L)
2,2-Dichloropropane	2000	0.5	2	10	20	30	50	100
1,1-Dichloropropene	2000	0.5	2	10	20	30	50	100
cis-1,3-Dichloropropene	2000	0.5	2	10	20	30	50	100
trans-1,3-Dichloropropene	2000	0.5	2	10	20	30	50	100
Ethylbenzene	2000	0.5	2	10	20	30	50	100
Ethyl ether	2000	0.5	2	10	20	30	50	100
Hexachlorobutadiene	2000	0.5	2	10	20	30	50	100
2-Hexanone	2000	0.5	2	10	20	30	50	100
Isopropylbenzene	2000	0.5	2	10	20	30	50	100
p-Isopropyltoluene	2000	0.5	2	10	20	30	50	100
Methylene chloride	2000	0.5	2	10	20	30	50	100
4-Methyl-2-pentanone	2000	0.5	2	10	20	30	50	100
Methyl-tert-butyl-ether	2000	0.5	2	10	20	30	50	100
Naphthalene	2000	0.5	2	10	20	30	50	100
n-Propylbenzene	2000	0.5	2	10	20	30	50	100
Styrene	2000	1	4	20	40	60	100	200
1,1,1,2-Tetrachloroethane	2000	0.5	2	10	20	30	50	100
1,1,2,2-Tetrachloroethane	2000	0.5	2	10	20	30	50	100
Tetrachloroethene	2000	0.5	2	10	20	30	50	100
Tetrahydrofuran	2000	0.5	2	10	20	30	50	100
Toluene	2000	0.5	2	10	20	30	50	100
1,2,3-Trichlorobenzene	2000	0.5	2	10	20	30	50	100
1,2,4-Trichlorobenzene	2000	0.5	2	10	20	30	50	100
1,1,1-Trichloroethane	2000	0.5	2	10	20	30	50	100
1,1,2-Trichloroethane	2000	0.5	2	10	20	30	50	100
Trichloroethene	2000	0.5	2	10	20	30	50	100
Trichlorofluoromethane	2000	0.5	2	10	20	30	50	100
1,2,3-Trichloropropane	2000	0.5	2	10	20	30	50	100
1,2,4-Trimethylbenzene	2000	0.5	2	10	20	30	50	100
1,3,5-Trimethylbenzene	2000	0.5	2	10	20	30	50	100
Vinyl chloride	2000	0.5	2	10	20	30	50	100
m/p-Xylenes	2000	1	4	20	40	60	100	200
o-Xylene	2000	1	4	20	40	60	100	200
Diisopropyl Ether	2000	0.5	2	10	20	30	50	100
Ethyl-tert-butyl Ether	2000	0.5	2	10	20	30	50	100
Tertiary-Amyl Methyl Ether	2000	0.5	2	10	20	30	50	100
1,4-Dioxane	10000	100	400	1000	1500	2000	3000	5000

Table 4 (continued): Stock Standard Concentrations and Calibration Concentration Levels

Target Compounds	Stock (µg/mL)	Level 1 (ug/L)	Level 2 (ug/L)	Level 3 (ug/L)	Level 4 (ug/L)	Level 5 (ug/L)	Level 6 (ug/L)	Level 7 (ug/L)
Internal Standards								
Fluorobenzene	2500	10	10	10	10	10	10	10
Chlorobenzene-d5	2500	10	10	10	10	10	10	10
1,4-Dichlorobenzene-d4	2500	10	10	10	10	10	10	10
Surrogates								
Dibromofluoromethane	2500	10	10	10	10	10	10	10
1,2-Dichloroethane-d4	2500	10	10	10	10	10	10	10
Toluene-d8	2500	10	10	10	10	10	10	10
4-Bromofluorobenzene	2500	10	10	10	10	10	10	10

TABLE 5

MCP 8260B Volatile Internal Standards with Corresponding Target Compounds and Surrogates Assigned for Quantitation

Fluorobenzene	Chlorobenzene-d5	1,4-Dichlorobenzene-d4
dichlorodifluoromethane	toluene-d8 surr	bromoform
chloromethane	toluene	1,1,2,2,-tetrachloroethane
vinyl chloride	trans-1,3-dichloropropene	4-bromofluorobenzene surr
bromomethane	1,1,2-trichloroethane	1,2,3-trichloropropane
chloroethane	2-hexanone	trans-1,4-dichloro-2-butene
trichlorofluoromethane	1,3-dichloropropane	n-propylbenzene
ethyl ether	tetrachloroethene	bromobenzene
Freon 113	chlorodibromomethane	1,3,5-trimethybenzene
acetone	1,2-dibromoethane	2-chlorotoluene
1,1,-dichloroethene	chlorobenzene	4-chorotoluene
carbon disulfide	1,1,1,2-tetrachloroethane	tert-butylbenzene
methylene chloride	ethyl benzene	1,2,4-trimethylbenzene
acrylonitrile	p/m xylene	sec-butylbenzene
methyl tert butyl ether	o xylene	p-isopropyltoluene
Hexane	styrene	1,3-dichlorobenzene
trans-1,2-dichloroethene	isopropylbenzene	1,4-dichlorobenzene
Diisopropyl Ether		n-butylbenzene
1,1-dichloroethane		1,2-dichlorobenzene
Ethyl-Tert-Butyl-Ether		1,2-dibromo-3-chloropropane
2-butanone		1,2,4-trichlorobenzene
2,2-dichloropropane		hexachlorobutadiene
cis-1,2-dichloroethene		naphthalene
chloroform		1,2,3-trichlorobenzene
bromochloromethane		
tetrahydrofuran		
dibromofluoromethane		
1,1,1-trichloroethane		
1,1-dichloropropene		
carbon tetrachloride		
Tertiary-Amyl Methyl Ether		
1,2-dichloroethane-d4 surr		
1,2-dichloroethane		
benzene		
trichloroethene		
1,2-dichloropropane		
bromodichloromethane		
1,4-Dioxane		
dibromomethane		

TABLE 6

MCP 8260B Quantitation Ions

Compound	Quantitation Ion	Compound	Quantitation Ion
Dichlorodifluoromethane	85	toluene	92
Chloromethane	50	trans-1,3-dichloropropene	75
Vinyl Chloride	62	2-hexanone	43
Bromomethane	94	1,1,2-trichloroethane	83
Chloroethane	64	tetrachloroethene	166
Trichlorofluoromethane	101	chlorodibromomethane	129
Ethyl ether	74	1,2-dibromoethane	107
Acetone	43	chlorobenzene	112
1,1-Dichloroethene	96	1,1,1,2-tetrachloroethane	131
Methylene Chloride	84	ethyl benzene	91
Carbon disulfide	76	p/m xylene	106
Methyl tert butyl ether	73	o xylene	106
Trans-1,2-dichloroethene	96	styrene	104
Diisopropyl ether	45	bromoform	173
1,1-dichloroethane	63	isopropylbenzene	105
Ethyl-tert-butyl-ether	59	1,1,2,2-tetrachloroethane	83
2-butanone	43	1,2,3-trichloropropane	75
2,2-dichloropropene	77	n-propylbenzene	91
Cis-1,2-dichloroethene	96	bromobenzene	156
Chloroform	83	2-chlorotoluene	91
bromochloromethane	128	1,3,5-trimethylbenzene	105
tetrahydrofuran	42	4-chlorotoluene	91
1,1,1-trichloroethane	97	tert-butylbenzene	119
1,1-dichloropropene	75	1,2,4-trimethylbenzene	105
Tertiary-amyl methyl ether	73	sec-butylbenzene	105
carbon tetrachloride	117	p-isopropyltoluene	119
1,2-dichloroethane	62	1,3-dichlorobenzene	146
benzene	78	1,4-dichlorobenzene	146
trichloroethene	95	n-butylbenzene	91
1,2-dichloropropane	63	1,2-dichlorobenzene	146
bromodichloromethane	83	1,2-dibromo-3-chloropropane	75
1,4-dioxane	88	1,2,4-trichlorobenzene	180
dibromomethane	93	hexachlorobutadiene	225
4-methyl-2-pentanone	58	naphthalene	128
cis-1,3-dichloropropene	75	1,2,3-trichlorobenzene	180

Table 7: Difficult Analyte List

2-Butanone
Acetone
4-Methyl-2-Pentanone
2-Hexanone
Bromomethane
Bromoform
Dichlorodifluoromethane
1,2-Dibromo-3-Chloropropane
1,4-Dioxane
Chloromethane

Approved: Joe Watkins **(Signature)** **Date:** 4/3/07

Joe Watkins **(Printed Name)**

Nitrogen, Ammonia

Reference Methods: **SM4500 NH_3-BH,** Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF, 18th Edition, 1992.

Method 350.1, Methods Methods for the Chemical Analysis of Water and Wastes, EPA 600/ 4-82-055, 1982.

Method 10-107-06-1-A, Methods for Automatied Ion Analyzers, May 20, 1998.

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Prepared by:

Name: Elena Dayn Position: Wet Chemistry Analyst

Signature: E. Dayn Date: 3/31/05

Authorized by:

Name: Joseph Clements Position: Inorganics Supervisor

Signature: Date: 3/31/05

ISSUE AMENDMENTS

Changes since last issue:

Section 8.8: Edited the preparation of 0.2% Boric Acid.

Section 8.9.1.1.7 – 8.9.1.1.9: Added that these standards could be prepared by autodilution.

Section 9.2.1.1: Corrected the low range concentrations.

Section 9.2.3: Added ICB analysis.

Secton 9.6: Clarified that results are calculated by the Lachat software.

Section 10.2.2: Clarified the ICB.

Nitrogen, Ammonia

Reference Methods: **SM4500 NH_3-BH,** Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF, 18th Edition, 1992.

Method 350.1, Methods Methods for the Chemical Analysis of Water and Wastes, EPA 600/ 4-82-055, 1982.

Method 10-107-06-1-A, Methods for Automatied Ion Analyzers, May 20, 1998.

1. Scope and Application

Matrices: Ammonia nitrogen can be determined in potable, surface, and saline waters as well as domestic and industrial wastewaters.

Definitions: See Alpha Laboratories Quality Manual Appendix A.

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one of the following laboratory personnel before performing the modification: Area Supervisor, Laboratory Services Manager, Laboratory Director, or Quality Assurance Officer

This method is restricted to use by or under the supervision of analysts experienced in the operation of the Tecator and/or Lachat Instrument and in the interpretation of Lachat data. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability, analyzing a proficiency test sample and completing the record of training.

After initial demonstration, ongoing demonstration is based on acceptable laboratory performance of at least a quarterly laboratory control sample or acceptable performance from an annual proficiency test sample. A major modification to this procedure requires demonstration of performance. The identification of major method modification requiring performance demonstration is directed by the QA Officer and Laboratory Director on a case by case basis.

In waters and wastewaters the forms of nitrogen of greatest interest are, in order of decreasing oxidation state: nitrate, nitrite, ammonia, and organic nitrogen. All these forms of nitrogen, as well as nitrogen gas (N_2), are biochemically interconvertible and are components of the nitrogen cycle. They are of interest for many reasons. Organic nitrogen is defined functionally as organically bound nitrogen in the trinegative oxidation state. It does not include all organic nitrogen compounds. Analytically, organic nitrogen and ammonia can be determined together and have been referred to as "kjeldahl nitrogen," a term that reflects the technique used in their determination. Organic nitrogen includes such natural materials as proteins and peptides, nucleic acids and urea, and numerous synthetic organic materials. Typical organic nitrogen concentrations vary from a few hundred micrograms per liter in some lakes to more than 20mg/L in raw sewage.

Ammonia is present naturally in surface and wastewaters. Its concentration generally is low in groundwaters because it adsorbs to soil particles and clays and is not leached readily from soils. It is produced largely by deamination of organic nitrogen containing compounds and by hydrolysis of urea. At some water treatment plants ammonia is added to react with chlorine to form a combined chlorine residual.

In the chlorination of wastewater effluents containing ammonia, virtually no free residual chlorine is obtained until the ammonia has been oxidized. Rather, the chlorine reacts with ammonia to form mono- and dichloramines. Ammonia concentrations encountered in water vary from less than 10µg

ammonia nitrogen/L in some natural surface and groundwaters to more than 30mg/L in some wastewaters.

In this discussion, organic nitrogen is referred to as organic N, nitrate nitrogen as NO_3-N, nitrite nitrogen as NO_2-N, and ammonia nitrogen as NH_3-N.

2. Summary of Method

The sample is buffered at pH 9.5 with a borate buffer to decrease hydrolysis of cyanates and organic nitrogen compounds. It is distilled into a solution of boric acid. The ammonia in the distillate is determined colorimetrically by the phenate method.

The phenate method is base on the Berthelot reaction. Ammonia reacts with alkaline phenol, then with sodium hypochlorite to form indophenol blue. Sodium nitroprusside (nitroferricyanide) is added to enhance sensitivity. The absorbance of the reaction product is measured at 630nm, and is directly proportional to the original ammonia concentration.

2.1 Method Modifications from Reference

None.

3. Detection Limits

The laboratory follows the procedure found in 40CFR Part 136 to determine the MDL on an annual basis. The method detection limits determined by the laboratory are on file for review.

The RDL is determined to be 0.075mg/L based on a 100mL sample size.

4. Interferences

Most of the following interferences refer to the direct analysis of a water sample. The distillation steps remove most of these interferences.

4.1 Instrument

Samples with a high concentration of NH_3 may carry-over into the next sample and therefore yield false high results in that next sample. If a sample with a low concentration follows a sample with a high concentration, re-analyze the low sample to ensure results are accurate.

4.2 Parameters

4.2.1 Glycine, urea, glutamic acid, cyanates, and acetamide hydrolyze very slowly in solution on standing but, of these, only urea and cyanates will hydrolyze on distillation at pH of 9.5. Hydrolysis amounts to about 7% at this pH for urea and about 5% for cyanates. Some of the organic compounds that may interfere, such as formaldehyde, may be eliminated by boiling off at a low pH before nesslerization. Remove residual chlorine by sample pretreatment.

4.2.2 Color and turbidity of the sample distillate may interfere with analysis. These interferences are removed by manual filtration of the distillate prior to Lachat analysis, or by dilution of the sample prior to distillation.

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5. Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material data handling sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

Note: Phenol used in this method is hazardous and general laboratory safety practices must be observed.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

6. Sample Collection, Preservation, and Handling

6.1 Sample Collection

The most reliable results are obtained on fresh samples. Use plastic or glass containers.

6.2 Sample Preservation

If prompt analysis is impossible, preserve samples with approximately 0.8mL concentrated H_2SO_4/L sample. The pH of the acid-preserved samples should be <2. (Some wastewaters may require more concentrated H_2SO_4 to achieve this pH.) Store samples at 4°C.

6.3 Sample Handling

Samples should be analyzed within 28 days after collection.

7. Equipment and Supplies

7.1 Distillation apparatus: Tecator Instruments Automatic Distillation Unit. Follow the instrument manufacturer's instructions for proper operation.

7.2 pH Strips: Range 7.5 to 14 units.

7.3 250mL Disposable Polypropylene cups with covers.

7.4 Automated Ion Analyzer: Lachat Instruments.

7.5 Helium gas, He: 140kPa (20 lb/in^2).

7.6 Volumetric flasks, various volumes.

7.7 Pipets, various volumes.

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8. Standards and Reagents

8.1 Borate buffer solution: Add 88mL 0.1N NaOH solution to 500mL of approximately 0.025M sodium tetraborate ($Na_2B_4O_7$) solution (9.5g $Na_2B_4O_7 \cdot 10\ H_2O$/L) and dilute to 1L with DI water.

8.2 Sodium thiosulfate (dechlorinating reagent): Dissolve 0.35g $Na_2S_2O_3 \cdot 5H_2O$ in DI water and dilute to 100mL. Prepare fresh daily as needed.

8.3 Neutralization agents: Prepare with DI water:

8.3.1 Sodium hydroxide, NaOH, 6N.

8.3.2 Sulfuric acid, H_2SO_4, 10%.

8.4 Sodium Phenolate: CAUTION! Wear gloves. Phenol causes severe burns and is rapidly absorbed into the body through the skin. In a 1L volumetric flask, dissolve 88mL of 88% liquified phenol or 83g crystalline phenol (C_6H_5OH) in approximately 600mL DI water. While stirring, slowly add 32g sodium hydroxide (NaOH). Cool, dilute to the mark, and invert three times. Do **not** degas this reagent.

8.5 Sodium Hypochlorite (approximate 2.6%): In a 500mL volumetric flask, dilute 250mL Regular Chlorine bleach [5.25% sodium hypochlorite (NaOCl)] to the mark with DI water. Invert three times to mix.

8.6 Sodium Nitroprusside (coloring agent): In a 1L volumetric flask, dissolve 3.50g sodium nitroprusside (Sodium Nitroferricyanide [$Na_2Fe(CN)_5NO_2 \cdot H_2O$]) dilute to the mark with DI water. Degas with helium to prevent bubble formation. Use He at 140kPa (20 lb/in^2) through a helium degassing tube. Bubble He vigorously through the solution for one minute.

8.7 Boric 1.5% Boric Acid Solution: To a 1000mL volumetric flask add 15g Boric Acid. Dilute to the mark with DI water.

8.8 0.2% Boric Acid Solution (Carrier Solution): To a 2L volumetric flask, dissolve 4g Boric Acid (H_3BO_3) in DI water. Degas by bubbling vigorously with Helium for one minute.

8.9 Stock Standard, 1000ppm as NH_3 (for calibration and spike solutions): Commercially prepared. Certificate of analysis is required.

8.9.1 Intermediate Calibration Stock Standard, 100ppm as NH_3: To a 100mL volumetric flask, add 10.0mL of Stock Standard (Section 8.9) and dilute to the mark with 0.2% Boric Acid solution (Section 8.8). Invert three times.

8.9.1.1 Nine Working Calibration Standards: Prepare the following standards in volumetric flasks:

8.9.1.1.1 20.0ppm: 40mL of 100ppm standard (Section 8.9.1) to 200mL with 0.2% Boric Acid solution (Section 8.8).

8.9.1.1.2 8.00ppm: 8mL of 100ppm standard (Section 8.9.1) to 100mL with 0.2% Boric Acid solution (Section 8.8).

8.9.1.1.3 4.00ppm: 8mL of 100ppm standard (Section 8.9.1) to 200mL with 0.2% Boric Acid solution (Section 8.8).

8.9.1.1.4 2.00ppm: 2mL of 100ppm standard (Section 8.9.1) to 100mL with 0.2% Boric Acid solution (Section 8.8).

8.9.1.1.5 1.00ppm: 1mL of 100ppm standard (Section 8.9.1) to 100mL with 0.2% Boric Acid solution (Section 8.8).

8.9.1.1.6 **0.400ppm:** 4mL of 20ppm standard (Section 8.9.1.1.1) to 200mL with 0.2% Boric Acid solution (Section 8.8).

8.9.1.1.7 **0.200ppm:** 1mL of 20ppm standard (Section 8.9.1.1.1) to 100mL with 0.2% Boric Acid solution (Section 8.8). Alternately, this standard may be prepared utilizing autodilution of the 20ppm standard on the autosampler.

8.9.1.1.8 **0.100ppm:** 1mL of 20ppm standard (Section 8.9.1.1.1) to 200mL with 0.2% Boric Acid solution (Section 8.8). Alternately, this standard may be prepared utilizing autodilution of the 20ppm standard on the autosampler.

8.9.1.1.9 **0.050ppm:** 20mL of 0.100ppm standard (Section 8.9.1.1.8) to 40mL with 0.2% Boric Acid solution (Section 8.8). Alternately, this standard may be prepared utilizing autodilution of the 20ppm standard on the autosampler.

8.9.1.2 Continuing Calibration Standards:

8.9.1.2.1 **0.400ppm Low CCV:** 4mL of 20ppm standard (Section 8.9.1.1.1) to 200mL with 0.2% Boric Acid solution (Section 8.8).

8.9.1.2.2 **4.00ppm Hi CCV:** 8mL of 100ppm standard (Section 8.9.1) to 200mL with 0.2% Boric Acid solution (Section 8.8).

8.9.2 Spiking solution, 200ppm as NH_3: To a 100mL volumetric flask add 20mL of 1000ppm Stock Standard (Section 8.9) and dilute to the mark with DI water.

8.10 Stock Standard Solution, 1000ppm as NH_3 (for ICV and LCS): Commercially prepared. Certificate of analysis is required. This must be from a <u>different source</u> than that used for Stock Standard (Section 8.9).

8.10.1 Initial Calibration Verification Standards (ICV):

8.10.1.1 Hi ICV, 10ppm: To a 100mL volumetric flask add 1mL of 1000ppm standard (Section 8.10). Dilute to the mark with 0.2% Boric Acid Solution (Section 8.8).

8.10.1.2 Low ICV, 1.0ppm: To a 100mL volumetric flask add 10mL of 10ppm ICV (Section 8.10.1.1). Dilute to the mark with 0.2% Boric Acid Solution (Section 8.8).

8.10.2 LCS solution, 200ppm as NH_3: To a 100mL volumetric flask add 20mL of 1000ppm Stock Standard (Section 8.10) and dilute to the mark with DI water.

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9. Procedure

9.1 SET-UP

9.1.1 Prior to analysis, organize samples in order from low to high odor.

9.1.2 Clean 250mL Tecator tubes by rinsing twice with approximately 0.5mL of 6N NaOH solution and 100mL RO water. Rinse twice again with DI water.

9.2 Initial Calibration

Calibrate the Lachat ion analyzer according to manufacturer's instructions.

9.2.1 Calibration

Two boards are used to calibrate the Lachat instrument. Each curve has 7 calibration points. The correlation coefficient of each curve must be $\geq$ 0.995, otherwise re-calibration is necessary. Prepare standard curves by plotting the peak areas of standards processed through the manifold against NH_3-N concentrations in standards.

9.2.1.1 Channel 1 is used to generate a calibration curve on the low range from 0.00 – 2ppm.

9.2.1.2 Channel 2 is used to generate a calibration curve on the high range from 0 – 20ppm.

9.2.2 Initial Calibration Verification (ICV)

Prior to sample analysis, an ICV is analyzed at 1.0ppm to verify the low calibration curve on Channel 1. Another ICV is analyzed at 10ppm to verify the high calibration curve on Channel 2. Both ICVs must yield results ± 10% of their true value, otherwise re-calibration is necessary.

9.2.3 Initial Calibration Blank (ICB)

Following the ICV is the analysis of an ICB. The ICB consists of an aliquot of 0.2% Boric Acid (Section 8.8). Results must be less than < 0.05mg/L.

9.3 Standardization (Continuing Calibration Verification)

Analyze the following after every 10 samples and at the completion of analysis:

0.400ppm Low CCV, (Section 8.9.1.2.1)

4.0ppm Hi CCV, (Section 8.9.1.2.2)

Blank, 0.2% Boric Acid Solution. (Section 8.8)

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9.4 Equipment Operation and Sample Analysis

9.4.1 Sample preparation: Add 100mL dechlorinated sample or a portion diluted to 100mL with DI water, to pre-washed Tecator tubes that are numbered to correspond with the samples.

In a similar manner, prepare the QC samples to be distilled with the batch (refer to Sections 10.2.1, 10.3, 10.5 and 10.8).

Add approximately 1.0mL of $Na_2S_2O_3$ to each tube, followed by 5.0mL of Borate Buffer solution. Add small amounts of 6N NaOH until the pH is adjusted to 9.5.

9.4.2 Distillation

9.4.2.1 Equipment preparation: To clean any prior contamination, first rinse the Tecator distillation unit by running a series of 3 rinse tubes. The first rinse containing 90mL DI and 10mL 6N NaOH. The second and third rinses are with100mL DI and 0.5mL 6N NaOH.

9.4.2.2. Distillation: Begin by distilling rinse tubes, Blank, Low and Hi LCS, and then Samples and QC Samples using the Tecator Instruments Automatic Distillation Unit according to the manufacturer's instructions.

Distillate is collected from the Tecator unit in 250mL disposable polypropylene cups that contain 20mL of 1.5% Boric acid (Section 8.7). Distillation is complete after collection of approximately 140mL. Fill each cup to 150mL with DI water. Cover and store at 1-4° C if Lachat analysis is to be delayed.

9.4.3 Ammonia analysis of distillate: Follow the manufacturer's instructions for the proper operation of the Lachat ion analyzer. The following are specific notes for this analysis.

Sample throughput:	90 samples/hr; 40sec/sample
Pump speed:	35
Cycle period:	40 s
Inject to start of peak period:	25 s
Inject to end of peak period:	63 ± s

9.4.4 System Notes:

9.4.4.1 Allow 15 minutes for heating unit to warm up to 60°C.

9.4.4.2 System IV GAIN: 175 X 1

9.4.4.3 If standards are not distilled, samples should be multiplied by 1.5 to correct for the increase in volume after the distillation.

9.4.4.4 If baseline drifts, peaks are too wide, or other problems with precision arise, clean the manifold by the following procedure:

9.4.4.4.1 Place all reagent lines in deionized water and pump to clear reagents (2-5 minutes).

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9.4.4.4.2 Place reagent lines and carrier in 1M hydrochloric acid (1 volume concentrated HCl added to 11 volumes of deionized water) and pump for several minutes.

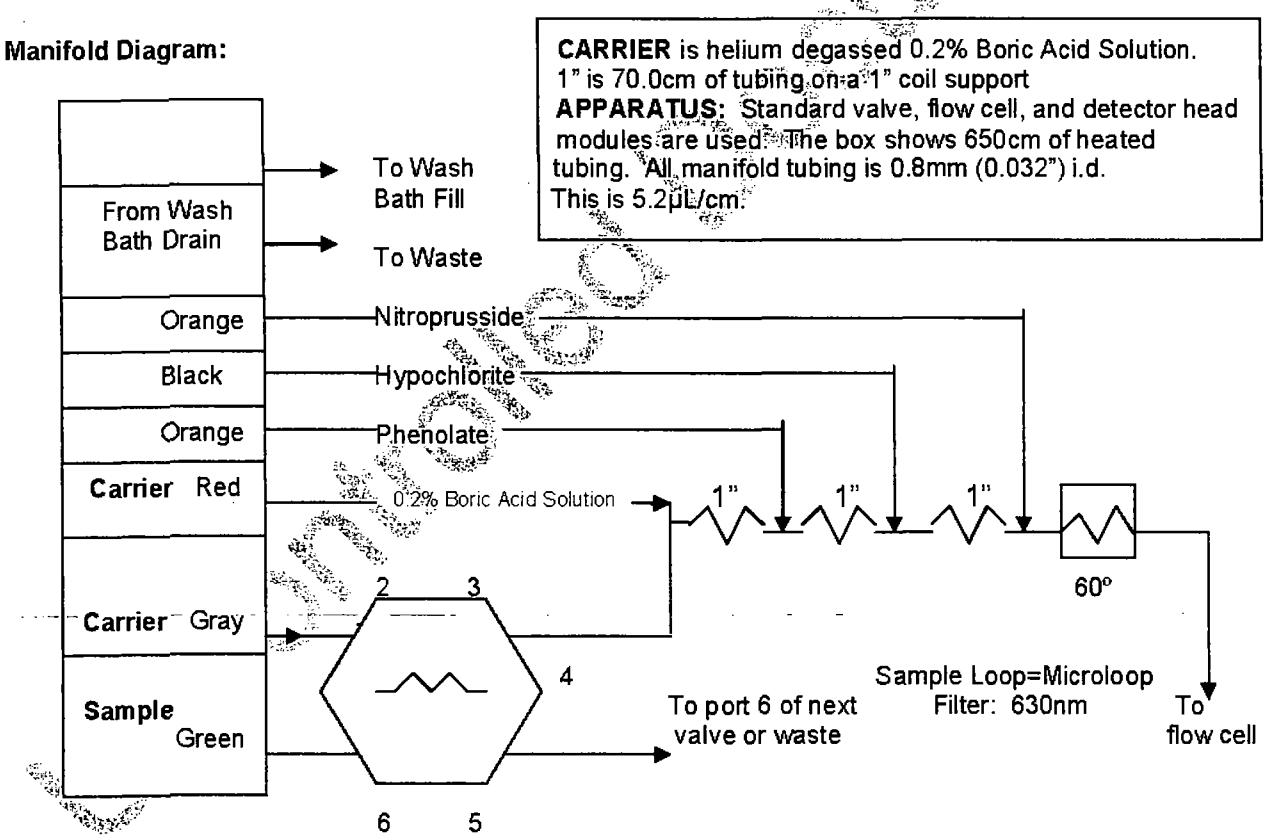
9.4.4.4.3 Place all lines in deionized water and pump until the HCl is thoroughly washed out.

9.4.4.4.4 Resume pumping reagents.

9.4.4.4.5 If sample distillate is colored or turbid, discard the sample distillate and re-distill the original sample at a higher dilution (Sections 9.4.1 and 9.4.2).

If there is not sufficient original sample volume for re-distillation, the colored/turbid distillate may be filtered through a 0.45µm filter and diluted on the Lachat instrument.

Manifold Diagram:



9.5 Preventative Maintenance

9.5.1 All lines are flushed at the end of each run.

9.5.2 All equipment is kept clean.

9.6 Calculations

Compute sample NH_3-N concentration by comparing sample peak areas with standard curve, as determined by the Lachat instrument software.

9.6.1 If the sample has a concentration of less than 2ppm, calculate results by using the low curve generated on Channel 1.

9.6.2 If the sample concentration is greater than 2ppm but less than 20ppm, calculate results by using the high curve generated on Channel 2.

9.6.3 If the concentration is greater than 20ppm, dilute the sample and reanalyze.

10. Quality Control and Data Assessment

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method. When results of sample spikes indicate atypical method performance, a calibration verification standard is used to confirm the measurements were performed in an in-control mode of operation.

10.1 Demonstration of Capability

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method. Each time a method modification is made, the analyst is required to repeat the procedure.

When one or more of the parameters tested fail at least one of the acceptance criteria, the analyst must locate and correct the source of the problem and repeat the test for failed parameters of the method.

Repeated failure confirms a general problem with the measurement system or analytical technique of the analyst. If the failure repeats, locate and correct the source of the problem and repeat the test for all parameters listed in the method.

10.2 Blank

10.2.1 The Distillation Blank is 100 mL DI. Distill one per batch of 20 samples or less.

10.2.2 The Analytical Blank (ICB) for the Lachat analysis is not distilled and is 0.2% Boric Acid Solution (Section 8.8).

The ICB is run after the initial calibration verification standards (ICV) and another is run after the continuing calibration standards (CCV).

10.3 Laboratory Control Samples (LCS)

10.3.1 Distillation: Distill a Low and a Hi LCS with each batch of 20 samples or less.

10.3.1.1 Low 2ppm LCS: Add 1mL of 200ppm LCS solution (Section 8.10.2) to 100mL DI. This is used for the Low 0 – 2ppm curve.

10.3.1.2 Hi 20ppm LCS: Add 10mL of 200ppm LCS solution (Section 8.10.2) to 100mL DI. This is used for the Hi 2 – 20ppm curve.

10.4 Initial Calibration Verification Standards

10.4.1 Lachat Analysis: The ICVs are not distilled. Analyze the following after calibration of the Lachat instrument. Recoveries must be within 10% of the true value, otherwise recalibration of the instrument is necessary.

10.4.1.1 Low ICV, 1.0ppm (Section 8.10.1.2)

10.4.1.2 Hi ICV, 10ppm (Section 8.10.1.1)

10.5 Continuing Calibration Verification Standards

10.5.1 Lachat Analysis: The CCVs are not distilled. Analyze the following after every ten samples and at the completion of analysis. Recoveries must be within 10% of the true value.

If recoveries fall outside of this range, the cause for the failure is determined and corrected, and the instrument is recalibrated. All samples that were analyzed since the last CCV that was within range are reanalyzed.

10.5.1.1 0.4ppm Low CCV (Section 8.9.1.2.1)

10.5.1.2 4.0ppm Hi CCV (Section 8.9.1.2.2)

10.6 Interference Check Standards

None.

10.7 Matrix Spike

One per batch of 20 samples or less. Prior to distillation, use 2mL of 200ppm Intermediate Stock Standard (Section 8.9.2) per 100mL of sample.

10.8 Duplicates

Distill one duplicate sample per batch of 20 samples or less.

10.9 Control Limits

The laboratory maintains performance records to document the quality of data that is generated. Method accuracy for samples is assessed and records maintained.

Control limits for the method parameters are generated by the QC staff. The control limits are calculated based on in-house performance data. The limits are compared to the control limits found in the reference method.

10.10 Analytical Sequences

10.10.1 Distillation Sequence:

3 Rinse tubes
Blank
Low LCS
Hi LCS
Rinse
Samples
Rinse after suspected high samples
Duplicate
Spike
Rinse
Shut-Down

10.10.2 Lachat Analytical Sequence:

Instrument Calibration
CCV
Low ICV
Hi ICV
IC Blank
Samples
CCV : Low, Hi, CC Blank every 10 samples and at completion of analysis
Shut-Down

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11. Method Performance

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations were obtained using reagent water. Similar results were achieved using representative wastewaters. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects.

Method performance data is on file in the laboratory QC department. Comparison of method performance data for the laboratory to the reference method criteria occurs when laboratory in-house acceptance limits are generated. In-house generated data must be within the specifications of the reference method or the analysis is not continued until corrective action is completed.

12. Corrective Actions

Holding time exceedence, improper preservation and observed sample headspace are noted on the nonconformance report form.

Perform routine preventative maintenance following manufacturer's specification. Record all maintenance in the instrument logbook.

Review of standards, blanks and standard response for acceptable performance occurs for each batch of samples. Record any trends or unusual performance on a nonconformance action form.

If the CV or LCS recovery of any parameter falls outside the designated acceptance range, the laboratory performance for that parameter is judged to be out of control, and the problem must be immediately identified and corrected. The analytical result for that parameter in the unspiked samples is suspect and is only reported for regulatory compliance purposes with the appropriate nonconformance action form. Immediate corrective action includes reanalyzing all affected samples by using any retained sample before the expiration of the holding time and/or recalibration of the instrument.

13. Pollution Prevention

NOTE: Lachat Phenol waste is hazardous and must be disposed of in "Hazmat" Lachat waste drums.

See Chemical Hygiene Plan for pollution prevention operations.

14. Waste Management

See Chemical Hygiene Plan for waste handling and disposal.

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Nitrate, Nitrite and Nitrate/Nitrite Nitrogen

Automated Cadmium Reduction Method

References: **Methods 353.2:** Methods for the Determination of Inorganic Substances in Environmental Samples, EPA 600/ R-93/ 100. August, 1993.

Methods 4500NO_3-F: Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF, 18th Edition, 1992.

Method 10-107-04-1, Lachat Instruments, 6645 West Mill Road, Milwaukee, WI 53218, 1992.

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Prepared by:

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Signature: E. Dayn Date: 10/13/08

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Name: Christopher Wakefield Position: Laboratory/Technical Director

Signature: [signature] Date: 10/14/08

ISSUE AMENDMENTS

Changes since last issue:

Section 4.4: Clarified procedure for samples containing large concentrations of oil and grease.
Section 4.5: Clarified procedure for samples containing residual chlorine.
Section 6.3: Clarified procedure to be followed if 48 hour hold time cannot be met.
Section 8: Clarified preparation, storage and expiration of of Stock Standards, Intermediate Standards and Calibration Standards.
Section 8.13: Added use of DPD Powder Pillows for 25mL sample aliquot.
Section 9.3: Clarified Continuing Calibration to be performed at the beginning of first tray.
Sections 10.4 and 10.5: Added acceptance criteria information and corrective action.

Nitrate, Nitrite and Nitrate/Nitrite Nitrogen

Automated Cadmium Reduction Method

References: **Methods 353.2, 354.1:** Methods for the Determination of Inorganic Substances in Environmental Samples, EPA 600/ R-93/ 100. August, 1993.

Methods 4500NO_3-F, 4500NO_2-B: Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF, 18th Edition, 1992.

Method 10-107-04-1, Lachat Instruments, 6645 West Mill Road, Milwaukee, WI 53218, 1992.

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1. Scope and Application

Matrices: This method is limited to optically clear water samples with a total concentration of nitrite and nitrate below 8mg N/L.

Definitions: See Alpha Laboratories Quality Manual Appendix A

In waters and wastewaters, the forms of nitrogen of greatest interest are, in order of decreasing oxidation state, nitrate, nitrite, ammonia, and organic nitrogen. All these forms of nitrogen, as well as nitrogen gas (N_2), are biochemically interconvertible and are components of the nitrogen cycle. They are of interest for many reasons.

Organic nitrogen is defined functionally as organically bound nitrogen in the trinegative oxidation state. It does not include all organic nitrogen compounds. Analytically, organic nitrogen and ammonia can be determined together and have been referred to as "kjeldahl nitrogen," a term that reflects the technique used in their determination. Organic nitrogen includes such natural materials as proteins and peptides, nucleic acids and urea. Numerous concentrations vary from a few hundred micrograms per liter in some lakes to more than 20mg/L in raw sewage.

Total oxidized nitrogen is the sum of nitrate and nitrite nitrogen. Nitrate generally occurs in trace quantities in surface water but many attain high levels in some groundwater. In excessive amounts, it contributes to the illness known as methemoglobinemia in infants. A limit of 10mg nitrate as nitrogen/L has been imposed on drinking water to prevent this disorder. Nitrate is found only in small amounts in fresh domestic wastewater but in the effluent of nitrifying biological treatment plants, nitrate may be found in concentrations of up to 30mg nitrate as nitrogen/L. It is an essential nutrient for many photosynthetic autotrophs and has been identified as a growth-limiting nutrient.

Nitrite is an intermediate oxidation state of nitrogen, both in the oxidation of ammonia to nitrate and in the reduction of nitrate. Such oxidation and reduction may occur in wastewater treatment plants, water distribution systems, and natural waters. Nitrite can enter a water supply system through its use as a corrosion inhibitor in industrial process water. Nitrite is the actual etiologic agent of methemoglobinemia. Nitrous acid, which is formed from nitrite in acidic solution, can react with secondary amines (RR'NH) to form nitrosamines (RR'N-NO), many of which are known to be carcinogens. The toxicologic significance of nitrosation reactions in vivo and in the natural environment is the subject of much current concern and research.

Within this SOP, organic nitrogen is referred to as organic N, nitrate nitrogen as NO_3^--N, and nitrite nitrogen as NO_2^--N.

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one of the following laboratory personnel

before performing the modification: Area Supervisor, Laboratory Director, or Quality Assurance Officer.

This method is restricted to use by or under the supervision of analysts experienced in the operation of the Lachat Analyzer and in the interpretation of Lachat data. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability, analyzing a proficiency test sample and completing the record of training.

After initial demonstration, ongoing demonstration is based on acceptable laboratory performance of at least a quarterly laboratory control sample or acceptable performance from an annual proficiency test sample. A major modification to this procedure requires demonstration of performance. The identification of major method modification requiring performance demonstration is directed by the QA Officer and/or Laboratory Director on a case-by-case basis.

2. Summary of Method

Nitrate is quantitatively reduced to nitrite by passage of the sample through a copperized cadmium column. The nitrite (reduced nitrate plus original nitrite) is then determined by diazotizing with sulfanilamide followed by coupling with N-(1-naphthyl)ethylenediamine dihydrochloride. The resulting water-soluble dye has a magenta color, which is read at 520nm. Nitrite alone can be determined by removing the cadmium column. The nitrate is calculated as the difference between the reduced and non-reduced sample.

2.1 Method Modifications from Reference

None.

3. Detection Limits

The laboratory follows the procedure found in 40CFR Part 136 to determine the MDL on an annual basis. The method detection limits determined by the laboratory are on file for review.

This method has an analytical range of 0.1 to 8.0mg N/L in the form of nitrate and/or nitrite.

The Reporting Limit is 0.1mg/L.

4. Interferences

4.1 Suspended matter in the column will restrict sample flow.

4.2 For turbid samples, filter through 0.45µm membrane filter prior to analysis.

4.3 Low results would be obtained for samples that contain high concentrations of iron, copper or other metals. In this method, EDTA is added to the buffer to reduce this interference.

4.4 Samples that contain large concentrations of oil and grease will coat the surface of the cadmium. In this case, only the water phase of the sample is used for analysis and a narrative is submitted with the data. Dilutions are performed as necessary.

4.5 Residual chlorine can interfere by oxidizing the Cd column, reducing its efficiency. Prior to analysis, check wastewater and drinking water samples for residual chlorine and record results in the Laboratory Notebook. If residual chlorine is present, and the samples are preserved with H_2SO_4, the sample may be analyzed for NO_3/NO_2 determination. However, NO_2 must be performed by a manual method. If it is not possible to analyze NO_2 by a manual method, the result is reported as NA and a narrative is submitted.

4.6 Sample color interferes if it is absorbed at about 540nm.

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5. Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material data handling sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

6. Sample Collection, Preservation, and Handling

6.1 Sample Collection

Samples are collected in glass or plastic bottles; 250mL minimum volume.

6.2 Sample Preservation

Refrigerate samples at 4 ± 2 °C.

For Nitrate/Nitrite analysis, the samples are preserved with 1:1 H_2SO_4.

6.3 Sample Handling

Begin NO_3^- and/or NO_2^- determinations promptly after sampling. If storage is necessary, store for up to 48 hours at 4 ± 2 °C.

NOTE: If the 48-hour hold time cannot be met, the sample is to be handled as follows, only in an emergency situation. These instructions are not to be used on a regular basis.

Prior to the expiration of the 48-hour hold time, the following three steps are executed:

1. A manually colored Nitrite test is performed by Method 354.2. Results are recorded in the Laboratory Notebook.
2. A 50mL aliquot of the sample is preserved to a pH of <2 with concentrated H_2SO_4. Preservation is recorded in the Laboratory Notebook.

Prior to analysis, within 14 days of preservation, the preserved sample is neutralized using 6N NaOH. The sample is analyzed using only the Lachat Instrument.

CAUTION! Samples must NOT be preserved with mercuric chloride or thiosulfate because this will degrade the cadmium column.

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7. Equipment and Supplies

7.1 Lachat 8000 Automated Ion Analyzer

7.2 Nitrate+Nitrite Lachat Board

7.3 Nitrite Lachat Board

7.4 Pre-packed Cadmium Columns: Available from Lachat.

8. Standards and Reagents

8.1 Stock Nitrate Standard, 1000mg N/L as NO_3^-: Purchased commercially prepared with certificate of analysis. Expires upon manufacturer's expiration date.

8.1.1 Stock Nitrate Standard, 200.0mg N/L as NO_3^-: Pipet 20mL of 1000ppm standard (Section 8.1) into 100mL volumetric flask and bring to volume with DI.

Alternately, in a 1L volumetric flask, dissolve 1.444g potassium nitrate (KNO_3) in about 600mL DI. Add 2mL chloroform. Dilute to the mark with DI and invert to mix. Refrigerate at 4±2°C. This solution is stable for six months.

8.2 Stock Nitrite Standard, 1000mg N/L as NO_2^-: Purchased commercially prepared with certificate of analysis. Expires upon manufacturer's expiration date.

8.2.1 Stock Nitrite Standard, 200.0mg N/L as NO_2^-: Pipet 20mL of 1000ppm standard (Section 8.2) into 100mL volumetric flask and bring to volume with DI.

Alternately, in a 1L volumetric flask, dissolve 0.986g sodium nitrite ($NaNO_2$) or 1.214g potassium nitrite (KNO_2) in approximately 800mL DI. Add 2mL chloroform. Dilute to the mark with DI and invert to mix. Refrigerate at 4±2°C. This solution is stable for six months.

8.3 Intermediate Nitrate Working Standard, 20 mg N/L as Nitrate: To a 250mL volumetric flask, add 25.0mL of the 200mg N/L NO_3^- stock standard. Dilute to the mark with DI and invert to mix. These solutions are stable for two weeks. Refrigerate at 4±2°C.

8.4 Intermediate Nitrite Working Standard, 20 mg N/L as Nitrite: To a 250mL volumetric flask, add 25.0mL of the 200mg N/L NO_2^- stock standard. Dilute to the mark with DI and invert to mix. These solutions are stable for two weeks. Refrigerate at 4±2°C.

8.5 Set of Six Calibration NO_3^- Standards, 8.0, 4.0, 1.00, 0.40, 0.20 and 0.1mg N/L as Nitrate: These standards are stable for 2 weeks. Refrigerate at 4±2°C.

To four 200mL volumetric flasks, add respectively: 8.0, 4.0, 1.0 and 0.5mL of the 200mg N/L NO_3^- stock standard. Bring to volume with DI water.

To two 200mL volumetric flasks, add respectively: 2.0 and 1.0mL of the 20mg N/L NO_3^- intermediate standard. Bring to volume with DI water.

8.6 Set of Seven Calibration NO_2^- Standards, 8.0, 4.0, 1.00, 0.40, 0.20, 0.10 and 0.05mg N/L as Nitrite: These standards are stable for 2 weeks. Refrigerate at 4±2°C.

To three 200mL volumetric flasks, add respectively: 8.0, 4.0 and 1.0 of the 200mg N/L NO_2^- stock standard. Bring to volume with DI water.

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To three 200mL volumetric flasks, add respectively: 2.0, 1.0mL and 0.05mL of the 20mg N/L NO_2^- intermediate standard. Bring to volume with DI water.

To one 250mL volumetric flask, add 0.5mL of 200mg N/L NO_2^- stock standard. Bring to volume with DI water.

8.7 Ammonium Chloride Buffer, pH 8.5: In a 1L volumetric flask, dissolve 85.0g ammonium chloride (NH_4Cl) and 1.0g disodium ethylenediamine tetraacetic acid dihydrate ($Na_2EDTA{\cdot}2H_2O$) in about 800mL water. Dilute to the mark with DI water and invert to mix. Adjust the pH to 8.5 with concentrated ammonium hydroxide. This solution is prepared monthly and stored at room temperature.

8.8 Sulfanilamide Color Reagent: To a 1L volumetric flask add about 600mL water. Then add 100mL of 85% phosphoric acid (H_3PO_4), 40.0g sulfanilamide, and 1.0g N-(1-naphthyl)ethylenediamine dihydrochloride (NED). Shake to wet, and stir to dissolve for 30 minutes. Dilute to the mark with DI water and invert to mix. Store in a dark bottle. This solution is stable for one month. Store at room temperature.

8.9 100ppm Nitrate Stock Standard: Commercially prepared. Must be separate source from stocks used for calibration standards. Store refrigerated at 4±2°C. Expires upon manufacturer's expiration date.

8.10 100ppm Nitrite Stock Standard: Commercially prepared. Must be separate source from stocks used for calibration standards. Store refrigerated at 4±2°C. Expires upon manufacturer's expiration date.

8.11 Initial Calibration Verification Standard (ICV)/Laboratory Control Sample (LCS): Store refrigerated at 4±2°C. Expiration is 2 weeks from date of preparation.

8.11.1 Nitrate ICV/LCS, 5.0ppm: Pipet 5.0mL of 100ppm stock (Section 8.9) into a 100mL volumetric flask and bring to volume with DI.

8.11.2 Nitrate ICV/LCS, 0.5ppm: Pipet 10.0mL of 5.0ppm standard (Section 8.11.1) into a 100mL volumetric flask and bring to volume with DI.

8.11.3 Nitrite ICV/LCS, 5.0ppm: Pipet 5.0mL of 100ppm stock (Section 8.9) into a 100mL volumetric flask and bring to volume with DI.

8.11.4 Nitrite ICV/LCS, 0.5ppm: Pipet 10.0mL of 5.0ppm standard (Section 8.11.3) into a 100mL volumetric flask and bring to volume with DI.

8.12 DPD Free Chlorine Reagent Powder Pillows: HACH brand, for 25mL sample. Store at room temperature. Expires upon manufacturer's expiration date.

9. Procedure

9.1 SET-UP

9.1.1 Preparation

9.1.1.1 Place the Nitrate+Nitrite board (containing the cadmium column) in Channel 1. Place the Nitrite board in Channel 2. Make sure the valve to the cadmium column is closed prior to starting to pump the reagents.

9.1.1.2 Commence pumping of reagents.

9.1.1.3 Once the lines are full of reagent and free of gas bubbles, open the valve to allow reagent to flow through the cadmium column.

NOTE: Be sure to switch the valve back before rinsing the manifold with DI water at the completion of the run.

NOTE: DO NOT LET AIR ENTER THE CADMIUM COLUMN.

9.1.2 Column Efficiency Procedure

9.1.2.1 Visually inspect the column. Check for air bubbles in the column or lines, gaps in the column or any change in the cadmium surface characteristics, (cadmium granules should be dark gray). If air bubbles are present in column, connect the column into the manifold, turn the pump on maximum and tap firmly with a screwdriver handle, being careful not to break the column, working up the column until all air is removed. If air cannot be removed, the column should be repacked. Cadmium columns should be stored filled with buffer. If air enters the column, efficiency will decrease. Check the flow efficiency by disconnecting the cadmium column from the manifold and reconnecting to a green pump tube. Pump buffer through the packed column and collect in a graduated cylinder. The flow rate with the column connected should be greater than 4.0 mL/minute.

9.1.2.2 **Column Efficiency – Slope Ratio Method:** Calibrate with the mid-range NO_3–N standards. Calibrate with a matching concentration range of NO_2–N standards. The column efficiency is determined by the equation:

$$E = \frac{S_{NO3\text{-}N}}{S_{NO2\text{-}N}} \times 100$$

where:

$S_{NO3\text{-}N}$ = slope of NO_3 calibration
$S_{NO2\text{-}N}$ = slope of NO_2 calibration
E = % efficiency

9.1.2.3 **Column Efficiency – Concentration Ratio Method:** Calibrate with the mid-range NO_2-N and NO_3-N standards. Run a known concentration NO_2-N standard. Run a matching concentration NO_3-N standard. The column efficiency is determined by the following equation:

$$E = \frac{C_{NO3\text{-}N}}{C_{NO2\text{-}N}} \times 100$$

where:

$C_{NO3\text{-}N}$ = concentration of NO_3 standard
$C_{NO2\text{-}N}$ = concentration of NO_2 standard
E = % efficiency

9.1.2.4 **Column Efficiency Result:** If the efficiency is <75%, the column is repacked. All results are recorded and maintained on file in the QC department.

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9.1.3 Residual Chlorine Screening

Check all wastewater and drinking water samples for residual chlorine prior to analysis.

9.1.3.1 Add 1 DPD Free Chlorine powder pillow (Section 8.12) to 25mL of sample in a centrifuge tube. An immediate color change to pink indicates residual chlorine is present. If residual chlorine is present, do not analyze the sample. Notify the Department Supervisor and/or the Laboratory Director. Results will be reported as Not Applicable (N/A).

If residual chlorine is not present, continue with sample analysis.

9.2 Initial Calibration

Calibrate the Lachat ion analyzer according to manufacturer's instructions.

9.2.1 Calibration

Two boards are used to calibrate the Lachat instrument. Each curve has seven calibration points. The correlation coefficient of each curve must be $\geq$0.995, otherwise recalibration is necessary. Prepare standard curves by plotting the peak areas of standards processed through the manifold against NO_3+NO_2 as N and NO_2 as N concentrations in standards.

9.2.1.1 Channel 1 is used to generate a calibration curve for Nitrate/Nitrite ranging from 0 to 8.0ppm.

9.2.1.2 Channel 2 is used to generate a calibration curve for Nitrite ranging from 0 to 8.0ppm.

9.2.2 Initial Calibration Verification (ICV)

9.2.2.1 Prior to sample analysis, the following ICVs must be analyzed to verify both calibration curves.

9.2.2.1.1 Nitrate ICV, 0.5ppm (Section 8.12.2)

9.2.2.1.2 Nitrate ICV, 5.0ppm (Section 8.12.1)

9.2.2.1.3 Nitrite ICV, 0.5ppm (Section 8.12.4)

9.2.2.1.4 Nitrite ICV, 5.0ppm (Section 8.12.3)

9.2.2.2 The results must be within $\pm$10% of the true value, otherwise re-calibration is required.

9.3 Continuing Calibration Verification

9.3.1 Continuing Calibration Verification, (CCV) and Continuing Calibration Blank, (CCB)

9.3.1.1 At the beginning of the first tray, after every ten samples and at the end of every analytical sequence, a CCV and a CCB pair must be analyzed to verify both calibration curves.

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9.3.1.1.1 1.0ppm Nitrate CCV (Section 8.5)

9.3.1.1.2 1.0ppm Nitrite ICV (Section 8.6)

9.3.1.1.3 Calibration Blank (DI)

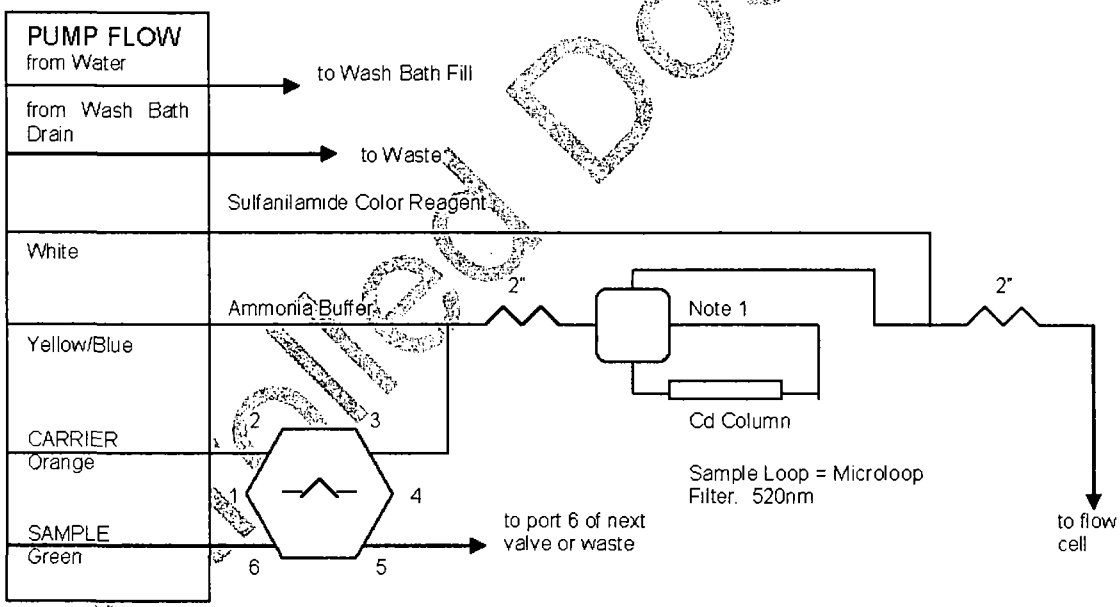
9.3.1.2 The results of the CCVs must be within ±10% of the true value, otherwise re-calibration is required.

9.3.1.3 The results of the CCBs must be less than our standard limit of detection, otherwise the analysis is stopped and the problem corrected.

9.4 Equipment Operation and Sample Analysis

Follow the manufacturer's directions for the operation of the Lachat 8000.

The Manifold Diagram follows:



CARRIER is water.

2" is 135cm of tubing on a 2-inch coil support.
APPARATUS: Standard valve, flow cell, and detector head modules are used.

All manifold tubing is 0.8mm (0.032") i.d. This is 5.2µL/cm.

NOTE 1: This is a two-state switching valve used to place the cadmium column in line with the manifold.

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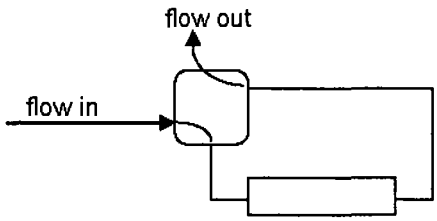
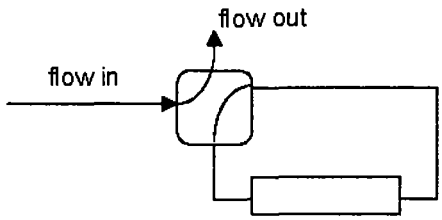
State 1: Nitrate + Nitrite



State 2: Nitrite Only



9.5 Preventative Maintenance

Tubing is changed monthly or as needed.

At the end of each analytical sequence, the valve to the column is closed. DI is rinsed through the Lachat for five minutes followed by five minutes of air.

All maintenance is documented in the Instrument Maintenance Logbook.

9.6 Calculations

9.6.1 **Nitrate/Nitrite:** When the software is set up according to the manufacturer's recommendations, the concentration of nitrate plus nitrite in mg NO_3/NO_2-N/L is reported directly when the Cd column is included in the sample train in Channel 1.

9.6.2 **Nitrite:** When the software is set up according to the manufacturer's recommendations, the concentration nitrite in mg NO_2-N/L is reported directly when the Cd is not included in the sample train in Channel 2.

9.6.3 **Nitrate:** The concentration of nitrate is determined by the subtraction of the nitrite concentration, (Section 9.6.2 above), from the nitrate-nitrite concentration, (Section 9.6.1 above).

9.6.3.1 If the sample was preserved initially as described in Section 6.3, subtract the Nitrite value generated manually from the Nitrate/Nitrite value generated by the Lachat Instrument. This value is reported as the Nitrate result.

When the sample is preserved initially as described in Section 6.3, the value generated by the Lachat instrument for Nitrite is invalid and therefore disregarded.

9.6.4 If any sample exceeds a concentration of 8.0 mg/L, the sample must be diluted and re-analyzed. All sample concentrations must fall within the calibration curve.

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10. Quality Control and Data Assessment

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method. When results of sample spikes indicate atypical method performance, a calibration verification standard is used to confirm the measurements were performed in an in-control mode of operation.

10.1 Demonstration of Capability

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method. Each time a method modification is made, the analyst is required to repeat the procedure.

When one or more of the parameters tested fail at least one of the acceptance criteria, the analyst must locate and correct the source of the problem and repeat the test for failed parameters of the method.

Repeated failure confirms a general problem with the measurement system or analytical technique of the analyst. If the failure repeats, locate and correct the source of the problem and repeat the test for all parameters listed in the method.

10.2 Method Blank

One Method Blank is analyzed per batch of 20 samples or less. The Method Blank consists of DI. Results must be < 0.1mg/L. If this criterion is not met, the blank is re-analyzed. If there is still failure, the problem must be found and corrected prior to any sample analysis.

10.3 Calibration Verification and Laboratory Control Samples (LCS)

Two ICVs are analyzed at the beginning of the analytical sequence. One is at a concentration of 0.5ppm, and the other is at a concentration of 5.0ppm.

Both must be recovered within ± 10% of the true value. If these criteria are not met, the ICVs must be re-analyzed. If failure continues, the ICVs are to be re-made and/or a new calibration curve is to be generated.

The 5ppm ICV is reported as the LCS for the batch.

10.4 Matrix Spike

One Matrix Spike is analyzed per batch of 20 samples or less. Separate spikes are performed for Nitrate and Nitrite. In a 25mL volumetric flask, 0.5mL of 200ppm stock calibration standard (Section 8.1 or 8.2) is added to the sample. The final concentration of the matrix spike is 4.0ppm. The nitrate standard is used for spikes for Nitrate-N as well as Nitrate/Nitrite-N. The nitrite standard is used for spikes for Nitrite-N.

% Recovery for the Matrix Spike must be within in-house control limits. If acceptance criteria are not met, the Matrix Spike is reanalyzed. If failure continues, a narrative is included with the data for inclusion on the Client report.

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10.5 Duplicates

One Duplicate sample is analyzed per batch of 20 samples or less. A separate aliquot of the sample is analyzed for this purpose.

% RPD for the Duplicate must be within in-house control limits. If acceptance criteria are not met, the Duplicate is reanalyzed. If failure continues, a narrative is included with the data for inclusion on the Client report.

10.6 Control Limits

The laboratory maintains performance records to document the quality of data that is generated. Method accuracy for samples is assessed and records maintained.

Control limits for the method parameters are generated by the QC staff. The control limits are calculated based on in-house performance data. The limits are compared to the control limits found in the reference method.

10.7 Analytical Sequence

- Calibration
- ICV/LCS – both levels
- Sample analysis
- CCV – every ten samples and at the end of the analytical sequence

11. Method Performance

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations were obtained using reagent water. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects.

Method performance data is on file in the laboratory QA department. Comparison of method performance data for the laboratory to the reference method criteria occurs when laboratory in-house acceptance limits are generated. In-house generated data must be within the specifications of the reference method or the analysis is not continued until corrective action is completed.

12. Corrective Actions

Holding time exceedence and improper preservation are noted on the nonconformance report form.

Perform routine preventative maintenance following manufacturer's specification. Record all maintenance in the instrument logbook.

Review of standards, blanks and standard response for acceptable performance occurs for each batch of samples. Record any trends or unusual performance on a nonconformance action form.

If the CV or LCS recovery of any parameter falls outside the designated acceptance range, the laboratory performance for that parameter is judged to be out of control, and the problem must be immediately identified and corrected. The analytical result for that parameter in the unspiked samples is suspect and is only reported for regulatory compliance purposes with the appropriate nonconformance action form. Immediate corrective action includes reanalyzing all affected samples by using any retained sample before the expiration of the holding time.

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13. Pollution Prevention

See Chemical Hygiene Plan for pollution prevention operations.

14. Waste Management

See Chemical Hygiene Plan for waste management and disposal.

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Nitrogen, Total Kjeldahl

References: **Method 351.3/.1,** Methods for Chemical Analysis of Water and Waste, EPA-600/4-79-020, U.S. Environmental Protection agency, Office of Research and Development, Environmental Monitoring and Support Laboratory, Cincinnati, OH 45268 (March 1979)

Method SM 4500N$_{org}$-C, Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF, 18th Edition, 1992.

Method 10-107-06-2-D, Methods for Automated Ion Analyzers, May 20, 1998.

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Prepared by:

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Signature: E. Dayn Date: 8/31/07

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Name: Christopher Wakefield Position: Laboratory/Technical Director

Signature: Christopher Wakefield Date: 8/31/07

ISSUE AMENDMENTS

Changes since last issue:

Section 2.1: Added modification for soil sample digestion.

Section 3: RL is 0.3 mg/L for aqueous samples and 150mg/L for soil/solid samples.

Section 8.9: Edited Stock standard to be for Calibration only.

Section 8.10: Edited Section to be for matrix spiking solution.

Section 8.11: Clarified that standard is to be used for ICV only.

Section 8.12: Edited Section to be for LCS solution.

Section 9.4.1: Added soil sample digestion.

Section 9.6: Added soil sample calculation of results.

Section 10.2.1: Edited distillation blank.

Section 10.3.1: Edited reporting of Hi LCS.

Section 11: RL reported may be from 0.3 to 60mg N/L, depending on sample loop size used.

Nitrogen, Total Kjeldahl

References: **Method 351.3/.1,** Methods for Chemical Analysis of Water and Waste, EPA-600/4-79-020, U.S. Environmental Protection agency, Office of Research and Development, Environmental Monitoring and Support Laboratory, Cincinnati, OH 45268 (March 1979)

Method SM 4500N_{org}-C, Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF, 18th Edition, 1992.

Method 10-107-06-2-D, Methods for Automated Ion Analyzers, May 20, 1998.

1. Scope and Application

Matrices: Total Kjeldahl nitrogen can be determined in potable, surface, and saline waters as well as domestic and industrial wastewaters.

Definitions: See Alpha Laboratories Quality Manual Appendix A.

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one of the following laboratory personnel before performing the modification: Area Supervisor, Laboratory Director, or Quality Assurance Officer.

This method is restricted to use by or under the supervision of analysts experienced in the operation of the Tecator and/or Lachat Instrument and in the interpretation of Lachat data. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability, analyzing a proficiency test sample and completing the record of training.

After initial demonstration, ongoing demonstration is based on acceptable laboratory performance of at least a quarterly laboratory control sample or acceptable performance from an annual proficiency test sample. A major modification to this procedure requires demonstration of performance. The identification of major method modification requiring performance demonstration is directed by the QA Officer and/or Laboratory Director on a case by case basis.

This method covers the determination of total kjeldahl nitrogen in drinking, surface and saline waters, and domestic and industrial wastes. The procedure converts nitrogen components of biological origin such as amino acids, proteins and peptides to ammonia, but may not convert the nitrogenous compounds of some industrial wastes such as amines, nitro compounds, hydrazones, oximes, semicarbazones and some refractory tertiary amines.

In waters and wastewaters the forms of nitrogen of greatest interest are, in order of decreasing oxidation state, nitrate, nitrite, ammonia, and organic nitrogen. All these forms of nitrogen, as well as nitrogen gas (N_2), are biochemically interconvertible and are components of the nitrogen cycle. They are of interest for many reasons.

Organic nitrogen is defined functionally as organically bound nitrogen in the trinegative oxidation state. It does not include all organic nitrogen compounds. Analytically, organic nitrogen and ammonia can be determined together and have been referred to as "Kjeldahl nitrogen", a term that reflects the technique used in their determination. Organic nitrogen includes such natural materials as proteins and peptides, nucleic acids and urea, and numerous synthetic organic materials. Typical organic nitrogen concentrations vary from a few hundred micrograms per liter in some lakes to more than 20mg/L in raw sewage.

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Ammonia is present naturally in surface and wastewaters. Its concentration generally is low in groundwaters because it adsorbs to soil particles and clays and is not leached readily from soils. It is produced largely by deamination of organic nitrogen containing compounds and by hydrolysis of urea. At some water treatment plants ammonia is added to react with chlorine to form a combined chlorine residual.

In the chlorination of wastewater effluents containing ammonia, virtually no free residual chlorine is obtained until the ammonia has been oxidized. Rather, the chlorine reacts with ammonia to form mono- and dichloramines. Ammonia concentrations encountered in water vary from less than 10ug ammonia nitrogen/L in some natural surface and groundwaters to more than 30 mg/L in some wastewaters.

In this discussion, organic nitrogen is referred to as organic N, nitrate nitrogen as NO_3–N, nitrite nitrogen as NO_2 - - N, and ammonia nitrogen as NH_3–N.

Total Kjeldahl nitrogen is defined as the sum of free-ammonia and organic nitrogen compounds which are converted to ammonium sulfate $(NH_4)_2SO_4$, under the conditions of digestion described below.

Organic Kjeldahl nitrogen is defined as the difference obtained by subtracting the free-ammonia value from the total Kjeldahl nitrogen value. This may be determined directly by removal of ammonia before digestion.

2. Summary of Method

The organic nitrogen is converted to ammonia via heating in the presence of concentrated sulfuric acid, K_2SO_4, $HgSO_4$, and evaporated until SO_3 fumes are obtained and the solution becomes colorless or pale yellow. The residue is cooled, diluted, and treated and made alkaline with a hydroxide-thiosulfate solution. The digestate is distilled at high pH into a solution of boric acid. The ammonia in the distillate is determined colorimetrically by the phenate method.

The phenate method is based on the Berthelot reaction. Ammonia reacts with alkaline phenol, then with sodium hypochlorite to form indophenol blue. Sodium nitroprusside (nitroferricyanide) is added to enhance sensitivity. The absorbance of the reaction product is measured at 630nm, and is directly proportional to the ammonia concentration in the digestate.

2.1 Method Modifications from Reference

This method has been modified for soil digestion, Section 9.4.1.

3. Detection Limits

The laboratory follows the procedure found in 40CFR Part 136 to determine the MDL on an annual basis. The method detection limits determined by the laboratory are on file for review.

The RDL is determined to be 0.3 mg/L for liquid samples and 150 mg/Kg for soil or solid samples.

4. Interferences

4.1 Instrumental

Samples with a high concentration of TKN may carry-over into the next sample and therefore yield false high results in that next sample. If a sample with a low concentration follows a sample with a high concentration, re-analyze the low sample to ensure results are accurate.

4.2 Parameters

High nitrate concentrations (10X or more than the TKN level) result in low TKN values. The reaction between nitrate and ammonia can be prevented by the use of an anion exchange resin (chloride form) to remove the nitrate prior to the TKN analysis.

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5. Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material data handling sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

NOTE: Both Phenol and Mercury used in this method are hazardous and general laboratory safety practices must be observed. Due to the Mercury used in this procedure, digestion must be done under a hood.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

6. Sample Collection, Preservation, and Handling

6.1 Sample Collection

The most reliable results are obtained on fresh samples. Use plastic or glass containers.

6.2 Sample Preservation

Samples may be preserved by addition of 2mL of concentrated H_2SO_4 per liter if sample cannot be analyzed immediately. Refrigerate at 4°C.

6.3 Sample Handling

Even when properly preserved, conversion of organic nitrogen to ammonia may occur. Therefore samples should be analyzed as soon as possible.

7. Equipment and Supplies

7.1 Digestion apparatus: Kjeldahl Digestion System 20, Model 1015 Digester. Follow the instrument manufacturer's instructions.

7.2 Distillation apparatus: Tecator Instruments Automatic Distillation Unit: Follow the instrument manufacturer's instructions for proper operation.

7.3 Automated Ion Analyzer: Lachat Instruments

7.4 Disposable polypropylene cups: 250mL with covers.

7.5 Glass Tuttlecaps: For digestion.

7.6 Glass Pipets: Various volumes.

7.7 Auto-pipettor with tips: For 10mL capability.

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8. Standards and Reagents

8.1 Sodium Phenolate: CAUTION! Wear gloves. Phenol causes severe burns and is rapidly absorbed into the body through the skin. In a 1L volumetric flask, dissolve 88mL of 88% liquified phenol or 83g crystalline phenol (C_6H_5OH) in approximately 600mL DI water. While stirring, slowly add 32g sodium hydroxide (NaOH). Cool, dilute to the mark, and invert three times. Do **not** degas this reagent.

8.2 Sodium Hypochlorite (approximate 2.6%): In a 500mL volumetric flask, dilute 250mL Regular Chlorine bleach [5.25% sodium hypochlorite (NaOCl)] to the mark with DI water. Invert three times to mix.

8.3 Sodium Nitroprusside (coloring agent): In a 1L volumetric flask, dissolve 3.50g sodium nitroprusside (Sodium Nitroferricyanide $[Na_2Fe(CN)_5NO_2H_2O]$) dilute to the mark with DI water. Degas with helium to prevent bubble formation. Use He at 140kPa (20 lb/in^2) through a helium degassing tube. Bubble He vigorously through the solution for one minute.

8.4 Boric 1.5% Boric Acid Solution: To a 1000mL volumetric flask add 15g Boric Acid. Dilute to the mark with DI water.

8.5 Mercuric Sulfate Solution: Dissolve 8g red mercuric oxide (HgO) in 50mL of 1:4 sulfuric acid (10.0mL concentrated H_2SO_4 : 40mL distilled water) and dilute to 100mL with distilled water.

8.6 Digestion Solution (Sulfuric Acid-Mercuric Sulfate-Potassium Sulfate): Dissolve 267g K_2SO_4 in 1300mL distilled water and 400mL concentrated H_2SO_4. Add 50mL mercuric sulfate (Section 8.5) solution and dilute to 2L with distilled water.

8.7 Sodium Hydroxide-Sodium Thiosulfate Solution: Dissolve 500g NaOH and 25g $Na_2S_2O_3 \cdot 5H_2O$ in distilled water and dilute to 1L.

8.8 0.2% Boric Acid Solution (Carrier Solution): To a 2L volumetric flask, dissolve 4g Boric Acid (H_3BO_3) in DI water. Degas by bubbling vigorously with Helium for one minute.

8.9 Stock Standard, 1000ppm as NH_3 (for calibration solutions): Commercially prepared. Certificate of analysis is required.

8.9.1 Intermediate Calibration Stock Standard, 100ppm as NH_3: To a 100mL volumetric flask, add 10.0mL of Stock Standard (Section 8.9) and dilute to the mark with 0.2% Boric Acid solution (Section 8.8). Invert three times.

8.9.1.1 Nine Working Calibration Standards: Prepare the following standards in volumetric flasks:

8.9.1.1.1 20.0ppm: 40mL of 100ppm standard (Section 8.9.1) to 200mL with 0.2% Boric Acid solution (Section 8.8).

8.9.1.1.2 8.00ppm: 8mL of 100ppm standard (Section 8.9.1) to 100mL with 0.2% Boric Acid solution (Section 8.8).

8.9.1.1.3 4.00ppm: 8mL of 100ppm standard (Section 8.9.1) to 200mL with 0.2% Boric Acid solution (Section 8.8).

8.9.1.1.4 2.00ppm: 2mL of 100ppm standard (Section 8.9.1) to 100mL with 0.2% Boric Acid solution (Section 8.8).

8.9.1.1.5 1.00ppm: 1mL of 100ppm standard (Section 8.9.1) to 100mL with 0.2% Boric Acid solution (Section 8.8).

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8.9.1.1.6 **0.400ppm:** 4mL of 20ppm standard (Section 8.9.1.1.1) to 200mL with 0.2% Boric Acid solution (Section 8.8).

8.9.1.1.7 **0.200ppm:** 1mL of 20ppm standard (Section 8.9.1.1.1) to 100mL with 0.2% Boric Acid solution (Section 8.8). Alternately, this standard may be prepared utilizing autodilution of the 20ppm standard on the autosampler.

8.9.1.1.8 **0.100ppm:** 1mL of 20ppm standard (Section 8.9.1.1.1) to 200mL with 0.2% Boric Acid solution (Section 8.8). Alternately, this standard may be prepared utilizing autodilution of the 20ppm standard on the autosampler.

8.9.1.1.9 **0.050ppm:** 20mL of 0.100ppm standard (Section 8.9.1.1.8) to 40mL with 0.2% Boric Acid solution (Section 8.8). Alternately, this standard may be prepared utilizing autodilution of the 20ppm standard on the autosampler.

8.9.1.2 Continuing Calibration Standards:

8.9.1.2.1 **0.400ppm Low CCV:** 4mL of 20ppm standard (Section 8.9.1.1.1) to 200mL with 0.2% Boric Acid solution (Section 8.8).

8.9.1.2.2 **4.00ppm Hi CCV:** 8mL of 100ppm standard (Section 8.9.1) to 200mL with 0.2% Boric Acid solution (Section 8.8).

8.10 Stock Standard, 1000ppm as TKN (for spike): Commercially prepared. Certificate of analysis is required

8.10.1 Intermediate spike Stock Standard, 200ppm as TKN: To a 100mL volumetric flask, add 20.0mL of Stock Standard (Section 8.10) and dilute to the mark with 0.2% Boric Acid solution (Section 8.8). Invert three times.

8.11 Stock Standard Solution, 1000ppm as NH_3 (for ICV only): Commercially prepared. Certificate of analysis is required. This must be from a different source than that used for Stock Standard (Section 8.9).

8.11.1 Initial Calibration Verification Standards (ICV):

8.11.1.1 Hi ICV, 10ppm: To a 100mL volumetric flask add 1mL of 1000ppm standard (Section 8.10). Dilute to the mark with 0.2% Boric Acid Solution (Section 8.8).

8.11.1.2 Low ICV, 1.0ppm: To a 100mL volumetric flask add 10mL of 10ppm ICV (Section 8.10.1.1). Dilute to the mark with 0.2% Boric Acid Solution (Section 8.8).

8.12 Stock Standard Solution, 1000ppm as TKN (for LCS): Commercially prepared. Certificate of analysis is required. This must be from a different independent source than that used for Stock Standard (Section 8.10).

8.12.1 LCS solution, 200ppm as TKN: To a 100mL volumetric flask add 20mL of 1000ppm Stock Standard (Section 8.12) and dilute to the mark with DI water.

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9. Procedure

9.1 SET-UP

9.1.1 Clean 250mL Tecator tubes by rinsing twice with approximately 0.5mL of 6N NaOH solution and 100mL RO water. Rinse twice again with DI water.

9.1.2 Rinse glass tuttlecaps under the hood in a 1000mL beaker with approximately 500mL DI and 1.0 mL NaOH. Allow to sit in this solution until use.

9.2 Initial Calibration

Calibrate the Lachat ion analyzer according to manufacturer's instructions.

9.2.1 Calibration
Two boards are used to calibrate the Lachat instrument. Each curve has 7 calibration points. The correlation coefficient of each curve must be ≥ 0.995, otherwise re-calibration is necessary. Prepare standard curves by plotting the peak areas of standards processed through the manifold against NH_3-N concentrations in standards.

9.2.1.1 Channel 1 is used to generate a calibration curve on the low range from 0.00 – 2ppm.

9.2.1.2 Channel 2 is used to generate a calibration curve on the high range from 0 – 20ppm.

9.2.2 Initial Calibration Verification (ICV)
Prior to sample analysis, an ICV is analyzed at 1.0ppm (Section 8.10.1.2) to verify the low calibration curve on Channel 1. Another ICV is analyzed at 10ppm (Section 8.10.1.1) to verify the high calibration curve on Channel 2. Both ICVs must yield results ± 10% of their true value, otherwise re-calibration is necessary.

9.2.3 Initial Calibration Blank (ICB)
Following the ICV is the analysis of an ICB. The ICB consists of an aliquot of 0.2% Boric Acid (Section 8.8). Results must be less than < 0.05mg/L.

9.3 Standardization (Continuing Calibration Verification)

Analyze the following after every 10 samples and at the completion of analysis:

0.400ppm Low CCV, (Section 8.9.1.2.1)

4.0ppm Hi CCV, (Section 8.9.1.2.2)

Blank, 0.2% Boric Acid Solution. (Section 8.8)

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9.4 Equipment Operation and Sample Analysis

9.4.1 Aqueous Sample Digestion: Add 50mL of sample or a portion diluted to 50mL with DI water, to pre-washed Tecator tubes that are numbered to correspond with the samples.

Soil/Solid Sample Digestion: Weigh 0.1g of soil/solid sample and record the weight in the laboratory notebook. Transfer to a pre-washed, pre-numbered Tecator tube and add 50mL of DI water.

In a similar manner, for each matrix, prepare the QC samples to be digested with the batch (refer to Sections 10.2.1, 10.3.1, 10.7 and 10.8)

Then add approximately 1g of black boiling chips to each tube. Move to hood before adding 10mL of Digestion Solution (Section 8.6) to each tube with a calibrated pipettor.

Rinse glass tuttlecaps with DI and place one onto the top of each Tecator tube. Place Tecator tube rack onto Tecator digestion block and turn temperature control knob to "4" which represents approximately 250°C. (Temperature should never exceed 300°C.) Cook for approximately 2 hours to SO_3 fumes. The remaining mixture will be clear or pale yellow in color. Remove tube from digestion block and allow to cool to ~80 °C before adding DI to the 90mL mark on the tube.

9.4.2 Distillation: To minimize contamination, leave distillation apparatus assembled after steaming out and until just before starting sample distillation. Make the digestate alkaline by careful addition of 20mL of sodium hydroxide-thiosulfate solution (Section 8.7) without mixing. Do not mix until the digestion tube has been connected to the distillation apparatus. Connect the Tecator tube to the Tecator distillation unit's stopper as defined in the manual. Distill for 3 minutes 40 seconds as defined in the manual and collect distillate in 20mL boric acid solution (Section 8.4). Distill at maximum rate with the tip of the delivery tube below the surface of boric acid receiving solution. Collect at least 90mL distillate. Dilute to 150mL with DI water. Refrigerate at 0-4°C if Lachat analysis is delayed.

9.4.3 Ammonia analysis of distillate: Follow the manufacturer's instructions for the proper operation of the ion-analyzer. The following are specific notes for this analysis.

Sample throughput:	90 samples/hr; 40 sec/sample
Pump speed:	35
Cycle period:	40 s
Inject to start of peak period:	25 s
Inject to end of peak period:	63 s

9.4.4 System Notes:

9.4.4.1 Allow 15 minutes for heating unit to warm up to 60°C.

9.4.4.2 System IV GAIN: 175 x 1.

9.4.4.3 If standards are not distilled, samples should be multiplied by procedure dilution (final volume 150mL) divided by initial volume.

9.4.4.4 If baseline drifts, peaks are too wide, or other problems with precision arise, clean the manifold by the following procedure:

9.4.4.4.1 Place all reagent lines in deionized water and pump to clear reagents (2-5 minutes).

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9.4.4.4.2 Place reagent lines and carrier in 1M hydrochloric acid (1 volume concentrated HCl added to 11 volumes of deionized water) and pump for several minutes.

9.4.4.4.3 Place all lines in deionized water and pump until the HCl is thoroughly washed out.

9.4.4.4.4 Resume pumping reagents.

9.4.4.5 If samples are colored or are suspected to show a background absorbance, this interference should be subtracted. This can be done by diluting or by the following procedure:

9.4.4.5.1 Calibrate the system in the normal manner.

9.4.4.5.2 Disable the check standard or DQM features and analyze the samples.

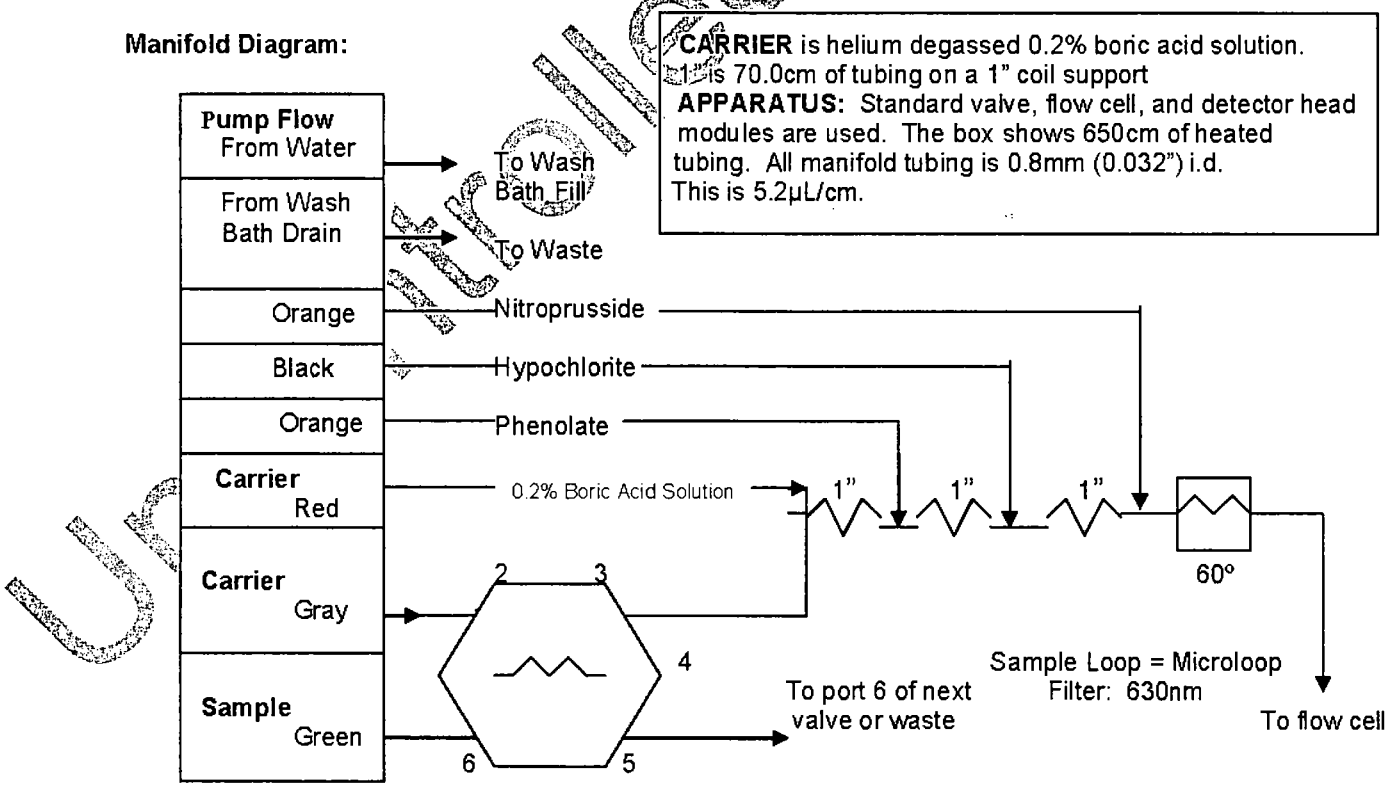
9.4.4.5.3 Place reagent and carrier lines in DI water and allow the baseline to stabilize.

9.4.4.5.4 Inject samples again without recalibrating.

9.4.4.5.5 Subtract the "background" concentration from the original concentration to give the corrected concentration.

Original Concentration – Background Concentration = Corrected Concentration.

Manifold Diagram:



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9.5 Preventative Maintenance

9.5.1 All lines are flushed at the end of each run.

9.5.2 All equipment is kept clean.

9.6 Calculations

Prepare standard curves by plotting peak areas of standards processed through the manifold against NH_3 -N concentrations in standards. Compute sample NH_3 -N concentration by comparing sample peak areas with standard curve, as determined by the Lachat instrument software.

9.6.1 If the sample has a concentration of less than 2ppm, calculate results by using the low curve generated on Channel 1.

9.6.2 If the sample concentration is greater than 2ppm, calculate results by using the high curve generated on Channel 2.

To compute final results for aqueous samples, multiply the direct reading by the dilution factor based on the initial preparation volume.

TKN mg/L = mg/L direct reading x dilution factor

To compute results for soil/solid samples, multiply the direct reading by the extraction final volume (150mL) and then divide by the weight of the sample used for extraction (Section 9.4.1), and multiply by a dilution factor as necessary.

$$\text{TKN mg/Kg} = \left[\frac{\text{(mg/L direct reading) x extraction final volume (150mL)}}{\text{Sample weight (g)}}\right] \times \text{dilution factor}$$

10. Quality Control and Data Assessment

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method. When results of sample spikes indicate atypical method performance, a calibration verification standard is used to confirm the measurements were performed in an in-control mode of operation.

10.1 Demonstration of Capability

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method. Each time a method modification is made, the analyst is required to repeat the procedure.

When one or more of the parameters tested fail at least one of the acceptance criteria, the analyst must locate and correct the source of the problem and repeat the test for failed parameters of the method.

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Repeated failure confirms a general problem with the measurement system or analytical technique of the analyst. If the failure repeats, locate and correct the source of the problem and repeat the test for all parameters listed in the method.

10.2 Blank

10.2.1 The Distillation Blank is 50mL of DI. Distill two per batch of 20 samples or less, but only the lowest is reported. Subtract any blank greater than 0.3mg/L from all samples and QC.

10.2.2 The Analytical Blank (ICB) for the Lachat analysis is not distilled and is 0.2% Boric Acid Solution (Section 8.8).

The ICB is run after the initial calibration verification standards (ICV) and another is run after the continuing calibration standards (CCV).

10.3 Laboratory Control Samples (LCS)

10.3.1 Distillation: Distill a Low and a Hi LCS with each batch of 20 samples or less. The results from the Hi LCS are reported for the batch. The Low LCS is used to verify the low curve, but is not reported.

10.3.1.1 Low 4.0ppm LCS: Add 1mL of 200ppm LCS solution (Section 8.10.2) to 50 mL DI. This is used for the Low 0 - 6 ppm curve.

10.3.1.2 Hi 40ppm LCS: Add 10mL of 200ppm LCS solution (Section 8.10.2) to 50 mL DI. This is used for the Hi 0 - 60 ppm curve.

10.4 Initial Calibration Verification Standards

10.4.1 Lachat Analysis: The ICVs are not distilled. Analyze the following after calibration of the Lachat instrument. Recoveries must be within 10% of the true value, otherwise recalibration of the instrument is necessary.

10.4.1.1 Low ICV, 1.0ppm (Section 8.10.1.2)

10.4.1.2 Hi ICV, 10ppm (Section 8.10.1.1)

10.5 Continuing Calibration Verification Standards

10.5.1 Lachat Analysis: The CCVs are not distilled. Analyze the following after every ten samples and at the completion of analysis. Recoveries must be within 10% of the true value.

If recoveries fall outside of this range, the cause for the failure is determined and corrected, and the instrument is recalibrated. All samples that were analyzed since the last CCV that was within range are reanalyzed.

10.5.1.1 0.4ppm Low CCV (Section 8.9.1.2.1)

10.5.1.2 4.0ppm Hi CCV (Section 8.9.1.2.2)

10.6 Interference Check Standards

None.

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10.7 Matrix Spike

One per batch of 20 samples or less. Prior to distillation, add 2mL of 200ppm Spiking Solution (Section 8.9.2) per 50mL of sample.

10.8 Duplicates

Distill one duplicate sample per batch of 20 samples or less.

10.9 Control Limits

The laboratory maintains performance records to document the quality of data that is generated. Method accuracy for samples is assessed and records maintained.

Control limits for the method parameters are generated by the QC staff. The control limits are calculated based on in-house performance data. The limits are compared to the control limits found in the reference method.

10.10 Analytical Sequences

10.10.1 Distillation Sequence:

3 Rinse tubes
Blank 1
Blank 2
Low LCS
Hi LCS
Rinse
Samples (each sample must be followed by rinse, except between sample and its spike or sample and its duplicate)
Duplicate
Spike
Rinse
Shut-down

10.10.2 Lachat Analytical Sequence:

Instrument Calibration
DQM = Hi 4.0ppm CCV
Low 0.4ppm CCV
CC Blank
Low 1.0ppm ICV
Hi 10ppm ICV
IC Blank
Samples
DQM : Run after every 10 samples and at completion of analysis
Rinse reagent lines with 1M HCl for 5 to 10 minutes
DI water rinse for 5 to 10 minutes
Air rinse 5 to 10 minutes.
Shut-Down.

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11. Method Performance

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations were obtained using reagent water. Similar results were achieved using representative wastewaters. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects.

Method performance data is on file in the laboratory QC department. Comparison of method performance data for the laboratory to the reference method criteria occurs when laboratory in-house acceptance limits are generated. In-house generated data must be within the specifications of the reference method or the analysis is not continued until corrective action is completed.

The reported detection limit for this procedure as outlined is 0.3 to 60mg N/L. The range and limit may be changed by a change of the sample loop.

12. Corrective Actions

Holding time exceedence, improper preservation and observed sample headspace are noted on the nonconformance report form.

Perform routine preventative maintenance following manufacturer's specification. Record all maintenance in the instrument logbook.

Review of standards, blanks and standard response for acceptable performance occurs for each batch of samples. Record any trends or unusual performance on a nonconformance action form.

If the CV or LCS recovery of any parameter falls outside the designated acceptance range, the laboratory performance for that parameter is judged to be out of control, and the problem must be immediately identified and corrected. The analytical result for that parameter in the unspiked samples is suspect and is only reported for regulatory compliance purposes with the appropriate nonconformance action form. Immediate corrective action includes reanalyzing all affected samples by using any retained sample before the expiration of the holding time.

13. Pollution Prevention

See Chemical Hygiene Plan for pollution prevention operations.

14. Waste Management

See Chemical Hygiene Plan for waste handling and disposal.

NOTE: TKN Lachat waste contains Mercury and must be deposited into TKN/Lachat waste stream in the Waste Room.

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Total Suspended Solids Dried at 103-105°C

Total Volatile Suspended Solids Dried at 500°C

Reference Methods: **SM 2540 D**, Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF, 18th Edition, 1992.

EPA 160.2, Methods for the Chemical Analysis of Water and Wastes, EPA 600 / 4-82-055, 1982.

Copy No. ____

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Prepared by:

Name: Elena Dayn Position: Wet Chemistry Manager

Signature: E. Dayn Date: 8/29/07

Authorized by:

Name: Christopher Wakefield Position: Laboratory/Technical Director

Signature: [signature] Date: 8/29/07

ISSUE AMENDMENTS

Changes since last issue:

Sections 9.2.8, 9.2.9 and 9.2.12.2: Added recording of date, time and oven temperature in the laboratory notebook.

Total Suspended Solids Dried at 103-105°C

Total Volatile Suspended Solids Dried at 500°C

Reference Methods: **SM 2540 D**, Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF, 18th Edition, 1992.

EPA 160.2, Methods for the Chemical Analysis of Water and Wastes, EPA 600 / 4-82-055, 1982.

1. Scope and Application

Matrices: This method is suitable for the determination of Total Suspended Solids (TSS) and Total Volatile Suspended Solids (TVSS) in potable, surface, and saline waters, as well as domestic and industrial wastewaters.

Definitions: See Alpha Laboratories Quality Manual Appendix A.

"Solids" refer to matter suspended or dissolved in water or wastewater. Solids may affect water or effluent quality adversely in a number of ways. Waters with high dissolved solids generally are of inferior palatability and may induce an unfavorable physiological reaction in the transient consumer. For these reasons, a limit of 500mg dissolved solids/L is desirable for drinking waters. Highly mineralized waters also are unsuitable for many industrial applications. Waters high in suspended solids may be esthetically unsatisfactory for such purposes as bathing. Solids analyses are important in the control of biological and physical wastewater treatment processes and for assessing compliance with regulatory agency wastewater effluent limitations.

"Total solids" is the term applied to the material residue left in the vessel after evaporation of a sample and its subsequent drying in an oven at a defined temperature. Total solids include "total suspended solids," the portion of total solids retained by a filter, and "total dissolved solids," the portion that passes through the filter.

"Fixed solids" is the term applied to the residue of total, suspended, or dissolved solids after heating to dryness for a specified time at a specified temperature. The weight loss on ignition is called "volatile solids." Determinations of fixed and volatile solids do not distinguish precisely between inorganic and organic matter because the loss on ignition is not confined to organic matter. It includes losses due to decomposition or volatilization of some mineral salts.

The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one of the following laboratory personnel before performing the modification: Area Supervisor, Laboratory Services Manager, Laboratory Director, or Quality Assurance Officer.

This method is restricted to use by or under the supervision of trained analysts. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability and completing the record of training.

After initial demonstration, ongoing demonstration is based on acceptable laboratory performance of at least a quarterly laboratory control sample or acceptable performance from an annual proficiency test sample. A major modification to this procedure requires demonstration of performance. The identification of major method modification requiring performance demonstration is directed by the QA Officer and Laboratory Director on a case-by-case basis.

2. Summary of Method

A well-mixed sample is filtered through a weighed standard glass-fiber filter, and the residue retained on the filter is dried to a constant weight. The increase in the weight of the filter represents the total suspended solids. If the suspended material clogs the filter and prolongs filtration, the difference between the total solids and the total dissolved solids may provide an estimate of the total suspended solids. Samples submitted for Total Volatile Suspended Solids analysis are also dried at a higher temperature to a constant weight.

2.1 Method Modifications from Reference

None.

3. Detection Limits

3.1 The RDL for both TSS and TVSS analysis is 5mg/L using 1000mL of sample and an analytical balance sensitive to 0.1mg. A lower RDL may be achieved by using a larger sample (repeated evaporation of 100mL aliquots) or the use of a more sensitive balance.

4. Interferences

4.1 Highly mineralized water with a significant concentration of calcium, magnesium, chloride, and/or sulfate may be hygroscopic and require prolonged drying, proper desiccation and rapid weighing.

4.2 Mix small samples with a magnetic stirrer. If suspended solids are present, pipet with widebore pipets. If part of a sample adheres to the sample container, consider this in evaluating and reporting results. Some samples dry with the formation of a crust that prevents water evaporation; special handling is required to deal with this. Avoid using a magnetic stirrer with samples containing magnetic particles.

4.3 Exclude large, floating particles or submerged agglomerates of non-homogeneous materials from the sample if it is determined that their inclusion is not desired in the final result.

4.4 Disperse visible floating oil and grease with a blender before withdrawing a sample portion for analysis.

4.5 Because excessive residue in the dish may form a water-trapping crust, limit sample to no more than 200mg residue.

4.6 For samples high in dissolved solids, thoroughly wash the filter to ensure removal of dissolved material.

4.7 Prolonged filtration times resulting from filter clogging may produce high results due to increased colloidal materials captured on the clogged filter.

4.8 If the sample has high sediment/sand content, it is necessary to use a smaller volume for analysis. This will allow for a smooth transfer of the filter to the drying tin.

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5. Safety

The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material data handling sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

6. Sample Collection, Preservation, and Handling

6.1 Sample Collection

Samples are collected in glass or plastic bottles, provided that the material in suspension does not adhere to container walls.

Sampling, subsampling, and pipetting two-phase or three-phase samples may introduce serious errors. Make and keep such samples homogeneous during transfer. Use special handling to insure sample integrity when subsampling.

6.2 Sample Preservation

None.

6.3 Sample Handling

Begin analysis as soon as possible because of the impracticality of preserving the sample. Refrigerate sample at 4 ± 2°C up to the time of analysis to minimize microbiological decomposition of solids. In no case hold sample more than 7 days. Bring samples to room temperature before analysis.

7. Equipment and Supplies

7.1 Drying Tins: Aluminum.

7.1.1 50mm diameter: For use with 47mm filter disks (Section 7.2)

7.1.2 140mL capacity: For use with 90mm filter disks (Section 7.2)

7.2 Glass-Fiber Filter Disks: 90mm and 47mm diameter, without organic binder; use with drying tins from Section 7.1.

7.3 Filtration Apparatus: With a membrane filter funnel.

7.4 Side-arm Flask: Of sufficient capacity for sample size selected.

7.5 Desiccator: With a desiccant containing a color indicator of moisture concentration.

7.6 Drying Oven: For operation at 103 - 105°C.

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7.7 Analytical Balance: Capable of weighing to 0.1mg.

7.8 Magnetic Stirrer: With TFE stirring bar.

7.9 Wide-bore Pipets: Various volumes.

7.10 Graduated Cylinders: Glass or plastic at 100mL, 500mL,100mL volumes.

7.11 Muffle Furnace: Capable of 500°C.

7.12 Porcelain Crucibles

7.13 Tweezers: Flat tip, non-piercing.

7.14 Wax crayon or Sharpie pen

8. Standards and Reagents

8.1 Reagent Water: Deionized (DI) water.

9. Procedure

9.1 Preparation of Glass-Fiber Filter Disk

9.1.1 Attach a side-arm flask to the filtration apparatus.

9.1.2 Insert a glass-fiber filter disk (Section 7.2) with the wrinkled side up into the filtration apparatus.

9.1.3 Apply the vacuum, and wash the disk with three successive 20mL portions of DI water.

9.1.4 Continue the suction to thoroughly remove all traces of water, and discard washings.

9.1.5 Using tweezers, remove the filter from filtration apparatus and transfer to a drying tin (Section 7.1).

9.1.6 Dry the filter and tin in an oven at 103-105°C for at least two hours.

9.1.7 Cool in a desiccator to a constant temperature, and weigh. Record the weights on the computer worksheet. Print a copy of the worksheet for later use in Section 9.2.

9.1.8 The dried filters may be used immediately, or stored in a desiccator until needed. Proceed to Section 9.2.

9.2 Equipment Operation and Sample Analysis

9.2.1 Label drying tins with sample IDs.

9.2.2 Assemble filtering apparatus with a prepared filter from Section 9.1, attach a side-arm flask and apply vacuum. Wet filter with a small volume of DI water to seat it.

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9.2.3 Selection of Sample Sizes

Choose a sample volume to yield between 10 and 200mg dried residue. If more than 10 minutes are required to complete filtration, it is necessary to use another prepped filter (from Section 9.1) with a decreased sample volume.

If Total Dissolved Solids are to be determined, collect the filtrate into a clean side-arm flask. Refer to SOP/07-28.

9.2.3.1 Clean samples: Use a graduated cylinder to measure sample volume. Begin with a sample volume of 100mL. Continue filtering successive volumes of 100mL until the desired volume of 1000mL is reached. However, if the filtration begins to slow in efficiency during this time, do not add any more additional sample.

9.2.3.2 Samples containing sediment or other material: Begin with a smaller sample volume. (An initially large volume of these types of samples will likely clog the filter and require reanalysis.)

9.2.3.2.1 These types of samples require initial stirring on a magnetic stirrer. While stirring, withdraw a volume of sample using a wide-bore pipet (Section 7.9). Pipet the sample onto the filter, and then while holding the pipet over the filter, rinse the pipet with DI water and filter this rinseate as well. This will ensure that all of the solid material is transferred to the filter.

9.2.3.3 Sludge samples: These samples are always pipetted to the filter as stated above in Section 9.2.2.2.1. A small sample size is desirable to prevent crust formation and filter curling during the drying step of the procedure.

9.2.4 Write the volume of sample filtered on the computer worksheet that was printed in Section 9.1.7.

9.2.5 Wash with three successive 10mL volumes of DI water, allowing complete drainage between washings, and continue suction for about 3 minutes after filtration is complete.

9.2.6 Samples with high dissolved solids may require additional washings.

9.2.7 Using tweezers, carefully remove the filter from filtration apparatus and transfer to the corresponding, labelled drying tin.

9.2.8 Place the filter in the tin into a 103-105°C oven to dry for a minimum of 2 hours. Record the date, time in and the oven temperature in the laboratory notebook.

9.2.9 After drying, remove tin from the oven to cool in a desiccator to a constant temperature. Record the date, time out and the oven temperature in the laboratory notebook.

9.2.10 Weigh the tin on an analytical balance. Record the weights on the computer worksheet, and the sample volumes filtered as written down from Section 9.2.3.

9.2.11 Repeat the cycle of drying, cooling, desiccating, and weighing until a constant weight is obtained or until the weight change is less than 4% of the previous weight or 0.5mg, whichever is less. Record each weight on the computer worksheet.

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9.2.12 Total Volatile Suspended Solids

9.2.12.1 If TVSS analysis is requested, using tweezers, transfer the filter from the drying tin to a labelled crucible.

9.2.12.2 Place the crucible into a 500°C muffle furnace for a minimum of 2 hours, and record the date, time in, and the oven temperature in the laboratory notebook. Following removal from muffle furnace, place in a desiccator to cool to a constant temperature. Record the date, time out and the oven temperature in the laboratory notebook.

9.2.12.3 Using an analytical balance, tare a clean drying tin. Remove the filter from the crucible with tweezers and transfer the filter to the drying tin.

9.2.12.4 Record the weights on the computer worksheet.

9.2.12.5 Repeat the cycle of drying, cooling, desiccating, and weighing until a constant weight is obtained or until the weight change is less than 4% of the previous weight or 0.5mg, whichever is less. Record each weight on the computer worksheet.

9.3 Preventative Maintenance

9.3.1 Prior to each use, the filtering apparatus is rinsed thoroughly with DI water.

9.3.2 As needed, the filtering apparatus is washed in the industrial dishwasher.

9.3.3 As necessary, wipe the inside of the filtering apparatus with a paper towel and then rinse thoroughly with DI water

9.3.4 Ensure that there is an adequate supply of oil in the vacuum pump.

9.3.5 The temperature of the laboratory ovens is recorded constantly on a circular chart recorder.

9.3.6 The chart recorder, the laboratory ovens, and the muffle furnace are calibrated on an annual basis by an instrument service company. Certificates are kept on file in the QA Department.

9.4 Calculations

$$\text{mg TSS / L} = \frac{(\mathbf{A} - \mathbf{B}) \times 1000}{\text{sample volume, (L)}}$$

where:

A = Final weight (weight of filter + dried residue, g)
B = Initial weight (weight of clean filter, g)

$$\text{mg TVSS / L} = \frac{(\mathbf{G} - \mathbf{N}) \times 1000}{\text{sample volume, (L)}}$$

where:

G = Final Weight at 105 °C (weight of dish + dried residue, g)
N = Weight at 500 °C (weight of dish + dried residue, g)

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10. Quality Control and Data Assessment

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

10.1 Demonstration of Capability

The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method. Each time a method modification is made, the analyst is required to repeat the procedure.

When the parameter tested fails the acceptance criteria, the analyst must locate and correct the source of the problem and repeat the test for failed parameters of the method.

Repeated failure confirms a general problem with the measurement system or analytical technique of the analyst.

10.2 Blank

Filter one blank of 100mL of DI water per batch of 20 samples or less. Results must be less than the Reporting Limit (RL). If Blank results are less than 10 times the RL and the sample results are greater than 10 times the RL, the data is reported. If Blank results are greater than 10 times the RL, and there is sufficient sample volume remaining, the entire batch is reset and reanalyzed. A narrative is included with the report.

10.3 Duplicates

Filter one sample in duplicate per batch of 20 samples or less. Duplicate determinations must have a calculated %RPD ≤ 20%. If acceptance criteria are not met, and there is sufficient sample volume remaining, the sample is reset. Otherwise, the data is submitted a narrative is included with the final report.

10.4 Control Limits

The laboratory maintains performance records to document the quality of data that is generated. Method accuracy for samples is assessed and records maintained.

10.5 Analytical Sequence

- Prepare the filters.
- Weigh the clean filters, and/or drying tins.
- Filter the appropriate volumes of sample, and QC samples.
- Rinse the filter with DI water.
- Transfer the filter into to its corresponding drying tin.
- Total Suspended Solids are dried for a minimum of 2 hours in a 103 – 105 °C oven.
- Cool in a desiccator until temperature is constant.
- Weigh the filters until the weight change is less than 4% of the previous weight or 0.5mg, whichever is less.

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- Total Volatile Suspended Solids are also dried for a minimum of 2 hours in a 500 °C muffle furnace.
- Cool in a desiccator until temperature is constant.
- Weigh the filters until the weight change is less than 4% of the previous weight or 0.5mg, whichever is less.
- Calculate results.

11. Method Performance

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero.

12. Corrective Actions

Holding time exceedence and improper preservation are noted on the nonconformance report form.

Perform routine preventative maintenance as outlined in Section 9.3.

Review of blanks and duplicate samples for acceptable performance occurs for each batch of samples. Record any trends or unusual performance on a nonconformance action form.

13. Pollution Prevention

See Chemical Hygiene Plan for pollution prevention operations.

14. Waste Management

See Chemical Hygiene Plan for waste handling and disposal.

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ROUX ASSOCIATES INC
67 South Bedford Street, Suite 101W
Burlington, Massachusetts 01803
TEL 781-270-6600 FAX 781-270-9066

ROUX **MEMORANDUM**

TO: Roux Associates, Inc.

FROM: Roux Associates, Inc.

DATE: January 13, 2009

RE: **Stormwater System Investigation and Clean Out Waste Management Evaluation**

Roux has developed the following questions and/or concerns regarding the management of waste generated during the stormwater system clean out and investigation activities

- Are "Delisting" or "contained in rule determination" options that ExxonMobil is considering?
- Does the F037 Waste Code apply to material removed from all of the structures? Are some structures in certain areas of the Site not considered to be impacted by F037 waste (non-refinery portions of the terminal)?
    - If there will be separate waste codes for different areas of the terminal, should we plan on cleaning structures in upgradient to down gradient process to ensure that we do not recontaminate structures/mix waste streams? This process may also reduce the amount the F037 wastes.
- Can/should any water (liquid without product) be redirected to the o/w separator instead of generating waste during clean outs?
- Is there any existing analytical data for samples collected from the structures?
- Once a structure is cleaned, will any waste that enters the structure after the cleaning be considered F037?
- Has the EPA established a "what is clean" definition?
- Discuss evaluating soil generated during excavations regarding classification as an F037 Waste? If so, should we limit remedial efforts to extent necessary to repair the structures?
- Storage of the liquid waste in winter/freezing conditions:
    - Is there a heated area/garage to use?
    - Look at methods of generating waste volumes so that the wastes (if they can freeze) can be removed from the site daily?
    - What level of involvement will the terminal play in the work? Scheduling/limiting work in certain areas? Removal of snow/ice in areas?

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- Discuss evaluating soil generated during excavations regarding classification as an F037 Waste? If so, should we limit remedial efforts to extent necessary to repair the structures?
- Storage of the liquid waste in winter/freezing conditions:
    - Is there a heated area/garage to use?
    - Look at methods of generating waste volumes so that the wastes (if they can freeze) can be removed from the site daily?
    - What level of involvement will the terminal play in the work? Scheduling/limiting work in certain areas? Removal of snow/ice in areas?

ENVIRONMENTAL CONSULTING & MANAGEMENT
ROUX ASSOCIATES INC
67 South Bedford Street, Suite 101W
Burlington, Massachusetts 01803
TEL 781-270-6600 FAX 781-270-9066

ROUX **MEMORANDUM**

TO: Roux Associates, Inc.

FROM: Roux Associates, Inc.

DATE: January 13, 2009

RE: **Stormwater System Investigation and Clean Out Waste Management Evaluation**

Roux has developed the following questions and/or concerns regarding the management of waste generated during the stormwater system clean out and investigation activities

- Are "Delisting" or "contained in rule determination" options that ExxonMobil is considering?
- Does the F037 Waste Code apply to material removed from all of the structures? Are some structures in certain areas of the Site not considered to be impacted by F037 waste (non-refinery portions of the terminal)?
    - If there will be separate waste codes for different areas of the terminal, should we plan on cleaning structures in upgradient to down gradient process to ensure that we do not recontaminate structures/mix waste streams? This process may also reduce the amount the F037 wastes.
- Can/should any water (liquid without product) be redirected to the o/w separator instead of generating waste during clean outs?
- Is there any existing analytical data for samples collected from the structures?
- Once a structure is cleaned, will any waste that enters the structure after the cleaning be considered F037?
- Has the EPA established a "what is clean" definition?
- Discuss evaluating soil generated during excavations regarding classification as an F037 Waste? If so, should we limit remedial efforts to extent necessary to repair the structures?
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- Is there any existing analytical data for samples collected from the structures?
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- Has the EPA established a "what is clean" definition?
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ATTACHMENT B-3

Equipment Manuals

6712 Portable Samplers

Installation and Operation Guide

TELEDYNE ISCO
A Teledyne Technologies Company

Part #69-9003-588 of Assembly #60-9004-334
Copyright © 2001. All rights reserved, Teledyne Isco, Inc.
Revision V, April 2, 2007

Foreword

This instruction manual is designed to help you gain a thorough understanding of the operation of the equipment. Teledyne Isco recommends that you read this manual completely before placing the equipment in service.

Although Teledyne Isco designs reliability into all equipment, there is always the possibility of a malfunction. This manual may help in diagnosing and repairing the malfunction.

If the problem persists, call or e-mail the Teledyne Isco Technical Service Department for assistance. Simple difficulties can often be diagnosed over the phone.

If it is necessary to return the equipment to the factory for service, please follow the shipping instructions provided by the Customer Service Department, including the use of the **Return Authorization Number** specified. **Be sure to include a note describing the malfunction.** This will aid in the prompt repair and return of the equipment.

Teledyne Isco welcomes suggestions that would improve the information presented in this manual or enhance the operation of the equipment itself.

Teledyne Isco is continually improving its products and reserves the right to change product specifications, replacement parts, schematics, and instructions without notice.

Contact Information

Customer Service

Phone:	(800) 228-4373	(USA, Canada, Mexico)
	(402) 464-0231	(Outside North America)
Fax:	(402) 465-3022	
Email:	IscoCSR@teledyne.com	

Technical Service

Phone:	(800) 775-2965	(Analytical)
	(800) 228-4373	(Samplers and Flow Meters)
Email:	IscoService@teledyne.com	
Return equipment to:	4700 Superior Street, Lincoln, NE 68504-1398	

Other Correspondence

Mail to:	P.O. Box 82531, Lincoln, NE 68501-2531
Email:	IscoInfo@teledyne.com
Web site:	www.isco.com

Revised September 15, 2005

General Warnings

Before installing, operating, or maintaining this equipment, it is imperative that all hazards and preventive measures are fully understood. While specific hazards may vary according to location and application, take heed in the following general warnings:

⚠ WARNING

This instrument has not been certified for use in "hazardous locations" as defined by the National Electrical Code.

⚠ WARNING

Avoid hazardous practices! If you use this instrument in any way not specified in this manual, the protection provided by the instrument may be impaired; this will increase your risk of injury.

⚠ AVERTISSEMENT

Éviter les usages périlleux! Si vous utilisez cet instrument d'une manière autre que celles qui sont specifiées dans ce manuel, la protection fournie de l'instrument peut être affaiblie; cela augmentera votre risque de blessure.

This product is often installed in confined spaces. Some examples of confined spaces are manholes, pipelines, digesters, and storage tanks. These spaces may become hazardous environments that can prove fatal for those unprepared. These spaces are governed by OSHA 1910.146 and require a permit before entering.

Hazard Severity Levels

This manual applies *Hazard Severity Levels* to the safety alerts, These three levels are described in the following sample alerts.

⚠ CAUTION

Cautions identify a potential hazard, which if not avoided, may result in minor or moderate injury. This category can also warn you of unsafe practices, or conditions that may cause property damage.

⚠ WARNING

Warnings identify a potentially hazardous condition, which if not avoided, could result in death or serious injury.

⚠ DANGER

DANGER – limited to the most extreme situations to identify an imminent hazard, which if not avoided, will result in death or serious injury.

Hazard Symbols

The equipment and this manual use symbols used to warn of hazards. The symbols are explained below.

Hazard Symbols	
Warnings and Cautions	
	The exclamation point within the triangle is a warning sign alerting you of important instructions in the instrument's technical reference manual.
	The lightning flash and arrowhead within the triangle is a warning sign alerting you of "dangerous voltage" inside the product.
	Pinch point. These symbols warn you that your fingers or hands will be seriously injured if you place them between the moving parts of the mechanism near these symbols.
Symboles de sécurité	
	Ce symbole signale l'existence d'instructions importantes relatives au produit dans ce manuel.
	Ce symbole signale la présence d'un danger d'électocution.
	Risque de pincement. Ces symboles vous avertit que les mains ou les doigts seront blessés sérieusement si vous les mettez entre les éléments en mouvement du mécanisme près de ces symboles
Warnungen und Vorsichtshinweise	
	Das Ausrufezeichen in Dreieck ist ein Warnzeichen, das Sie darauf aufmerksam macht, daß wichtige Anleitungen zu diesem Handbuch gehören.
	Der gepfeilte Blitz im Dreieck ist ein Warnzeichen, das Sei vor "gefährlichen Spannungen" im Inneren des Produkts warnt.
	Vorsicht Quetschgefahr! Dieses Symbol warnt vor einer unmittelbar drohenden Verletzungsgefahr für Finger und Hände, wenn diese zwischen die beweglichen Teile des gekennzeichneten Gerätes geraten.

6712 Portable Sampler

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6712 Portable Sampler

Section 1 Introduction

The 6712 Series Samplers are an integral part of Teledyne Isco's comprehensive sampling system. The system includes the 6712 Compact Sampler, the 6712 Standard Sampler and the 6712FR and 6712SR Refrigerated Samplers.

6712 Controller

The 6712 portable samplers are easily moved from site to site. Constructed from durable, corrosion-resistant materials, the samplers withstand the hostile environments of industrial and municipal monitoring sites.

The 6712 Compact differs from the 6712 Standard Sampler only in size and sampling capacity. Both samplers use the same controller and sample-delivery system. Both instruments accept a variety of composite and multiple bottle kits. Because the 6712 Compact and Standard Samplers share many features, this manual includes programming, operation, and maintenance information for both instruments. Except where specifically noted, the contents of this manual apply to both units.

1.1 About this Manual

This manual contains the information you will need to install, program, operate, and maintain a 6712 portable sampler. There are seven sections and five appendices:

- *Section 1, Introduction* lists the features and specifications of the 6712 portable samplers.
- *Section 2, Installation/Preparation* steps you through installing the sampler and preparing it for use.
- *Section 3, Getting Started* describes features that are common to both standard and extended programming modes.
- *Section 4, Standard Programming* shows how to program your sampler using standard programming mode.
- *Section 5, Extended Programming* shows how to program your sampler using extended programming mode.
- *Section 6, SDI-12 Sondes* provides information on setting up sondes to work with the 6712.
- *Section 7, Remote Operation* explains how the 6712 controller can be operated remotely from external devices.
- *Section 8, Maintenance* covers the basic maintenance required to keep your sampler in top operating condition.

The appendices are:

- *Appendix A, Menu Flowcharts*
- *Appendix B, Material Safety Data Sheets*
- *Appendix C, General Safety Procedures*
- *Appendix D, Replacement Parts*
- *Appendix E, Accessories List*

1.2 About 700 Series Modules

The bay on the controller's side accepts any of Teledyne Isco's 700 Series Modules. The 700 Series includes:

- 701 pH Parameter Module for monitoring pH and temperature.
- 710 Ultrasonic Module for monitoring a flow stream's level and flow rate with an ultrasonic level sensor.
- 720 Submerged Probe Module for monitoring a flow stream's level and flow rate with a submerged probe.
- 730 Bubbler Flow Module for monitoring a flow stream's level and flow rate with a bubbler system.
- 750 Area Velocity Module for monitoring a flow stream's level, velocity, and flow rate.
- 780 4-20mA Input Module for interfacing to non-Teledyne Isco devices with 4 to 20 milliampere output signals.

The modules are optional accessories. The samplers do not require them for operation. However, the modules offer a number of advantages: they are an economical way to combine flow-rate or parameter monitoring with sampling, and you can program the samplers and modules as a single unit. Finally, the samplers store the readings in memory.

1.3 SDI-12 Sondes

As an option, the sampler accepts up to 16 parameters from up to ten sensors with SDI-12 addresses from 0 - 9 (refer to SDI-12 Sonde Readings, page 1-11, for specific parameters).

The data parameters used by the sensing device (sonde) and recording device (sampler) must match. Certain vendors' sondes have enhanced commands that facilitate "plug and play" setup. These Teledyne Isco Ready sondes can tell the 6712 what values they have, their order, and units of measure. Other sondes can be used, but require manual setup to identify proper data types for each data value reported.

1.4 Memory to Store Monitoring Data

The samplers contain enough memory to store five sampling programs, sampling data, Teledyne Isco 700 Series Module readings, and SDI-12 parameter readings. You can view the readings on your sampler's display.

You can also retrieve the readings and reports so the information can be processed on a personal computer. Readings and reports may be collected with a computer running Teledyne Isco's Flowlink™ software. Flowlink can download the information through a direct connection, a modem connection (when the

sampler is equipped with the optional 4200T dial-out modem), or from a 581 Rapid Transfer Device (RTD). The RTD is a quick and simple way to transfer the data from the field to your computer. Reports are easily collected with Teledyne Isco's Samplink software.

1.5 Pump Requirements

The sampler's peristaltic pump is extremely powerful. This pump requires a high capacity power source such as Teledyne Isco's model 913 or 923 power pack. Older model power packs do not provide the needed power. A list of recommended power packs and batteries can be found in *Installing a Power Source* on page 2-9.

The pump also requires a pump tube made specifically for the 6712 and 6700 Series samplers. These pump tubes are easily recognized by their blue alignment collars. The 6712 pump tubing is the same as that for Teledyne Isco's 6700 Series samplers, but different from Teledyne Isco's earlier model samplers, such as the 3700 Series. Other types of pump tubing will not work in the 6712. Refer to *Replacing the Pump Tube* on page 8-8.

Table 1-1 6712 Standard and Compact Sampler Features

General Features	
Top Cover	• Protects pump, power source, and controller. • Lockable latches.
Controller	• Contains a rechargeable desiccant to prevent moisture damage to the electronics, pump, and distributor systems. • Control panel sloped 15 degrees for easy reading. • Keys labeled with large, vivid icons. • 80-character display (4 lines by 20 columns). • Display has selectable backlight: Always on or always off. Timed, switching off when keypad is inactive for 60 seconds. • Memory for program and data storage. • Flash memory for easy software upgrades. • NEMA 4X and 6 (IP67) ratings.
Center Section	• Secured to tub with lockable latches. • Large handles.
Adjustable Distributor Arm	• A single distributor arm adjusts quickly to fit all bottle kits. Easily removed for composite sampling.
Discharge Tube and Support Spring	• Routes sample liquid from pump tube, through distributor arm to sample bottle.
Composite Tube Guide for Composite Sampling	• Keeps discharge tube in place over composite bottles.

Table 1-1 6712 Standard and Compact Sampler Features (Continued)	
Tub	• Large, comfortable handles. • Both compact and standard samplers accept a variety of bottle kits. • **Compact Tubs Only**: Removable bottle-carrier insert. • **Standard Tubs Only**: Tub drain. • Optional five gallon bottle base: fits the standard sampler
Compatible Teledyne Isco Products	• 581 Rapid Transfer Device • 1640 Liquid Level Actuator • 674 Rain Gauge • 2100 Series Flow Modules • 700 Series Modules • 4100 Series Flow Loggers • SDI-12 Sondes • 4200 Series Flow Meters • Refrigerator Temperature Sensor • Flowlink, Samplink
Real-Time Displays	As the sampler runs a sampling program, it displays the program's status. The status display may include such information as the time of the next sample, the number of the next bottle, or whether the sampler is disabled or stopped. If the sampler encounters an error while running the program, it displays a message alerting you to the problem.
Programming for Modules	Program the modules from the sampler's control panel. The module's program settings become part of the sampling program.
Setup for SDI-12 Sondes	Calibrate and program SDI-12 sondes from the sampler's control panel. The program settings become part of the sampling program. See Section 6.
Memory for Stored Programs and Readings	512 kilobytes of battery-backed RAM (Random Access Memory), to store: • Five sampling programs. • A sampling report from the most recently run program. It records as many as 1000 sampling events; events can be the program start time, enable time, sample event information, etc. • 700 Series module readings. The readings can be: level, flow rate, velocity, pH, temperature, or the data collected by the 4-20 mA module. • Rain gauge and refrigerator temperature readings. • SDI-12 sonde readings.
Five Reports Available	• The Program Settings report, listing current program settings. • The Sampling Results report, listing the events occurring during the program. • The Combined Results report, combining sampling events with readings from a rain gauge, module, or SDI -12 sonde. • The Module Summary report, summarizing flow rate or parameter readings. • The Rainfall Summary report, listing a summary of rainfall readings.
Serial Data Output	• ASCII data output from the interrogator port.
Units of Measure	A variety of metric and English units of measure for length, flow rate, flow volume, and temperature.
External Sampler Enable	Teledyne Isco flow meters and flow loggers have a programmable sampler enable feature that lets them send an electronic signal to a 6712 that enables (starts) or disables (stops) a running sampling program.
Dual Sampler Mode	Dual Sampler Mode operates two samplers.

Table 1-1 6712 Standard and Compact Sampler Features (Continued)	
Command Driven Operation	• Operate sampler functions using RS-232 communications.
Warning Messages	• Pump Tube Warning. The 6712 displays a warning to inspect the tube. • Internal Battery Warning. From the Maintenance screen, the 6712 displays a warning when it is time to replace the internal battery. The internal battery preserves stored data when the 6712 is without external power.
Optional Dialout 4200T Modem	The 6712 controller can be ordered with a factory-installed 2400 baud dialout modem. With the modem you can: • connect to the sampler and download data using Flowlink software. • program the sampler to call a contact list when an “alarm” condition exists. • use the Remote Commands to control the sampler’s operation from a remote location.
On-Line Help Notes	When programming the sampler, press the [?] (Help) key for a brief help note. All help topics appear in the index.
Two Programming Levels	Standard programming lets you set up typical sampling programs quickly. Extended programming includes all features available in standard programming plus additional features.
Sample Delivery System Features	
Peristaltic Pump	• **Benefits**: Liquid moves continuously under pumped flow. The pump has no metering chambers or gravity fed internal tubing to trap sediment or residual liquid. Sample liquid contacts only the strainer, suction line, tube coupling, pump tube, bulkhead fitting, and sample bottles.
LD90 Liquid Detector	• **Non wetted Detection**: Sample liquid never touches the detector.
Two Line Purges in Sampling Cycle	The sampling cycle always includes a pre-sample purge and post-sample purge that clears the suction line of residual liquid.
Easy Grab Samples	Simply disconnect the pump tube from the bulkhead fitting on the center section, and place the pump tube over your sample container.
Vinyl and Teflon® Suction Lines	• 3/8-inch ID (Inside Diameter) vinyl line. • 3/8-inch ID Teflon® lined with polyethylene jacket.
Standard Programming Features	
Pacing	• **Uniform Time Pacing**: Sampling at regular time intervals. • **Flow Pacing**: Sampling at regular flow-volume intervals.
Distribution Methods	• **Composite**: Samples deposited in a single large bottle. • **Sequential**: Only one sample placed in each bottle. • **Samples Per Bottle**: Multiple samples placed in each bottle. • **Bottles Per Sample**: One sample deposited in multiple bottles.
Three Flexible Start-Time Settings	• **Start Immediately**: Starts the sampling program immediately. • **Delayed Start**: Starts the sampling program after a user-definable delay of 1 to 999 minutes. • **Clock Time**: Starts the sampling program at a user-definable time on one or more days of the week.

Table 1-1 6712 Standard and Compact Sampler Features (Continued)	
Option for a Continuous Running Program	• **Continuous Sampling**: When sample bottles are regularly replaced, the sample distribution can restart with the first bottle set after the last bottle set is filled, without interrupting the running program.
Extended Programming Features	
Pacing	• **Uniform Time Pacing**: Sampling at regular time intervals. • **Nonuniform Time Pacing**: Sampling at irregular time intervals. • **Random Interval Pacing**: Sampling at unique random time intervals generated by the controller. • **Flow Pacing**: Sampling at regular flow-volume intervals. • **Event Pacing**: Sampling each time a user-definable event occurs.
Flow Proportional Sample Volumes	Allows for sample sizes to be based on flow. (This option is available only with uniform time pacing.)
Distribution Methods	• **Composite**: Samples deposited in a single large bottle. • **Sequential**: Only one sample placed in each bottle. • **Samples Per Bottle**: Multiple samples placed in each bottle • **Bottles Per Sample**: One sample deposited in multiple bottles • **Multiple Bottle Compositing**: A combination of samples per bottle and bottles per sample distribution methods. • **Time Switched Bottles or Bottle sets**: Control the sample distribution using clock times.
Programmable Sampler Enable	A 6712 sampler can be programmed to enable or disable a running sampling program when readings received from a connected rain gauge, module, or SDI-12 Sonde meet certain conditions.
Pauses and Resumes	Create intermittent sampling schedules.
Two-Part Programming	Two-part programming lets you set up a sampling program that divides the bottles into two groups, filling each group according to separate pacing, distribution, sampler enable, and pause and resume settings. This is ideal for storm-water run-off sampling.
Auto Suction Head or Fixed Suction Head	The suction head, is the vertical distance from the flow stream to the liquid detector. Extended programming has two settings. • **Auto-Suction Head**: The head is automatically determined. • **Fixed Suction Head**: A user-definable measurement for the head.
Suction Line Rinses	Program setting for the number of times (0 to 3) that the 6712 rinses the suction line before drawing a sample.
Sampling Retries	Program setting for the number of times (0 to 3) that the 6712 attempts to sample if it fails to deliver the entire sample volume.
Three Flexible Start Time Settings	• **Run Immediately**: Starts the sampling program immediately. • **Delayed Start**: Starts the sampling program after a user-definable delay of 1 to 999 minutes. • **Clock Time**: Starts the sampling program at a user-definable time on one or more days of the week.
Option for a Continuous Running Program	**Continuous Sampling**: When sample bottles are regularly replaced, the sample distribution can restart with the first bottle set after the last bottle set is filled, without interrupting the running program.

Table 1-2 6712 Standard and Compact Sampler Construction Materials

Item	Material
Top Cover **Center Section** **Tubs** **Bottle Inserts** **Plastic Retaining Rings** **Bottle Carriers**	ABS (Acrylonitrile Butadiene Styrene) plastic
Bottle Rack	Powder coated steel
Controller Case **Distributor Arm**	Noryl®
Distributor Arm Nut **Pump Rollers**	Delrin®
Control Panel **Connector Labels**	Polyester
Distributor Shaft **Pump Shaft** **Pump Paddles** **Pump Band** **Bulkhead Fitting** **Latches** **Handles** **Metal Retaining Rings**	Stainless steel
Power-Source Draw Catches:	EPDM (Ethylene Propylene Diene Monomer) rubber
Amphenol Connectors	Cadmium Plated Aluminum
Retaining Ring Draw Cords (inside standard tub)	Polypropylene jacketed rubber with stainless steel clip
Retaining Ring Tie-Down (inside standard tub)	Iridited® aluminum
Drain Plug (standard tub only)	CPVC with polypropylene retaining strap
Webbing for Compact Bottle Carriers	Polypropylene.

Table 1-3 Technical Specifications for the 6712C and Standard Samplers

General Notes:

1. All weights may vary ±1 lb (±1/2 kg).

2. All dimensions may vary ±1/4 inch (±0.64 cm).

3. Sample delivery specifications valid for the following conditions and ranges, unless otherwise stated: 75°F (24°C) ambient, sample liquid–tap water at 50 to 80°F (10 to 27°C), sample volumes from 50 ml to 1000 ml, suction line lengths of 25 ft (7.6 m) or less, suction heads from 1 to 20 ft (0.3 to 6.1 m), atmospheric pressure between 29.92 and 31.89 inHg (760 and 810 mmHg), and a power source of a Teledyne Isco High Capacity Power Pack at 12.5 volts DC no load output.

6712 Controller, Pump, and Tubing: Mechanical Specifications	
Weight of Controller:	Controller only: 13.0 lbs (5.9 kg) With pump tube: 13.2 lbs (6.0 kg)
Weight of Nickel Cadmium Battery:	4.3 lbs (2.0 kg)
Weight of Lead Acid Battery:	5.7 lbs (2.6 kg)
Weight of Power Pack:	6.0 lbs (2.7 kg)
Weight of Battery Backed Power Pack:	6.6 lbs (3.0 kg)
Controller Dimensions:	Length:10.3 in (26.0 cm) Width:12.5 in (31.7 cm) Height:10 in (25.4 cm)
Temperature Ranges:	Operational: 32°F to 120°F (0°C to 49°C) Storage: 0°F to 140°F (-18°C to 60°C)
Maximum Altitude:	2,000 Meters
Installation Category:	II
Pollution Degree:	2
Humidity:	95% RH Maximum
Enclosure:	NEMA 4X and 6 Pump: IP17 Enclosure: IP67
Typical Delivered Volume Accuracy:	(The ability to deliver the programmed sample volume.) ±10 ml or ±10% of programmed value, whichever is greater.
Typical Repeatability:	(The ability to repeat the delivered volume for a set of samples collected under the same conditions.) ±5 ml or ±5% of the average of the maximum and minimum sample volume in a sample set, whichever is greater, at lifts up to 25 feet.
Typical Pump Flow Rate and Line Transport Velocity:	Suction Head — Flow Rate — Line Transport Velocity 3 feet — 3.9 liters per minute — 3.0 ft/s (0.91 m/s) 5 feet — 3.9 liters per minute — 3.0 ft/s (0.90 m/s) 10 feet — 3.7 liters per minute — 2.9 ft/s (0.87 m/s) 15 feet — 3.6 liters per minute — 2.7 ft/s (0.83 m/s) 20 feet — 3.3 liters per minute — 2.5 ft/s (0.77 m/s) 23 feet — 3.1 liters per minute — 2.3 ft/s (0.71 m/s) 25 feet — 2.8 liters per minute — 2.2 ft/s (0.66 m/s)
Maximum Suction Head:	(The maximum suction head is the vertical height at which a sample can be taken.) 28 ft (8.5 m) at 30 inHg (762 mmHg)

Table 1-3 Technical Specifications for the 6712C and Standard Samplers (Continued)

Pump Tube Life:	Tube life may vary depending on the abrasiveness of the sample liquid. Recommended maximum 1,000,000 pump counts. This equates to 912 standard samples. A standard sample is 200 ml at 5 ft (1.5 m) suction head using a 10 ft (3 m) vinyl suction line.
6712 Controller: Electrical Specifications	
Controller Internal Battery:	5 years minimum (maintains internal logic, program settings & stored data)
Real Time Clock Accuracy:	1 minute per month
Program Memory:	Nonvolatile programmable Flash. Can be field updated via interrogator connector.
Sampler Power Requirements:	Nominal: 12 volts DC by battery or AC power converter Operational: 11 to 13 Volts DC Absolute Maximum: 14.4 Volts DC
Power Pack Requirements: Use only Teledyne Isco-made power packs certified by UL. (P/N 60-1684-088)	120VAC ±12VAC, 60 Hz., 1.0 Amp. Note: This is the **only** version certified by UL. The line cord (mains connect cable) is the "Disconnect Device."
Power Pack Requirements: (Use only Teledyne Isco-made CE certified power packs. (P/N 60-3004-190)	230VAC ±23VAC, 2.0 Amp, 50/60 Hz. Note: The line cord (mains connect cable) is the "Disconnect Device."

Power Consumption[a]	
6712 Controller in Standby	10 mA
Average Current of Accessories	
Controller Display Backlight	228 mA
701 pH Module[b]	11 mA
710 Ultrasonic Module[b]	11 mA
720 Submerged Probe Module[b]	11 mA
730 Bubbler Module[b] — at 2 ft of liquid level — at 10 ft of liquid level	 24 mA 31 mA
750 Area Velocity Module[b]	12 mA
780 4-20 mA Module[b]	10 mA
YSI 600 with pH, DO, Conductivity, and Temperature[b]	11 mA
Programmable Analog 4-20 mA Output Option[c]	124 mA
CDMA cellular telephone modem — standby current — current while communicating	 35 mA 150 mA
GSM cellular telephone modem — standby current — current while communicating	 62 mA 230 mA

a. Current ratings when input power is 12.5 VDC and ambient temperature is 77 °F (25 °C)

b. Average current when programmed to take readings at 15 minute intervals.

c. Rating for three outputs.

Table 1-3 Technical Specifications for the 6712C and Standard Samplers (Continued)

Sampler Only Operating Current:	Approximately 30 mA based on 200 ml sample every hour, 10 ft (3 m) suction line, and 5 ft (1.5 m) suction head.

Teledyne Isco External Battery Capacity:Number of Complete Standard Sampling Routines

	Nickel-Cadmium Battery	Lead-Acid Battery
Sampler Only:	6	9
Sampler with pH Module:	6	9
Sampler with Ultrasonic Module:	6	9
Sampler with Submerged Probe Module:	6	9
Sampler with Bubbler Module (1-2 ft head):	3	5
Sampler with Area Velocity Module:	4	6
Sampler with 4-20 mA Module:	6	9

A Standard Sampling Routine is a 200 ml sample taken every hour in 24 bottle mode, with a 10 foot (3 m) vinyl suction line at 5 feet (1.5 m) of head. The module is set to take a reading every 15 minutes.

Flow Meter Signal Requirement:	5 to 15 volt DC pulse or isolated contact closure of at least 25 millisecond duration. (4 - 20 mA or pulse duration signal may be converted with optional interface unit.)

Table 1-3 Technical Specifications for the 6712C and Standard Samplers (Continued)

6712 Controller: Software Specifications

Suction Line:	Programmable 3 to 99 ft (1 to 30 m) lengths of: • 3/8" (0.95 cm) I.D. Vinyl • 3/8" (0.95 cm) I.D. Teflon®-lined with polyethylene jacket
Sample Frequency:	• From 1 minute to 99 hours and 59 minutes in 1 minute increments between consecutive samples. • Nonuniform times in minute intervals or clock time • Random time intervals between consecutive samples • From 1 to 9,999 flow pulses in single-pulse intervals • Flow paced in volume with attachable flow module
Rainfall Reading Units:	Inches or millimeters

Module Readings:		
pH	8 bits representing pH 16 bits representing temp.	0.1 pH storage resolution 0.1° C storage resolution
Ultrasonic	16 bits representing level	0.0001 m storage resolution
Submerged Probe	16 bits representing level	0.0001 m storage resolution
Bubbler	16 bits representing level	0.0001 m storage resolution
Area Velocity	16 bits representing level 16 bits representing velocity	0.0001 m storage resolution 0.001 ft/s storage resolution
4–20 mA	16 bits representing percent 16 bits representing level 32 bits representing flow	0.1% storage resolution

SDI-12 Sonde Readings:

Parameter	Range	Resolution	Storage Bytes
Temperature	-40 - 100 °C	0.1 °C	2
Conductivity	0 - 100 mS/cm	0.01 mS/cm	2
Specific Conductance	0 - 100 mS/cm	0.01 mS/cm	2
Total Dissolved Solids	0 - 90 g/l	0.01 g/l	2
Salinity	0 - 70 ppt	0.1 ppt	2
Dissolved Oxygen	0 - 20 mg/l	0.1 mg/l	1
pH	0 - 14	0.1	1
ORP	-999 - 999 mv	0.1 mv	2
Level	0 - 6.5279 m	0.0001 m	2
Ammonium-Nitrogen	0 - 200 mgN/l	0.1 mgN/l	2
Ammonia-Nitrogen	0 - 200 mgN/l	0.1 mgN/l	2
Nitrate-Nitrogen	0 - 200mgN/l	0.1 mgN/l	2
Turbidity	0 - 5000 NTU	0.1 NTU	2
Chloride	0 - 1000 mg/l	0.1 mg/l	2
Chlorophyll	0-400 ug/l	0.1 ug/l	2
Other	-99999.0-99999.0	0.0001	4

Table 1-3 Technical Specifications for the 6712C and Standard Samplers (Continued)	
Module Reading Conversions:	• Level and 4–20 mA readings converted to flow rate units: gallons per second — gallons per minute million gallons per day — cubic feet per second cubic meters per second — cubic meters per hour cubic meters per day — liters per second • Velocity units: feet per second — meters per second • Totalized flow units: gallons — million gallons cubic feet — cubic meters liters • Devices supported in flow conversion: Weirs: V-notch; 22.5, 30, 45, 60, 90, and 120 degrees Rectangular; with and without end contractions Cipoletti. Flumes: Parshall; 1", 2", 3", 6", 9", 1.5', 2', 3', 4', 5', 6', 8', 10', 12' Palmer-Bowlus; 4", 6", 8", 12", 15", 18", 21", 24", 27", 30", 48" Trapezoidal; LG 60 V, 2" 45 WSC, 12" 45 SRCRC H; 0.5', 0.75', 1', 1.5', 2', 2.5', 3', 4.5' Equation: $Q = a \times H^{b+c} \times H^{d}$ where: Q = flow H = head a,b,c, and d = entered values Manning Formula: Round, U-channel, Rectangular, Trapezoidal Area Velocity: Round, U-channel, Rectangular, Trapezoidal Data Points: 50 level-flow rate points, 50 level-area points
Refrigerator Temperature Sensor	Optional sensor and 5 ft (1.55 m) cable to record temperature readings. Intended for use with fiberglass refrigerated (FR) samplers. Range: -40.0 °C to 100 °C Accuracy specification: ±0.3 °C over a range of 0.0 to 10.0 °C. Reading data is 2 bytes, with a storage resolution of 0.1 °C.
6712 Standard Portable Sampler: Physical Specifications	
Dimensions:	Height: 27 inches (68.6 cm) Diameter: 19.96 inches (50.7 cm)
Sampler Tub Configurations:	• 24 wedge polypropylene bottles, 1,000 ml • 24 round glass bottles, 350 ml • 12 round polypropylene bottles, 1,000 ml • 12 round glass bottles, 950 ml • 8 round polyethylene bottles, 2.0 liters • 8 round glass bottles, 1.8 liters • 4 round polyethylene bottles, 3.7 liters (1 gal) • 4 round glass bottles, 3.7 liters (1 gal) • 1 round polyethylene bottle, 9.4 liters (2.5 gal) • 1 round glass bottle, 9.4 liters (2.5 gal)
Dry Weight:	32 lbs (15 kg)
This includes the top cover, center section, tub, controller, pump tube, distributor arm, distributor arm nut, and discharge tube for the 24 bottle configuration.	

Table 1-3 Technical Specifications for the 6712C and Standard Samplers (Continued)

Dry Weight With:	24 plastic bottles, hold down, no caps	36 lbs (17 kg)
	24 glass bottles, expander ring, no caps	55 lbs (25 kg)
	12 plastic bottles, insert, expander ring, no caps	37 lbs (17 kg)
	12 glass bottles, insert, expander ring, no caps	45 lbs (21 kg)
	8 plastic bottles, insert, hold down, no caps	36 lbs (17 kg)
	8 glass bottles, insert, hold down, no caps	46 lbs (21 kg)
	4 plastic bottles, insert, hold down, no caps	36 lbs (17 kg)
	4 glass bottles, insert, hold down, no caps	45 lbs (21 kg)
	1 plastic bottle and composite tube guide, no cap, arm or nut	34 lbs (16 kg)
	1 glass bottle and composite tube guide, no cap, arm or nut	38 lbs (18 kg)
Filled Bottle Weight:	24 plastic bottles	101 lbs(46 kg)
	24 glass bottles	104 lbs(48 kg)
	12 plastic bottles	89 lbs (41 kg)
	12 glass bottles	95 lbs (43 kg)
	8 plastic bottles	84 lbs (38 kg)
	8 glass bottles	90 lbs (41 kg)
	4 plastic bottles	98 lbs (45 kg)
	4 glass bottles	104 lbs(48 kg)
	1 plastic bottle	90 lbs (41 kg)
	1 glass bottle	94 lbs (43 kg)
This includes everything in the Dry Weight, Dry Weight With, and Ice Capacity specifications, and the bottles are filled to the capacities listed in Sampler Tub Configurations. This weight does not include a power source.		
Ice Capacity:	24 plastic bottles	12 lbs (5.4 kg)
	24 glass bottles	30 lbs (13.6 kg)
	12 plastic bottles	16 lbs (7.3 kg)
	12 glass bottles	16 lbs (7.3 kg)
	8 plastic bottles	12 lbs (5.4 kg)
	8 glass bottles	12 lbs (5.4 kg)
	4 plastic bottles	28 lbs (12.7 kg)
	4 glass bottles	25 lbs (11.3 kg)
	1 plastic bottle	35 lbs (15.9 kg)
	1 glass bottle	35 lbs (15.9 kg)
$^3/_4$" × $^3/_4$" × $^1/_4$" approximate ice cube size. Ice capacity will vary with the size of the cubes.		

Cooling Capacity Configuration:	Sample Size	Cooling Water	Last Sample	Last Sample Temp
24 plastic bottles	500 ml Sample	61°F (16°C)	Sample 24	63°F (17°C)
24 glass bottles	175 ml Sample	39°F (4°C)	Sample 24	41°F (5°C)
12 plastic bottles	500 ml Sample	36°F (2°C)	Sample 12	54°F (12°C)
12 glass bottles	475 ml Sample	36°F (2°C)	Sample 12	54°F (12°C)
8 plastic bottles	1,000 ml Sample	50°F (10°C)	Sample 8	57°F (14°C)
8 glass bottles	900 ml Sample	37°F (3°C)	Sample 8	54°F (12°C)
4 plastic bottles	1,850 ml Sample	34°F (1°C)	Sample 4	34°F (1°C)
4 glass bottles	1,850 ml Sample	37°F (3°C)	Sample 4	37°F (3°C)
1 plastic bottle	12–400 ml Samples	37°F (3°C)	Composite Sample	37°F (3°C)
1 glass bottle	12–400 ml Samples	36°F (2°C)	Composite Sample	36°F (2°C)

The cooling capacity is the temperature of the sample and the cooling water 24 hours after the last sample is taken. The amount of ice specified for the ice capacity was used. The temperature of the sample liquid is 65°F (18°C). The ambient temperature is 75°F (24°C).

Average Thermal Resistance Factor:	R-10

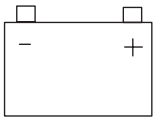
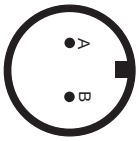
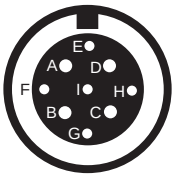
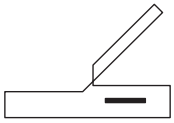
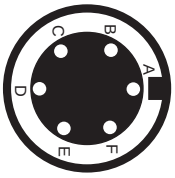
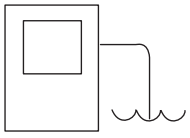
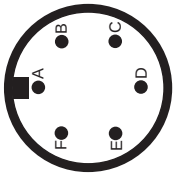
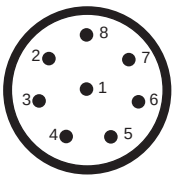
The average R-value for a complete sampler. This includes a tub, center section, top cover, controller, pump tube, distributor arm, and discharge tube.

Table 1-3 Technical Specifications for the 6712C and Standard Samplers (Continued)

6712 Standard Sampler with Optional 5 Gallon Bottle: Physical Specifications	
Dimensions **Base Alone:** **Assembled Sampler:**	 Height: 15.4 inches (39.1 cm) Diameter: 19.9 inches (50.6 cm) Height: 31.5 inches (80.0 cm) Diameter: 19.9 inches (50.6 cm)
Sampler Tub Configuration:	1 round glass bottle, 5 gallons (18.9 liters)
Dry Weight:	52 lbs (24 kg)
This includes the top cover, center section, bottle base, 5 gallon glass bottle, controller, pump tube, and discharge tube.	
Ice Capacity:	21 lbs (9.5 kg)
3/4" × 3/4" × 1/4" approximate ice cube size. Ice capacity will vary with the size of the cubes.	
Filled Bottle Weight:	115 lbs (52 kg)
This includes everything in the Dry Weight and the Ice Capacity specifications, and the bottle is filled to the capacities listed in Sampler Tub Configurations. This weight does not include a power source.	
Cooling Capacity:	Sample Size: 12–800 ml Samples Cooling Water: 36°F (2°C) Composite Sample Temperature: 36°F (2°C)
The cooling capacity is the temperature of the sample and the cooling water 24 hours after the last sample is taken. The amount of ice used is specified in "ice capacity." The sampler is set up to take one sample every hour for twelve hours filling the bottle half full. The temperature of the incoming sample liquid is 65°F (18°C). The ambient temperature is 75°F (24°C).	
Average Thermal Resistance Factor:	R-10
This is the average R-value for the complete sampler. This includes a bottle base, center section, top cover, controller, pump tube, discharge tube, and composite tube guide.	
6712 Compact Portable Sampler: Physical Specifications	
Dimensions:	Height: 27.6 inches (70.1 cm) Diameter: 17.75 inches (45.1 cm)
Sampler Tub Configurations:	• 24 wedge polyethylene bottles, 500 ml • 12 round polyethylene bottles, 500 ml • 12 round glass bottles, 375 ml • 1 round polyethylene bottle, 9.4 liters (2.5 gallon) • 1 round glass bottle, 9.4 liters (2.5 gallon)
Dry Weight:	31 lbs (14 kg)
This includes the top cover, center section, tub, controller, pump tube, distributor arm, distributor arm nut, and discharge tube for the 24 bottle configuration.	
Dry Weight With:	24 plastic bottles, insert, hold down, no caps 35 lbs (16 kg) 12 plastic bottles, insert, expander ring, no caps 35 lbs (16 kg) 12 glass bottles, insert, expander ring, no caps 43 lbs (20 kg) 1 plastic bottle and composite tube guide, no cap, arm or nut 33 lbs (15 kg) 1 glass bottle and composite tube guide, no cap, arm or nut 37 lbs (17 kg)

Table 1-3 Technical Specifications for the 6712C and Standard Samplers (Continued)

Filled Bottle Weight:	24 plastic bottles	70 lbs	(32 kg)			
	12 plastic bottles	62 lbs	(28 kg)			
	12 glass bottles	66 lbs	(30 kg)			
	1 plastic bottle	66 lbs	(30 kg)			
	1 glass bottle	73 lbs	(33 kg)			
This includes everything in the Dry Weight, Dry Weight With, and Ice Capacity specifications, and the bottles are filled to the capacities listed in Sampler Tub Configurations. This weight does not include a power source.						
Ice Capacity:	24 plastic bottles	8 lbs	(3.6 kg)			
	12 plastic bottles	13 lbs	(5.9 kg)			
	12 glass bottles	13 lbs	(5.9 kg)			
	1 plastic bottle	12 lbs	(5.4 kg)			
	1 glass bottle	15 lbs	(6.8 kg)			
3/4" x 3/4" x 1/4" approximate ice cube size. Ice capacity may vary with the size of the cubes.						
Cooling Capacity:						
Configuration:	Sample Size	Cooling Water		Last Sample	Last Sample Temp	
24 plastic bottles	250 ml Sample	41°F	(5°C)	Sample 24	55°F	(13°C)
12 plastic bottles	250 ml Sample	34°F	(1°C)	Sample 12	41°F	(5°C)
12 glass bottles	175 ml Sample	34°F	(1°C)	Sample 12	43°F	(6°C)
1 plastic bottle	12–400 ml Samples	43°F	(6°C)	Composite Sample	43°F	(6°C)
1 glass bottle	12–400 ml Samples	39°F	(4°C)	Composite Sample	39°F	(4°C)
The cooling capacity is the temperature of the sample and the cooling water 24 hour after the last sample is taken. The amount of ice specified for the ice capacity was used. The temperature of the sample liquid is 65°F (18°C). The ambient temperature is 75°F (24°C).						
Average Thermal Resistance Factor:	R-11					
The average R-value for a complete sampler. This includes a tub, center section, top cover, controller, pump tube, distributor arm, and discharge tube.						

Table 1-4 Connector Specifications		
Connector Icon	**Pin Location Diagram**	**Pin Function**
POWER SOURCE 	**2-PIN MALE, SEALED** 	A Ground B +12 volts DC
RAIN GAUGE 	**9-PIN FEMALE, SEALED** 	A +12 volts DC B Ground C Programmable I/O1 pin D Rain gauge input E Not Connected F SDI-12 Data G Not Connected H Programmable I/O2 pin I Programmable I/O3 pin
INTERROGATOR 	**6-PIN FEMALE, SEALED** 	A Switched +12 volts DC B Ground C Connection Sense D Transmit E Receive F NC
FLOW METER 	**6-PIN MALE, SEALED** 	A +12 volts DC B Ground C Flow Pulses In D Bottle Number Out Dual Sampler Out E Event Mark Out F Inhibit In
MODULE (IN MODULE BAY)	**8-PIN MALE, SEALED** 	1 NC 2 +12 volts DC 3 Ground 4 Module Sense 5 Receive 6 Transmit 7 Clock 8 Control

6712 Portable Sampler

Section 2 Installation/Preparation

2.1 Preparing the Sampler

When sampling with a single bottle, the composite tube guide is installed and the discharge tube is threaded through the guide.

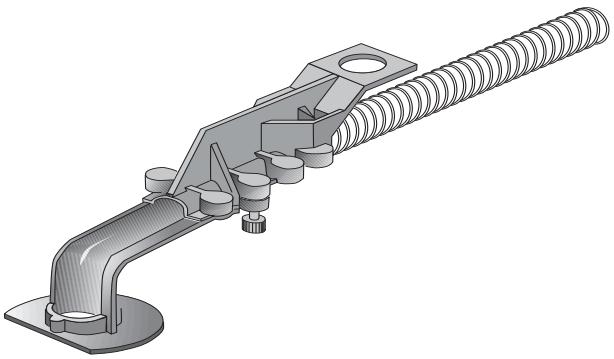
When sampling with multiple bottles, both the compact and standard 6712 Samplers use a distributor arm. It is adjustable so that you can position the discharge tube over the bottles of each kit. Each bottle kit also uses a discharge tube of a specific length. Table 2-1 lists the correct discharge tube lengths for each bottle kit. After installing the distributor arm and discharge tube, run the distributor to each bottle position to ensure proper installation.

If using bulk tubing to cut your own tubes, cut the ends of the tube square, not at an angle, and cut the length accurately.

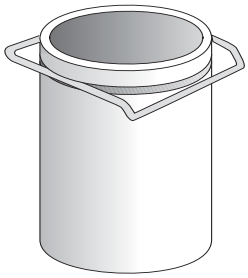
2.2 Installing the Distributor Arm and Discharge Tube

The two-piece distributor arm has four positions, marked on the underside with the letters A, B, C, and D. Adjust the arm to the correct position for the bottle kit being used. Table 2-1 shows the correct position for each kit. Thread the discharge tube through the spring and arm so that the tube protrudes from the arm $^{1}/_{16}$ to $^{1}/_{8}$ inch. If too much tube protrudes from the arm it can catch on bottles and jam the distributor arm.

Attach the arm to the distributor shaft. Secure the arm with the black plastic nut. Slide the free end of the discharge tube onto the bulkhead fitting.



Distributor Arm



Composite Tube Guide

Step 1

The two-piece arm has four positions, marked on the underside with the letters A, B, C, and D. Adjust the arm to the correct position for the bottle kit. Table 2-1 shows you the correct position for each kit.

Thread the discharge through the spring and arm so that the tube protrudes from the arm 1/16 to 1/8 inch.

Step 2

Attach the arm to the distributor shaft. The arm and shaft are keyed so that you can align them correctly. Secure the arm to the shaft with the black plastic nut.

Step 3

Slide the end of the discharge tube onto the bulkhead fitting.

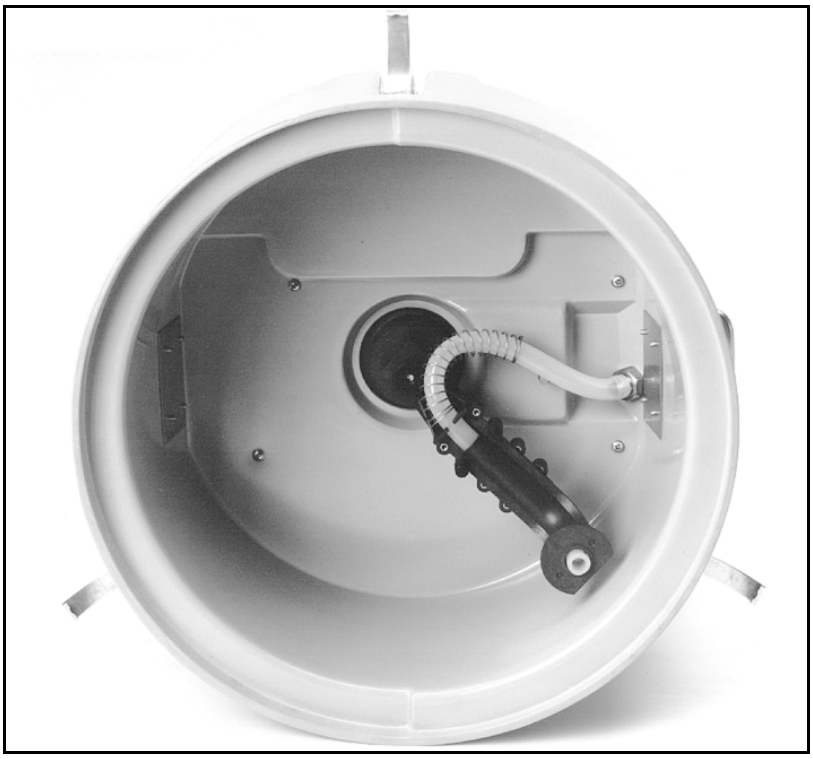


Figure 2-1 Installing the Distributor Arm

Table 2-1 Distributor Arm Adjustments and Discharge Tube Lengths for Bottle Kits

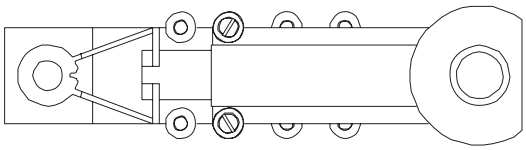
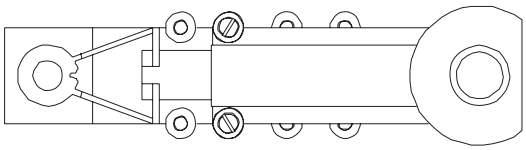
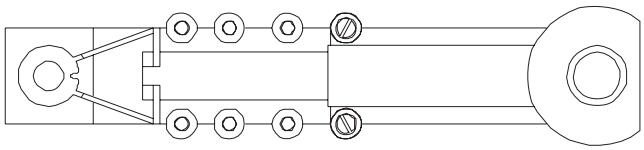
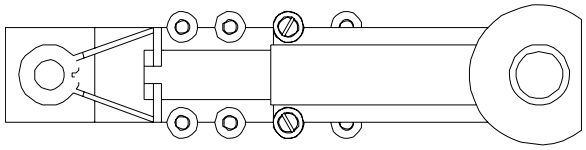
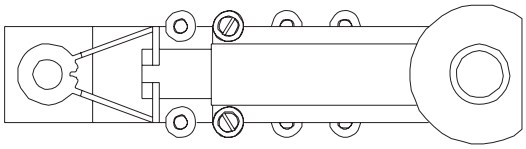
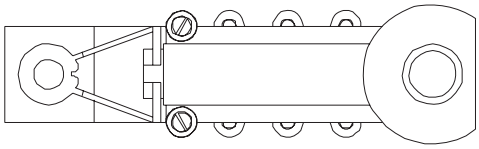
Compact 24-Bottle Kit • 500-milliliter polyethylene bottle Distributor Arm Position: B Discharge Tube: 60-9003-257 Discharge Tube Length: 14 1/4 inches (36.2 cm)	
Compact 12-Bottle Kit • 375-milliliter glass bottles • 500-milliliter polyethylene bottles Distributor Arm Position: B Discharge Tube: 60-9003-257 Discharge Tube Length: 14 1/4 inches (36.2 cm)	

Table 2-1 Distributor Arm Adjustments and Discharge Tube Lengths for Bottle Kits

Standard 24-Bottle Kit • 350-milliliter glass bottles • 1,000-milliliter polypropylene bottles Distributor Arm Position: D Discharge Tube: 60-9003-260 Discharge Tube Length: 17 1/4 inches (43.8 cm)	
Standard 12-Bottle Kit • 950-milliliter glass bottles • 1,000-milliliter polypropylene bottles Distributor Arm Position: C Discharge Tube: 60-9003-262 Discharge Tube Length: 16 1/2 inches (41.9 cm)	
Standard 8-Bottle Kit • 1.8-liter glass bottles • 2.0-liter polyethylene bottles Distributor Arm Position: B Discharge Tube: 60-9003-264 Discharge Tube Length: 15 3/4 inches (40.0 cm)	
Standard 4-Bottle Kit • 3.7-liter (1-gallon) glass bottles • 3.7-liter (1-gallon) polyethylene bottles Distributor Arm Position: A Discharge Tube: 60-9003-266 Discharge Tube Length: 15 inches (38.1 cm)	

2.3 Installing Bottle Kits for Multiplex Sampling

The samplers are shipped from the factory with sample bottles in place. When using the sampler for the first time, you will only need to remove the bottle lids. When installing cleaned bottles or a new kit, keep these guidelines in mind:

- **Never** mix glass and plastic bottles together.
- Install all bottles to insure that they remain in place.
- Align the bottles correctly. If the bottles are misaligned, the sampler may miss the bottle mouth, or the sampler will deposit samples in the “wrong” bottle.

- Each time you change from one size bottle to another, you must adjust the length of the distributor arm and install a discharge tube of the correct length.
- Each time you install a bottle kit, check the program settings for the number of bottles and bottle volume.

You must adjust the distributor arm and use a different discharge tube for each bottle kit. See *Installing Distributor Arm and Discharge Tube*, and Table 2-1 for more information.

2.3.1 Aligning Bottle Kits in the Standard Tub

Figures 2-2 through 2-5 show each kit being installed in the standard tub. Refer to Table 2-1 to adjust the distributor arm to the correct length and use the correct length of discharge tube.

1. Install the bottles then secure the plastic retaining ring with the three draw cords. (For glass bottles use the stainless steel retaining ring).
2. Adjust the distributor arm to the correct position, insert the discharge tube, and attach the distributor arm.

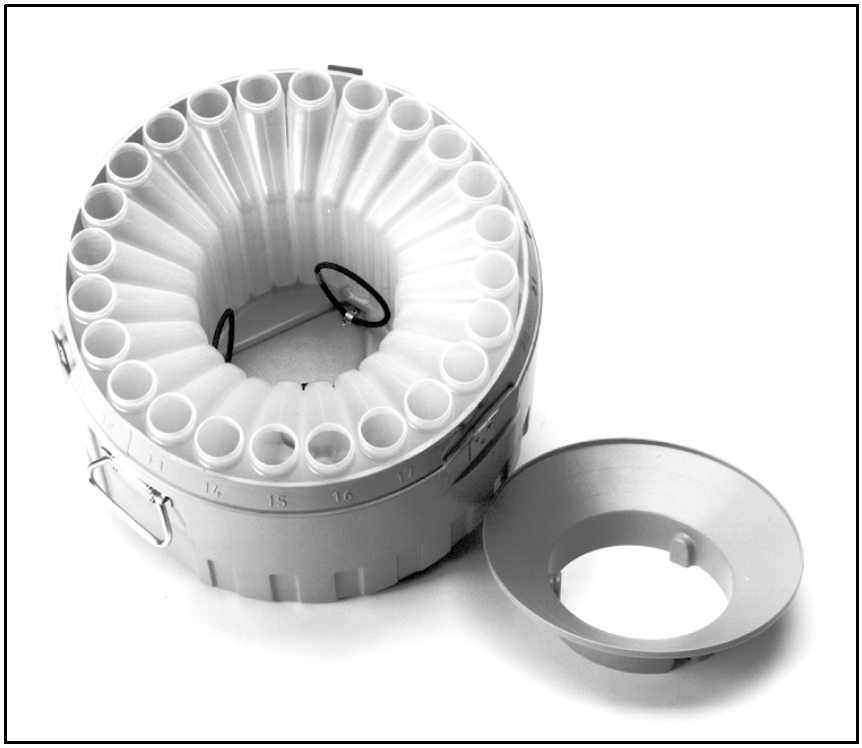


Figure 2-2 Placing the 24-Bottle Kit in a Standard Tub

1. Slide the 12-bottle insert into the tub, aligning the label with the corresponding numbers on the outside of the tub.
2. Place the bottles in the insert. Secure the bottles against the wall with the stainless steel retaining ring.
3. Adjust the distributor arm to the correct position, insert the discharge tube, and attach the distributor arm.

Figure 2-3 Placing the 12-Bottle Kit in a Standard Tub

1. Position the 8-bottle insert in the tub, aligning the label with the corresponding numbers on the outside of the tub.
2. Place the bottles in the insert then secure the plastic bottle insert with the three draw cords.
3. Adjust the distributor arm to the correct position, insert the discharge tube, and attach the distributor arm.

Figure 2-4 Placing the 8-Bottle Kit in a Standard Tub

1. Place the rack in the tub, aligning the label with the corresponding numbers molded on the outside of the tub.
2. Place bottles in the rack and secure the hold down over the bottles with the three draw cords.
3. Adjust the distributor arm to the correct position, insert the discharge tube, and attach the distributor arm.

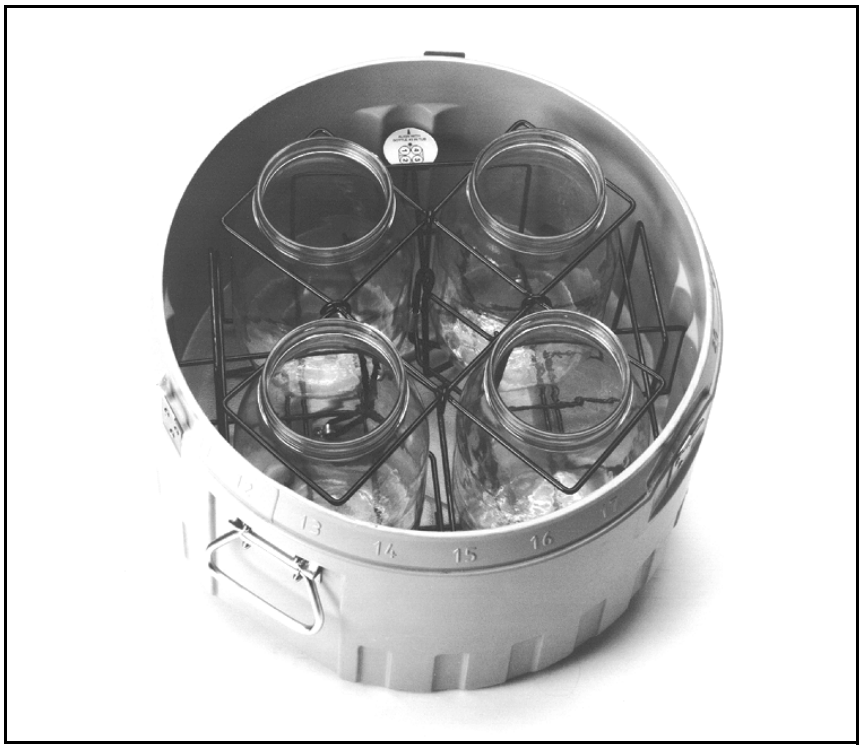


Figure 2-5 Placing the 4-Bottle Kit in a Standard Tub

Compact Sampler Tub Alignment Notches

Aligning the carrier

Figure 2-6 Placing the carrier in the compact tub

2.3.2 Aligning Bottle Kits in the Compact Tub

To align the bottles:

1. Place the bottles in the carrier, and secure them with the appropriate retaining ring.
2. Place the carrier in the tub, aligning it as shown in Figure 2-6. The carrier will drop into the notches when properly aligned.

2.4 Installing Bottle Kits for Composite Sampling

You can install a single $2^1/_2$ gallon bottle in either the standard or compact sampler tub for composite sampling. Single bottle sampling uses a composite tube guide instead of a distributor arm to position the discharge tube over the bottle. Install the composite tube guide and discharge tube as shown in Figure 2-7. Discharge tube part numbers and lengths are listed in Table 2-2.

The compact and standard sampler bottle bases accept a $2^1/_2$ gallon glass or plastic bottle. Place the bottle in the recess formed in the bottle base.

2.4.1 Optional Jumbo Bottle Base

You can install an optional bottle base on the standard sampler to collect larger composite volumes. The optional base replaces the standard tub and holds a 4 gallon (15 liter) polyethylene bottle, 5 gallon (19 liter) glass bottle or 5.5 gallon (20.8 liter) polyethylene bottle. Prepare the sampler as shown in Table 2-2 and Figure 2-7, and place the bottle in the recess formed in the bottle base.

Step 1

Both the compact and standard samplers use the same composite tube guide to hold the discharge tube in place over the composite bottle.

Attach the composite tube guide by firmly sliding it onto the distributor-shaft housing. It will snap in place. The guide has a slot that fits over a key on the housing to align it.

Step 2

Thread the discharge tube through the guide as shown. Attach the tube to the bulkhead fitting.

Removal

To remove the composite tube guide, rotate the metal clip to one side while pulling the guide away from the center section.

Figure 2-7 Installing the Composite Tube Guide

Table 2-2 Discharge Tubes for Composite Sampling		
Configuration	**Discharge Tube**	**Discharge Tube Length**
Compact 1 Bottle • 9.4-liter (2 1/2 gallon) glass bottle • 9.4-liter (2 1/2 gallon) polyethylene bottle	60-9003-258	10 inches (25.4 cm)
Standard 1 Bottle • 9.4-liter (2 1/2 gallon) glass bottle • 9.4-liter (2 1/2 gallon) polyethylene bottle	60-9003-271	12 inches (30.5 cm)
Jumbo Bottle Option • 15 liter (4 gallon) polyethylene bottle • 19 liter (5 gallon) glass bottle • 20.8 liter (5.5 gallon) polyethylene bottle *Standard samplers only. Requires the Jumbo Bottle Base*	60-9003-271	12 inches (30.5 cm)

5 Gallon Glass Composite Bottle | **2.5 Gallon Plastic Composite Bottle** | **2.5 Gallon Glass Composite Bottle**

Figure 2-8 Composite Bottles

2.5 Installing a Power Source

The 6712 Sampler requires 12-volt DC power. Power sources available from Teledyne Isco are listed below.

946 Lead Acid Battery

934 Nickel Cadmium Battery

913 High Capacity Power Pack (120 volts AC, 50/60 Hz)

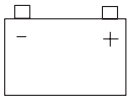
923 High Capacity Power Pack (240 volts AC, 50/60 Hz)

914 Battery Backed Power Pack (120 volts AC, 50/60 Hz)

924 Battery Backed Power Pack (240 volts AC, 50/60 Hz)

(the 924 is not certified for use in Europe)

948 45 Amp Hr Battery



Power Source Connector Icon

Connect the power source to the sampler connector that is labeled with this icon.

To install the smaller batteries or power packs on the sampler:

1. Place the power source in the sampler's battery recess.
2. Secure the power source with the black rubber draw-catches.
3. Attach the power-source cable to the power-source connector on the controller.

⚠ CAUTION

Use only Teledyne Isco-made power packs. If using a power pack with the 6712, Teledyne Isco recommends you use the new 913 or 923 power pack. Older model power packs may not provide sufficient power.

Refer to the *Teledyne Isco Power Products Guide* shipped with your sampler for more information on Teledyne Isco's power sources.

If you use a 120 or 240 volt AC-connected power pack, the AC line cord is the "Disconnect Device." Always install the sampler with the line cord and plug visible and readily accessible, so that power can be disconnected easily.

2.5.1 Connecting an External 12-Volt DC Source

You can also power the sampler with an external 12-volt DC source, such as an automotive battery. Connect the sampler to the battery with the External 12-Volt DC Power Cable.

⚠ CAUTION

Be sure to attach the positive and negative clips to the correct battery terminals. If polarity is reversed, the sampler may be permanently damaged.

2.6 Suction Line

The suction line is the tubing from the sampling point to the pump intake. The 6712 uses a 3/8-inch ID suction line of lengths 3 to 99 feet. Teledyne Isco offers vinyl or Teflon® suction lines. The Teflon® tubing has a polyethylene jacket to protect it from kinks and abrasions.

Guidelines for Measuring and Cutting the Suction Line:

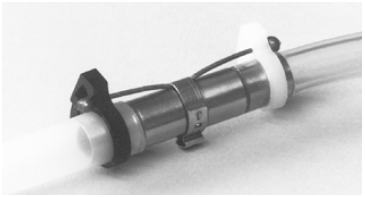
- Cut the line to the desired length but use the shortest length feasible for the installation.
- Cut the line in 1 foot increments. For instance, 4 feet, not 3 1/2. If using metric units of measure, cut the line in increments of 0.1 meter. Do not include the length of the strainer in the measurement.

The vinyl line contains a very low parts-per-million level of phenols. If phenol content affects your sample analysis, use the Teflon suction line.

When installing the sampler, be sure the vertical distance between the liquid level and the pump is as small as possible.

2.6.1 Attaching Suction Line to Pump Tube

Attach the vinyl suction line to the pump tube with the tube coupling. Use the black clamp for the pump tube and the white clamp for the suction line. Attach the line and tube to the coupling by pushing them onto each end of the coupling. Then tighten the clamps by squeezing the finger pads together. Loosen a clamp by twisting it until its teeth disengage. Attach the Teflon® suction line to the pump tube by inserting the line into the tube and secure with a suitable clamp.



Suction Line Tube Coupling

2.7 Strainers

Teledyne Isco offers three styles of strainer that help prevent solids from clogging the suction line:

- 3/8-inch standard weighted polypropylene strainer for routine and priority pollutant sampling
- 3/8-inch stainless steel low flow strainer
- 3/8-inch CPVC-coated strainer for acidic liquid sources

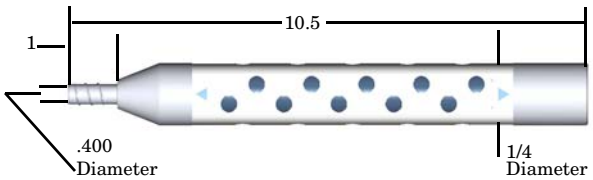
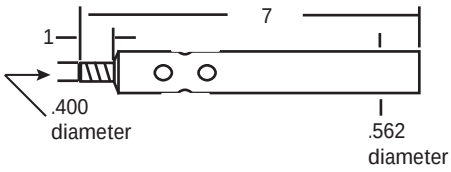
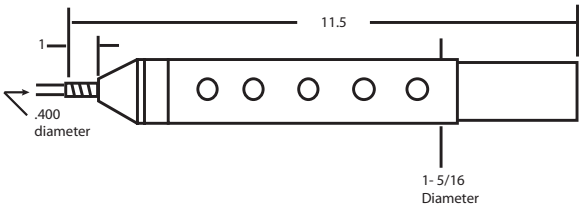
To select the right strainer for your application, see Table 2-3. To install the optional stainless strainer in Teflon suction line, heat the end of the suction line to make it more pliable, then carefully screw the strainer's threaded connector into the suction line.

2.7.1 Alternative to Strainers

When sampling from high velocity streams with heavy suspended solids, some field investigations suggest that more representative samples are obtained without the strainer. Consider attaching a short piece of thin walled aluminum tubing to the end of the suction line; anchor the tubing so that the inlet opens

upstream. The aluminum tubing's thin wall will not disturb the flow stream, and most sample analyses disregard aluminum ions. Under most conditions, the pre-sample purge removes any debris over the tubing entrance.

Table 2-3 Selecting the Right Strainer

Strainer	Dimensions	Application	Maximum Depth
3/8 Stainless Steel Ends, Polypropylene Center		Routine applications.	Vinyl Line: 22 feet (6.7m). Teflon Line: 15 feet (4.5m).
3/8 Stainless Steel Low Flow		Low flow applications	Vinyl Line: 22 feet (6.7m). Teflon Line: 15 feet (4.5m).
3/8 CPVC		Highly acidic liquids.	Vinyl Line: 4 feet (1.2m).

Note

- The suction lines will float when filled with air during the purge cycles and when depths exceed the listed ratings. Secure the suction lines when sampling at depths exceeding the maximum ratings.
- All strainer dimensions are in inches.
- Teflon suction line is compatible only with the 3/8 stainless steel strainer.

2.8 How Does the Sampler Work?

When the sampler takes a sample, it draws liquid through the strainer and suction line to the pump tube. The liquid flows through the pump tube and past the liquid detector, which senses the liquid. From the detector, the liquid follows the pump tube through the pump to the bulkhead fitting and then through the discharge tube to the sample bottle.

2.8.1 A Typical Sampling Cycle

1. The sampler moves the distributor arm over the bottle that is to receive the sample.
2. The pump reverses for the pre-sample purge.
3. The pump direction changes, filling the suction line.
4. When the detector senses liquid, the sampler begins measuring the sample.
5. After depositing the sample, the pump again reverses for the post-sample purge.

Sampling cycles vary somewhat according to program settings for distribution. The sampler can move the distributor arm clockwise and counterclockwise, making a number of distribution methods possible. (In this manual, the words "sample event" refer to a full sampling cycle for any distribution.)

Other variations include extended-program settings for suction-line rinses and sampling retries. A sampler running a program with line rinses completes the pre-sample purge and then rinses the line. The suction line is purged after each rinse. When programmed for sampling retries, the sampler will attempt to pump a sample again if it fails on previous attempts.

a. Controller.
b. Peristaltic pump.
c. Liquid Detector.
d. Strainer
e. Suction line
f. Stainless Steel Coupling
g. A pump tube routed from the liquid detector's intake port through the pump, out the detector's discharge port, and over the side of the controller to a bulkhead fitting at the top of the center section.
h. Bulkhead fitting.
i. Discharge tube running from the bulkhead fitting on the inside of the center section through the spring and distributor arm.
j. Distributor arm and spring.

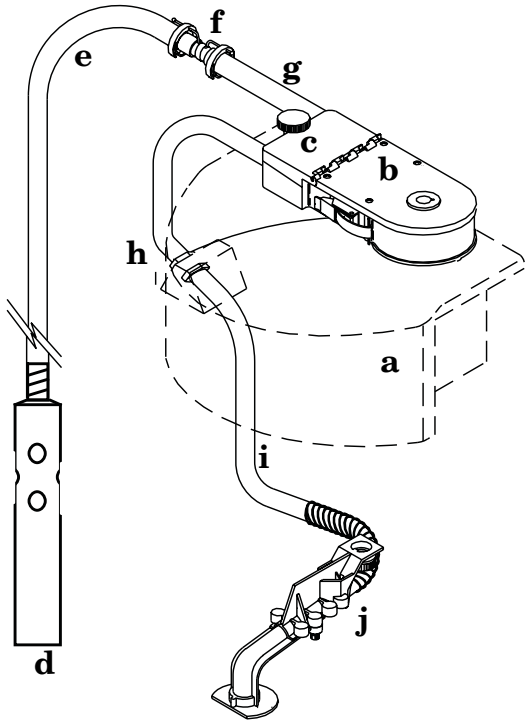


Figure 2-9 Identifying the Sampler Components

2.8.2 Measuring Sample Volume

"Sample volume" refers to the amount of liquid delivered into a bottle. The volume is determined by the programmed value. The volume is dependent on the volume per revolution of the pump, which is dependent on the suction head. The 6712 delivers the sample by counting the pump revolutions and automatically compensating for the suction head.

2.9 Installing the Sampler

The following paragraphs briefly describe initial sampler installation.

⚠ CAUTION

Tests indicate that the pump produces sound levels in excess of 85db at one meter. Prolonged exposure to this sound could result in hearing loss and requires the use of protective ear plugs.

2.9.1 Icing the Samples

Ice is placed in the center of the bottle kit or around the composite bottle. The ice capacity varies according to the bottle kit. To increase cooling for the multiple-bottle kits use an ice-water bath. Place as much ice as possible in the center of the bottle kit and slowly add cold water. Continually add ice, as the water will melt some ice.

Always use the retaining rings or hold downs. They hold the bottles in position and keep the bottles from floating.

2.9.2 Tips for Routing Suction Line

Route the line so that it runs continuously downhill from the sampler to the liquid source. This helps drain the line during pre-sample and post-sample purges. When the sampler is used in below freezing temperatures, there is a risk of the suction line being frozen. A suitably warm sampling source can usually prevent this, provided there are no loops in the suction line. Some situations may require more protective measures, such as insulation of the suction line, or heat tape. Thoroughly draining the suction line minimizes the possibility of frozen liquid clogging the line.

2.9.3 Intake Placement

For representative samples, place the intake in the main current of the flow stream, not in an eddy or at the edge of flow. Placing an intake at the bottom may produce samples with excess heavy solids and no floating materials, while placement at the top may produce the opposite conditions.

2.9.4 Positioning a Sampler

Place the sampler on a relatively flat, horizontal surface. Placing the sampler on a steep incline may cause the sample to miss the bottle mouth.

When installing the sampler, be sure the vertical distance between the level of the liquid and the pump is as small as possible.

⚠ CAUTION

When using the 6712 sampler with a 750 or 710 module, transmitters such as cell phones or walkie talkies must not be operated within 3 meters of the sampler. If water level readings are fluctuating due to TV/radio station transmitter towers in the area, the sampler must be relocated.

⚠ WARNING

The 6712 samplers have not been approved for use in hazardous locations as defined by the National Electrical Code.

⚠ WARNING

If you must enter a manhole or other dangerous location to install the sampler, observe standard safety precautions. Refer to Appendix C for a discussion of safety considerations.

2.9.5 Using the Suspension Harness or ProHanger

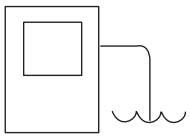
Teledyne Isco has a stainless steel suspension harness to lower or raise the sampler through a manhole or suspend the sampler during operation. You can suspend the harness from any suitable support. Prohanger is an X-shaped bracket that fits inside the lip of a manhole and lets you suspend the sampler using a cable harness.

2.10 Connecting External Instruments

The 6712 sampler can be used in conjunction with several types of external instruments.

2.10.1 Flow Meter

To connect the sampler to a Teledyne Isco open-channel flow meter, 4100 series flow logger, 2100 series flow module, or 1640 Liquid Level Actuator, attach the sampler-to-flow meter cable to the Flow Meter Connector. To connect the sampler to a closed-pipe flow meter, attach a Teledyne Isco 4-20 mA Input Interface device to the sampler's Flow Meter connector. When using the sampler with an external instrument, remember these guidelines:



Flow Meter Connector Icon

- Both the sampler and the flow instrument must be on and running a program.
- If using a flow meter, logger, or module for flow pacing, the sampler and the flow instrument must both run programs with flow pacing settings.
- If using a flow meter or flow logger for trigger pacing, the sampler must run a program with flow pacing settings, and the flow instrument must run a program with trigger pacing settings.
- When the sampler runs an event-paced program, it disregards pacing pulses from a flow meter or flow logger. However, the sampler continues to monitor for enable signals.

2.10.2 Rain Gauge Connector

Connect the rain gauge, SDI-12 Sonde, or Refrigerator Temperature Sensor connect cables to the nine-pin Rain Gauge Connector. When connecting a rain gauge and an SDI-12 Sonde, or rain gauge and a Refrigerator Temperature Sensor, use the appropriate Y-connect cable. See the Accessories appendix at the end of this manual.

Rain Gauge Connector Icon

⚠ WARNING

Most Teledyne Isco flow meters are not certified for use in hazardous locations as defined by the National Electrical Code. Contact your Teledyne Isco representative for your equipment's status. Never operate equipment in hazardous locations that has not been certified as safe for such use. Refer to Appendix C in the back of this manual for more safety information

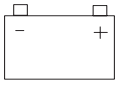
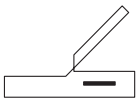
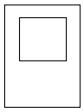
☑ Note

Select Extended Programming to use the SDI-12 sonde. (See Switching Between Standard and Extended Modes on page 4-1.)

☑ Note

Update the Hardware Setup whenever you add or remove an SDI-12 sonde. (See Section 6.) In Extended Programming, rain gauge and SDI-12 sonde readings are only available if they are selected in the Hardware Setup.

Table 2-4 Connecting Teledyne Isco Instruments to the Sampler

Connector Icon	Connect These Instruments:
Power Source 	12 volt power source
Rain Gauge	674 Rain Gauge Programmable I/O Pins (pins C, H, and I) SDI-12 Sonde Refrigerator Temperature Sensor
Interrogator 	581 RTD (Rapid Transfer Device) IBM PC or compatible computer running FLOWLINK or SAMPLINK External Modem External Data Logger/Controller
Flow Meter 	1640 Liquid Level Actuator 3000 Series Flow Transmitters 2100 Series Flow Modules 4100 Series Flow Loggers 4200 Series Flow Meters Master/Slave Sampler Pulse Duration Input Interface 4-20 mA Input Interface Closed-Pipe Flow Meters (using 4-20 mA Input Interface)

2.11 Locking the Sampler

Teledyne Isco offers stainless steel cables to lock the sampler (standard size – use P/N 68-6700-134; compact – use 68-6700-111). To lock the sampler, place the hook through the center section latch. Repeat this for the other two latches, and then pull the ends of the cables together over the top of the sampler. Lock the loops with the padlock. You can also lock each latch individually, using three padlocks, one for each of the latches.

2.12 Servicing the Sampler

Servicing the sampler includes:

- Recovering the sampler from the monitoring site
- Collecting the filled sample bottles and replacing them with clean bottles
- Replacing a battery, if required
- Collecting the data recorded by the sampler during the program.

Samplers are usually serviced after they complete a sampling program. When working up a service schedule, you will need to estimate the program completion time. You should also be familiar with the program's settings for the start time or if the sampler is programmed for continuous sampling.

Continuous sampling is controlled by the distribution setting entered at the "RUN CONTINUOUSLY?" screen. A "YES" response directs the sampler to reset the distribution sequence and continue the countdown to the next sample event. Appropriate service intervals will prevent overfilled bottles.

2.13 Recovering the Sampler

When recovering the sampler, keep it level to prevent spilling the collected samples.

If the battery's charge is questionable, replace it with a fully-charged battery.

The 6712 has a "fuel gauge" that gives an indication of power usage. The controller keeps track of how much power has been consumed since the last time it lost power. The current power consumption, as well as the previous power consumption, can be accessed by pressing the STOP key while in the main menu.

Keep in mind that the sampler has no idea as to how much charge was originally stored in the battery (or even if a battery is being used), and therefore has no idea as to the remaining capacity of its power source.

2.14 Collecting Sample Bottles

If you return the entire sampler back to the office, place caps on the bottles and drain any water from the carrier or tub. If you leave the sampler at the site and only need to collect the bottles, follow these guidelines for bottle collection.

2.14.1 Compact Sampler Bottle Collection

To collect the bottles from a compact sampler:

1. Open the latches, and lift the center section from the tub. Place caps on the bottles.
2. Remove the bottles by lifting the bottle carrier from the tub. Attach a label to the carrier detailing the location, date, etc.

Removing Bottles From the Compact Sampler

3. Pour any ice water out of the tub.
4. Slide a new bottle carrier filled with clean bottles into the tub.
5. Pour more ice into the carrier or tub.

2.14.2 Standard Sampler Bottle Collection

To collect the bottles from a standard sampler:

1. Open the latches, and lift the center section from the tub. Place caps on the bottles.
2. Drain any ice water from the standard tub by opening tub's drain plug. Remember to replace the plug's cap when done.
3. Attach a label to the tub or on each bottle detailing the location, time, date, etc.
4. Replace the standard tub and/or bottles with a clean set.
5. Pour more ice into the tub.

Drain Plug Location on the Tub

6712 Portable Sampler

Section 3 Getting Started

Before programming the 6712, you should become familiar with its keys and how to use the screens.

The 6712 Sampler has two sets of programming modes. The first mode, **Standard Programming**, lets you set up typical sampling programs easily and efficiently. The second mode, **Extended Programming**, lets you create sophisticated programs for complex sampling applications.

All of the sampling features available in standard programming mode are available in extended programming mode. However, extended programming provides many additional features.

Standard and extended programming features are explained in separate sections. This section focuses on some basic features that are common to both programming modes, such as using the menus and setting the clock.

3.1 Initial Operation

Turn the sampler on by pressing the On/Off key. It is labeled with this icon: ⏻. The start-up screen appears first.

```
6712 SAMPLER
STANDARD PROGRAMMING
For HELP at any
screen press ? key.
```

It remains on the display for about eight seconds or until you press a key. It tells you the type of programming screens the sampler is currently using — standard or extended — and gives you a tip about the on-line help. The main menu screen, shown below, appears next.

```
RUN
PROGRAM
VIEW REPORT
OTHER FUNCTIONS
```

6712 Control Panel

(If a module is attached, a different screen may appear first. See the module manual for more information.)

The sampler is programmed at the factory so that the standard programming screens appear when you first turn the sampler on. You can switch between programming modes by typing in a numerical command at the main menu:

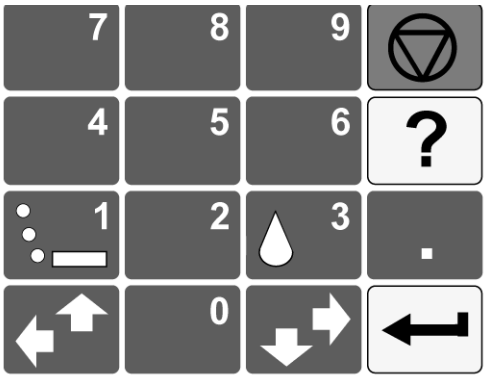
- At the main menu type **6712.2** to show the extended programming screens.
- At the main menu type **6712.1** to show the standard programming screens.

The sampler will continue to use the program mode you selected, even if the sampler is turned off and on again, until you manually switch to the other programming mode.

With the display backlight activated, the screen will glow for several seconds following your last keystroke.

If you press a key and the screen text does not change, it is probably because the keystroke turned the backlight on, instead of performing its function. Simply press the same key again.

Table 3-1 About the Keypad



Key	Name	Function
	On-Off	Turns sampler on or off.
	Stop	Stops the pump or distributor. Pauses a running sampling program. In programming screens, returns to a previous screen.
	Enter	Accepts a menu choice or number entry and goes to next screen.
	Help	In programming screens, displays a brief help message.
	Down-Right Arrow	Selects the menu option right or below the current choice.
	Up-Left Arrow	Selects the menu option left or above the current choice.
	Numbers	Types a number.
	Decimal Point	Types a decimal point.
	Pump Reverse	Press when at the main menu to run the pump in reverse.
	Pump Forward	Press when at the main menu to run the pump forward.

3.1.1 Selecting a Language

You have the option of having screens display in English or another language. The default is English. At the main menu, type **6712.8:**

```
ENGLISH
SPANISH
```

Use the arrow keys to move between the choices (languages other than those shown above could appear on your unit). When the language choice you want is blinking, press ↵(Enter). The ↵ (Enter) key always accepts the blinking option.

3.2 Using Menus and Entering Numbers

A menu is a list of options. The main menu has four options:

The Main Menu

```
RUN
PROGRAM
VIEW REPORT
OTHER FUNCTIONS
```

- RUN
- PROGRAM
- VIEW REPORT
- OTHER FUNCTIONS

The options identify the operations that can be performed from the menu. For example, to run the sampling program, select RUN; to modify the program, select PROGRAM.

3.2.1 Selecting Menu Options

In menu screens, one menu option always blinks.

- Press ↵ when the blinking option is the one you want; it will accept your choice and go to the next screen.
- Select a different option by pressing an arrow key until the option you want blinks. Then press ↵.

3.2.2 Entering Numbers

Number-entry screens prompt you to enter a value. An example is shown to the left.

To enter a number:

Press the number keys to type the number. Then, press ↵. As soon as you press ↵, the sampler saves your number and moves to the next screen. In some screens, you can use the . (Decimal Point) key in a number.

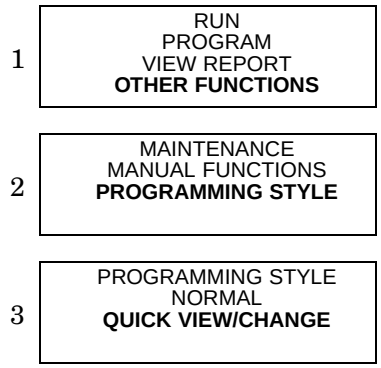
Some screens display the range of acceptable numbers between parentheses. If an entry is too low or high, the controller beeps and erases the entry. Type a new number and continue.

```
SUCTION LINE LENGTH
IS ___ft
(3-99)
```

- Type the length of the suction line. Acceptable values are shown between the parentheses. Press ↵ to accept the number.

3.3 Quick View Screens

Quick view screens are a special type of menu screen. They show the current program settings and let you move quickly through the program. You must change the programming style to QUICK VIEW/CHANGE to see the quick view screens, as shown below:



3.3.1 Paging Through Quick View Screens

The arrows in the corners of each quick view screen are menu options that let you move from one quick view screen to another.

Select the up arrow (↑) to go to the previous screen.

Select the down arrow (↓) to go to the next screen.

Press Stop to return to the main menu.

Because the forward arrow is always blinking when the screen appears, you can simply press ↵ to go to the next quick view screen, making it easy to page through the screens.

3.3.2 Changing Settings in a Quick View Screen

Although the quick view screens offer you a quick way to see the program settings, they also provide you with a way to change settings. Using quick view screens to change settings is sometimes a faster way to change a program because you can go quickly to the setting or settings that needs updating.

To change the program settings in a quick view screen:

Press an arrow until the setting blinks. Press ↵. The 6712 then displays the screen used to change the setting.

The Quick View screens below shows you how to change the sample volume. Begin by paging through the quick view screens until you see the screen containing the sample volume setting **200 ml SAMPLES.**

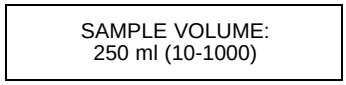
When you change a setting, the sampler stores the new settings and returns to the updated quick view screen. You can repeat this process until all settings shown in the quick view screens have been changed. When you are done, select the screen's forward arrow to move to the next quick view screen, or press Stop to return to the main menu.

Quick View Screens in Standard Programming

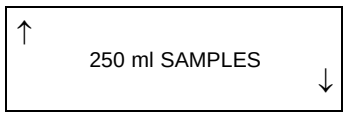
- To see the Quick View screens, select PROGRAM.

- Use the keypad's arrow key to select ↓ for the next quick view screen. When ↓ is blinking, press ↵.
- Use the keypad's arrow key to select ↑ for the previous quick view screen. When ↑ is blinking, press ↵.
- Use the keypad's arrow key to select the program setting. When the setting is blinking, press ↵ to display the screen used to change the setting.
- Press Stop for the main menu.
- All quick view screens work the same way.

- Press the arrow key until 200 ml SAMPLES blinks. Then press ↵.



- Type the new sample volume and press ↵.



3.4 Clock and Calendar

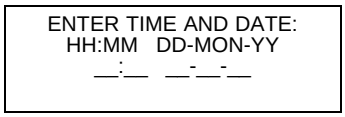
You may have to set the internal clock or calendar. The samplers are shipped with their clocks set to U.S. Central Standard time. If your sampler operates in a different time zone, you will have to reset the clock. The example to the left shows you how to find the time and date screen.

When setting the clock and calendar, use a 24-hour clock for times and the day-month-year format for dates. The illustration at the left shows blanks for each position that accepts an entry. The positions are called fields. When this screen appears on your sampler, the fields will contain the sampler's current settings for the time and date.

- To move from one field to another without changing the setting, press the arrow keys. Use this technique when you want to change only one or two settings.
- Change the setting by typing a new number. Press ↵ to accept the new setting.

For example, to enter 2:00 p.m. (2:00 p.m is 14:00 on a 24-hour clock), type 14. Press ↵. Next, type 0 (zero) for the minutes, and press ↵. To enter a date, such as January 22, 2001, type: 22 ↵ 01 ↵ 01 ↵ .

Entering Times and Dates



- Move from one field to another by pressing the arrow keys.
- Change a setting in a field by typing a number. Press ↵ to accept the new setting.

3.4.1 Setting the Clock and Calendar

1	RUN PROGRAM VIEW REPORT **OTHER FUNCTIONS**	Select OTHER FUNCTIONS.
2	**MAINTENANCE** MANUAL FUNCTIONS PROGRAMMING STYLE	Select MAINTENANCE.
3	**SET CLOCK** PUMP TUBE ALARM INTERNAL BATTERY DIAGNOSTICS	Select SET CLOCK.
4	ENTER TIME AND DATE: HH:MM DD-MON-YY **14:00 22-JAN-01**	Enter the time and date.
5	SET CLOCK PUMP TUBE ALARM INTERNAL BATTERY DIAGNOSTICS	Press Stop to return to the main menu.

3.4.2 Menu Screens: Clock Start Times

There are four start time settings you can use in a sampling program. This section discusses only one of these settings, the clock start time. A clock start time lets you set up a sampling program that starts at the same time on one or more days of the week. For example, you may want to begin sampling at 6:00 a.m. on Monday through Friday (refer to the screen below).

To select a day or days from the menu:

1. Press an arrow key until the cursor is on the correct day. Then, press ↵.
2. Repeat these steps until each day you want is blinking.
3. Press an arrow until DONE blinks. Press ↵.

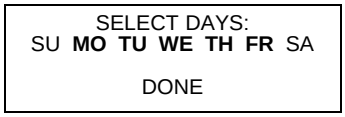
To remove days from the list:

1. Press an arrow key until the cursor is on the day you want to remove. Press ↵ to deselect it.
2. When finished, select DONE and press ↵

Using the Clock Start Time Menu

- Select CLOCK TIME.

- Type the time of day and press ↵.



- Press an arrow key until the cursor is on the correct day. Then, press ↵. To remove a day, move the cursor to it and press ↵ to deselect it.
- Repeat these steps until each day you want is blinking.
- Press an arrow until DONE blinks. Press ↵.

3.5 Menu Screens: Site Descriptions and Program Names

The sampler has two text-entry menus, one for site description and another for an extended-program name. They work in the same way. A site description is commonly a number, address, or other short note that helps identify the monitoring site. Extended programming has a similar screen that lets you enter program names for stored programs.

The example to the lower left shows how to change the site description from FACTORY01 to SITE 29. Line 1 contains text between two quotation marks. Lines 2 and 3 contain the menu options — numbers, letters, and punctuation marks — used to spell out the description. In line 3, the space between the ampersand (&) and the double quotes (") is a space character. Line 4 contains two additional options:

- BACK-UP, an option that moves the cursor on the text line to the left one character.
- DONE, an option that tells the sampler to save the text.

The cursor is the blinking rectangle that identifies the current field. When the screen first appears, the cursor blinks on the first character of the text in line 1. The matching character in line 2 or 3 also blinks.

When you press ↵, the cursor on line 1 moves to the right one position, and, at the same time, the sampler blinks on the matching character on lines 2 or 3.

To change any character in the text line:

1. Press the left or right arrow until the replacement character on lines 2 or 3 blinks.
2. Press ↵. The replacement character will appear on the first line, and the cursor will move to the next character.
3. *Repeat steps 1 and 2 until the text in the top line is complete*.
4. Finish the entry by selecting DONE. Then, press ↵.

Some additional tips for using the text-entry menus:

- Hold an arrow key down for faster movement.
- If your description uses all ten spaces in the text line, the sampler automatically moves to the next screen as soon as you add the tenth character.
- You can enter numbers by pressing the number keys.
- Erase characters by replacing them with a space character.
- Select the BACK-UP option to move the cursor to the left.
- To leave the menu before completing the entry, press Stop. The sampler will display this menu:

```
SAVE CHANGES?
YES   NO
```

Select YES to save any changes made. Select NO to leave the original description (or program name) unchanged.

Changing the Site Name

```
SITE: "FACTORY01"
ABCDEFGHIJKLMNOPQRST
UVWXYZ-& "0123456789
BACK-UP   DONE
```

```
SITE: "SACTORY01"
ABCDEFGHIJKLMNOPQRST
UVWXYZ-& "0123456789
BACK-UP   DONE
```

- Press the Down-Right arrow until the **S** on line 2 blinks. Then, press ↵.

```
SITE: "SICTORY051"
ABCDEFGHIJKLMNOPQRST
UVWXYZ-& "0123456789
BACK-UP   DONE
```

- Press the Up-Left arrow until the I blinks. Press ↵.
- Continue pressing arrow keys to select T, E, and space. Press ↵ after selecting each character.

```
SITE: "SITE_29_  "
ABCDEFGHIJKLMNOPQRST
UVWXYZ-&_"0123456789
BACK-UP   DONE
```

- Press 29 on the keypad, then Up-Left until space blinks. Press ↵.

```
SITE: "SITE_29_  "
ABCDEFGHIJKLMNOPQRST
UVWXYZ-&_"0123456789
BACK-UP   DONE
```

- Press the Down-Right arrow until DONE blinks. Press ↵.

3.6 Messages

The sampler has four sets of messages that supplement the programming screens. **Information messages** tell you about programming status. **Help Notes** are brief comments associated with programming screens describing the setting or offering

assistance. **Warning messages** tell you something is different tha Teledyne Isco's standard. **Operation messages** report the sampler's status as it runs a program.

3.6.1 Information Messages

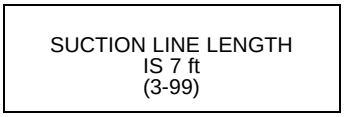
These are brief messages about the programming status, such as " 'ROM' PASSED TEST" or the status message that displays when you first start up the sampler. Information messages are displayed for four seconds, unless they are terminated by pressing any key on the keypad.

3.6.2 Help Notes

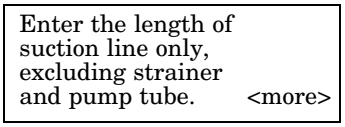
To see a Help note:

1. Press the ? (Help) key.
2. When the note requires several screens, the word "more" appears in the lower-right corner. Press ↵ for the next note.
3. Move back and forth between screens by pressing the arrow keys.
4. Press Stop at any time to return to the programming screen.

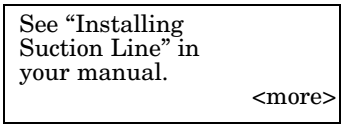
Most help notes refer to a related section in this manual. Screens that require extensive explanation have notes that contain only a reference to the manual. Sections mentioned in the notes appear in the index and the table of contents.



- Press ? (Help).



- Press ↵ or Down-Right to see the next screen.
- Press Stop to return to the programming screen.



- Press ↵ or Down-Right to see the next screen.
- Press Up-Left to see the previous screen.
- Press Stop to return to the programming screen.

- Press Up-Right to see the previous notes.
- Press Stop to return to the programming screen.

Using Help Notes

Although this example shows the help notes that are associated with the suction-line length screen, you can use the same technique to see help notes for other screens.

3.6.3 Warning Messages

Warning messages appear when the sampler determines something is out of the ordinary. For example, the following warning appears when you type a number that is larger than the standard bottle volume:

```
BOTTLE VOLUME IS
3500 ml   (300-30000)
```

```
WARNING!
STANDARD BOTTLE
VOLUME EXCEEDED!
```

The 6712 does accept nonstandard volumes because you might use a nonstandard container occasionally. For a list of recommended volumes for Teledyne Isco bottles press the ? (Help) key at the "Bottle Volume Is" screen, or refer to the Technical Specifications.

The 6712 uses the bottle and sample-volume settings to determine the maximum number of samples that can be deposited without overfilling the bottles. Entering a volume that exceeds the standard volume may cause the sampler to overfill the bottle.

3.6.4 Operation Messages

An operation message reports the sampler's status as it runs a program. An example is shown below.

```
PROGRAM WILL START
AT 06:00   TU   20-FEB

05:56:22   TU   20-FEB
```

3.7 Menu Trees

Selecting a menu option will take you to a number-entry screen or another menu screen. The screens are organized in a branching structure that resembles a tree. Refer to Figure 3-1 for a simple chart of the menu tree for standard programming. The standard programming structure is different — much simpler — than the extended programming structure. Charts that show you most of the sampler's screens appear in *Appendix A, Flowcharts*.

The entire structure changes a little when a module is attached because the sampler adds a set of screens for a module as soon as it detects the module's presence. The manuals for each module contain menu trees for its programming screens.

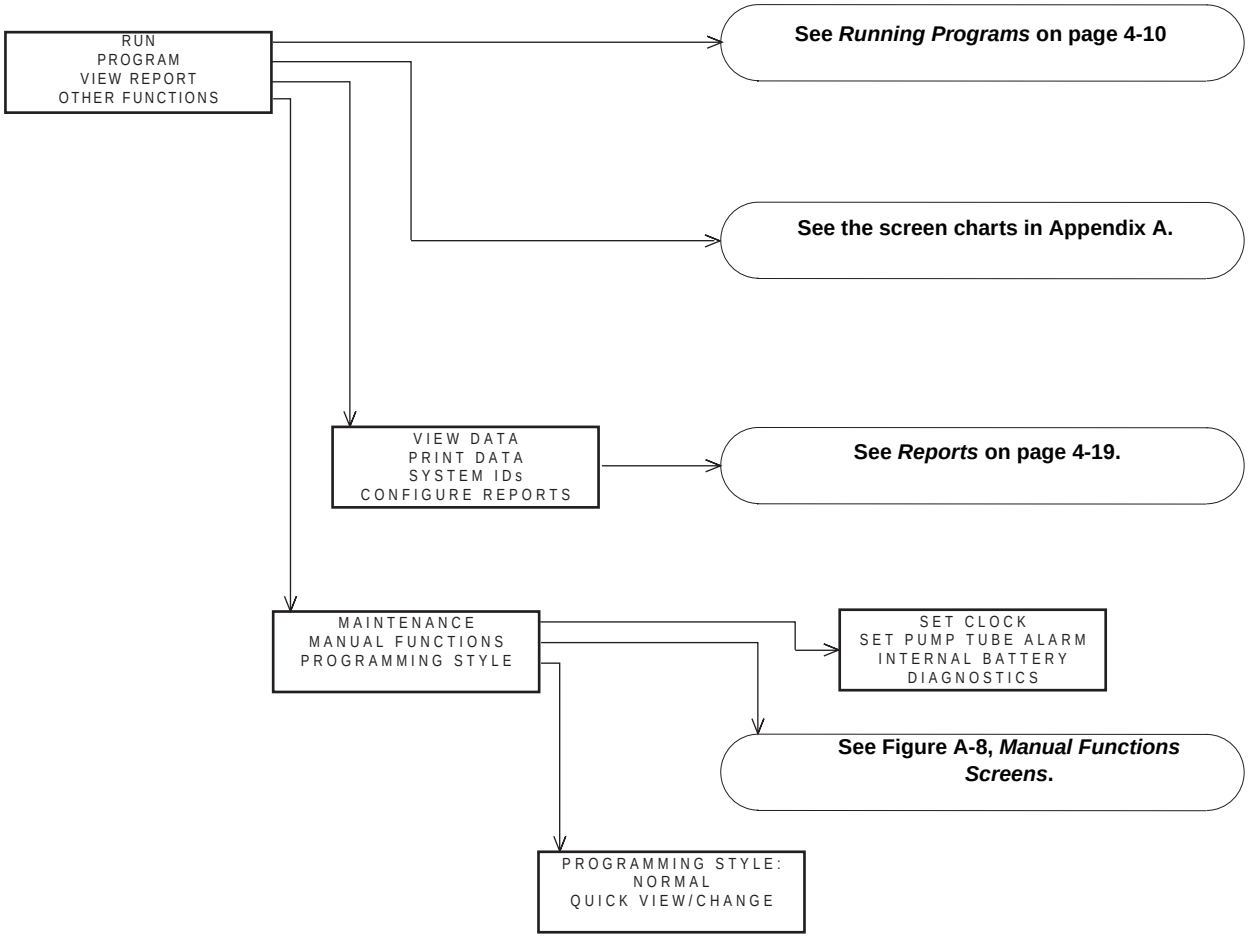


Figure 3-1 Menu Tree for Standard Programming

6712 Portable Sampler

Section 4 Standard Programming

The 6712 Sampler has two sets of programming screens. The first set, called standard programming screens, lets you set up typical sampling programs easily and efficiently. The second set, extended programming screens, lets you create sophisticated programs for complex sampling applications.

All of the sampling features available within the standard programming screens are available in extended programming. However, extended programming provides several additional features which are discussed in the next section. Menu flowcharts for both sets of programming screens are in Appendix A.

4.1 Switching Between Standard and Extended Modes

Factory default settings cause the sampler to begin in standard programming mode the first time you turn it on. The start-up screen tells you which programming mode the sampler is currently using. You can switch between programming modes by entering a numerical command at the main menu:

- At the main menu, type **6712.1** to enter standard programming mode.
- At the main menu, type **6712.2** to enter extended programming mode.

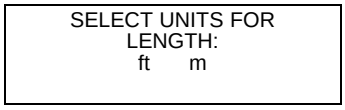
Main Menu

4.2 Language Selection, Units of Length

You have the option of displaying screens in English or Spanish (or possibly another language). The default is English. At the main menu, type **6712.8** to display:

Use the arrow key to move between the two choices. When the desired choice is blinking, press ↵.

If you select the English option, you will advance to a second screen that asks you to select your units of length:



Use the arrow key to move between the two choices, feet or meters. When the desired choice is blinking, press ↵. The default unit of length for the Spanish option is meters.

4.3 Programming Examples

The following table is an example of time-paced sampling. Further details about some of the menu items are provided in later sections.

Table 4-1 Standard Program: Sample Every 15 Minutes, One Sample Per Bottle

1	6712 SAMPLER STANDARD PROGRAMMING For HELP at any screen press ? key.	Turn the sampler on by pressing the On/Off key. Press ↵. This screen disappears on its own after 8 seconds.
2	RUN **PROGRAM** VIEW REPORT OTHER FUNCTIONS	The option PROGRAM will be blinking. Press ↵.
3	SITE DESCRIPTION: "FACTORY051" CHANGE? YES **NO**	The option NO will be blinking. Press ↵. For the purposes of this example, it isn't necessary to change the description.
4	NUMBER OF BOTTLES: 1 2 4 8 12 **24**	Select the number of bottles in your bottle kit by pressing either arrow key until the correct number blinks. Press ↵. For this example, select 24.
5	BOTTLE VOLUME IS 1000 ml (300-30000)	Type the volume for the bottles in your kit. For this example, 1000 is correct, so simply press ↵.
6	SUCTION LINE LENGTH IS 10 ft (3-99)	Type the length of the suction line, then press ↵. If you change the length, the sampler will display a message, "PLEASE WAIT!. . . GENERATING PUMP TABLES."
7	**TIME PACED** FLOW PACED	Because this example requires samples every 15 minutes, select TIME PACED by pressing an arrow until the option TIME PACED blinks. Then, press ↵.
8	TIME BETWEEN SAMPLE EVENTS 0 HOURS, 15 MINUTES	Type 0 for hours and press ↵. Type 15 for minutes and press ↵. Tip: Move back and forth between hours and minutes by pressing an arrow key.
9	**SEQUENTIAL** BOTTLES/SAMPLE SAMPLES/BOTTLE	Because this program requires one sample in each bottle, select SEQUENTIAL by pressing an arrow until the option SEQUENTIAL blinks. Then, press ↵.
10	RUN CONTINUOUSLY? YES **NO**	For this example, select NO by pressing an arrow until the option blinks. Then, press ↵. Selecting YES allows the program to run indefinitely by repeating the sample distribution. Continuous sampling assumes that filled bottles are replaced with empty bottles at regular service intervals.

Table 4-1 Standard Program: Sample Every 15 Minutes, One Sample Per Bottle (Continued)

11	SAMPLE VOLUME: 200 ml (10-1000)	Type the volume of the sample you want deposited in each bottle. Then, press ↵.
12	NO DELAY TO START **DELAYED START** CLOCK TIME WAIT FOR PHONE CALL	For this example, select DELAYED START by pressing an arrow until the option blinks. Then, press ↵.
13	FIRST SAMPLE AFTER A 5 MINUTE DELAY (1-999)	Type the delay period you want between the time you run the program and the time the sampler takes the first sample. Then, press ↵.
14	PROGRAMMING COMPLETE RUN THIS PROGRAM NOW? YES **NO**	Run the program immediately by selecting YES. Select NO if you want to run the program later by selecting RUN from the main menu. Press ↵ after making your choice. In this example, NO is selected.
15	**RUN** PROGRAM VIEW REPORT OTHER FUNCTIONS	Run the program by selecting RUN and pressing ↵.

The following table is an example of flow-paced sampling.

- Program type: Standard
- Site description: SITE 29
- Bottle kit: 24, 1000 milliliter bottles
- Suction line length: 7 feet
- Pacing: Flow pacing, every two pulses
- Distribution: 2 bottles per sample
- Sample Volume: 250 milliliters
- Start time: Clock Time, 6:00 a.m. on Monday, Wednesday, Friday
- Module: No module installed

Table 4-2 Standard Program: Flow-Paced Sampling, Two Bottles Per Sample

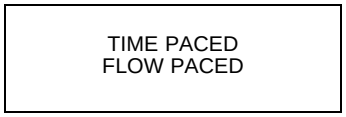
1	6712 SAMPLER STANDARD PROGRAMMING For HELP at any screen press ? key.	
2	RUN **PROGRAM** VIEW REPORT OTHER FUNCTIONS	Select PROGRAM.
3	SITE DESCRIPTION: “FACTORY051“ CHANGE? YES **NO**	Select NO.

Table 4-2 Standard Program: Flow-Paced Sampling, Two Bottles Per Sample (Continued)

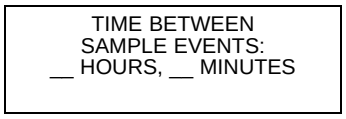
4	NUMBER OF BOTTLES: 1 2 4 8 12 **24**	Select 24.
5	BOTTLE VOLUME IS 1000 ml (300-30000)	Enter 1000.
6	SUCTION LINE LENGTH IS 10 ft (3-99)	Enter 7.
7	TIME PACED **FLOW PACED**	Select FLOW PACED.
8	FLOW BETWEEN SAMPLE EVENTS: 2 PULSES (1-9999)	Enter the number of pulses between sample events.
9	SEQUENTIAL **BOTTLES/SAMPLE** SAMPLES/BOTTLE	Select BOTTLES/SAMPLE.
10	RUN CONTINUOUSLY? YES **NO**	For this example, select NO by pressing an arrow until the option blinks. Then, press ↵. Selecting YES allows the program to run indefinitely by repeating the sample distribution. Continuous sampling assumes that filled bottles are replaced with empty bottles at regular service intervals.
11	1 BOTTLES PER SAMPLE EVENT (1-24)	Enter 2.
12	NO DELAY TO START DELAYED START **CLOCK TIME** WAIT FOR PHONE CALL	Select CLOCK TIME.
13	START FLOW COUNT AT: 00:00	Enter 6, then enter 0. This is the time at which the sampler will start the pacing countdown.
14	SELECT DAYS: SU **MO** TU **WE** TH **FR** SA DONE	Select MO, WE, and FR. Use the arrow keys and ↵ to select the days. When the correct days are blinking, select DONE and press ↵.
15	PROGRAMMING COMPLETE RUN THIS PROGRAM NOW? YES **NO**	Select NO.

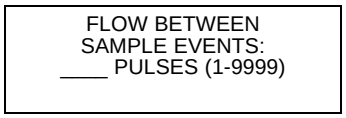
4.4 Pacing

Standard Time Pacing and Flow Pacing Screens for Samplers without Flow Modules



- When programming, you will be asked to select time or flow paced sampling. Depending upon your choice, you will see one of the following screens:





Sample pacing is the rate at which the sampler takes samples. Depending on the type of pacing you select, the rate is controlled by the sampler's internal clock or by inputs received from connected instruments.

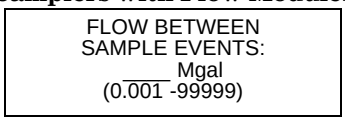
Standard programming provides time pacing and flow pacing (refer to Step 7 in the previous two programming examples). In time-paced sampling, the interval between samples is a constant time interval. When you program the sampler for time pacing, the sampler prompts you to enter the time between sample events in hours and minutes. Time paced programs always take a sample at the start time.

Flow paced sampling requires a flow meter, flow logger, or a module. A flow meter or flow logger paces a sampler by sending an electronic signal to the sampler after measuring a specified volume of liquid. Because each pulse represents a volume interval, flow pacing rates are proportional to the volume of water flowing through the channel.

When you program the sampler for flow pacing and are using a flow meter or flow logger, the sampler prompts you to enter the interval between sample events in pulses. The sampler initiates a sample event when the set number of pulses is received. Programs that are flow paced do not take a sample at the start time.

After setting the program start time, you will be prompted to enter a maximum run time of zero to 999 hours. If you would like the program to run indefinitely, enter 0 (zero) for maximum run time.

Flow Pacing Screen for Samplers with Flow Modules



The flow pacing screens change when you attach a flow module (see example to the left). Because the sampler is more closely integrated with the modules, the standard flow pacing screen prompts you for the flow volume between sample events instead of pulses between events. The flow volume units displayed are what you had previously programmed.

4.4.1 Trigger Pacing

Teledyne Isco 4200 Series Flow Meters and 4100 Series Flow Loggers send pulses for trigger pacing. The flow meter or flow logger sends pulses at two different time intervals when trigger pacing a sampler. Trigger pacing, for example, lets you sample less frequently when the trigger condition — a condition based on level, flow, or rainfall — remains below a set point. The intervals are determined by the flow instrument's program settings for trigger pacing.

When conditions change and readings pass the set point, triggering the new rate, you can sample more frequently. Or, when the trigger condition is a clock setting, the instrument changes the pacing interval according to the time of day. Using a clock trigger condition, for instance, the flow meter or flow logger can pace the sampler slowly at night and more frequently during the day. (For more information about trigger pacing, see your flow meter or FLOWLINK manual.)

The flow meter or flow logger sends the same pulse for both flow and trigger pacing, and the sampler cannot distinguish between them. Therefore, to program a sampler for trigger pacing, simply program it for flow pacing.

4.5 Distribution

Distribution describes how the sampler is to deposit samples. A sample is the volume of liquid deposited in a bottle. A sample event includes the full sampling cycle and may deposit a sample into more than one bottle.

In standard programming, you can program the sampler for these different distribution methods:

- Sequential
- Bottles Per Sample
- Samples Per Bottle
- Composite

4.5.1 Sequential

In sequential distribution, the sampler deposits one sample in each bottle. A sequential sample represents a "snapshot" of the flow stream at a point in time.

4.5.2 Bottles Per Sample

In bottles per sample distribution, the sampler deposits a sample in each of a set of bottles. A bottle set includes at least two bottles but may include all bottles. Use bottles per sample when the volume to be collected is larger than the amount one bottle can hold or when you need identical samples.

4.5.3 Samples Per Bottle

In samples per bottle distribution, the sampler deposits samples from several sample events in a single bottle before moving to the next bottle. Use samples per bottle distribution to collect a series of small composite samples.

4.5.4 Composite

For single bottle configurations, samples per bottle distribution is known as composite sampling. A composite sample represents an average of the flow stream's characteristics during the sampling period.

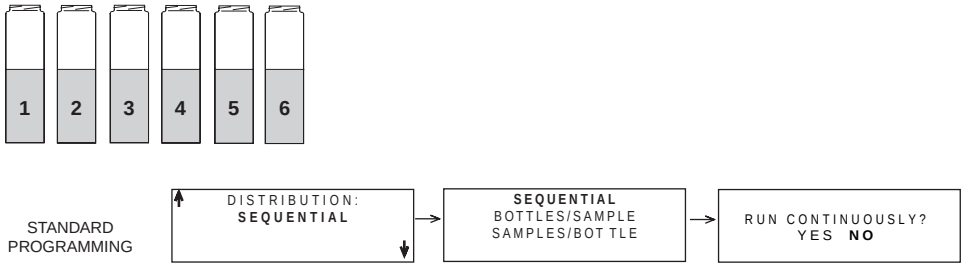
4.5.5 Continuous Sampling

Sample programs can be run indefinitely by selecting "YES" at the "RUN CONTINUOUSLY?" screen. Continuous sampling resets the distribution when the distribution sequence is complete. That is, when the last bottle/set is reached, the next bottle/set is the first bottle/set. All pacing modes except RANDOM are supported.

When running a program continuously, the bottles must be serviced at regular intervals to prevent overfilling the bottles. The sampler assumes that the next bottle/set is empty and ready to receive samples.

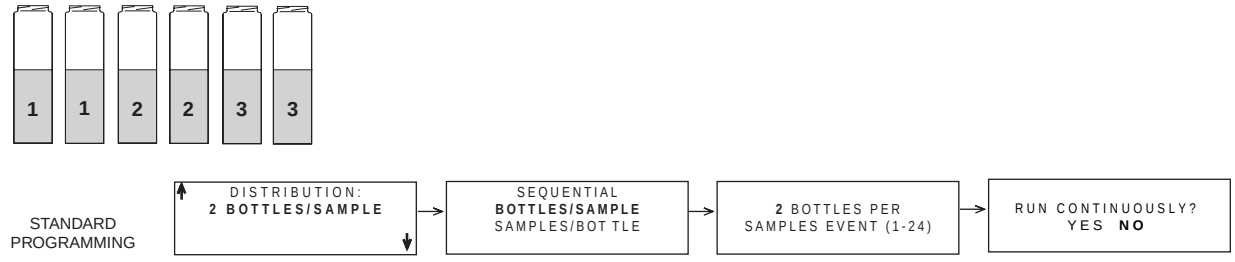
The figure on the next page steps through the programming screens for sequential, bottles per sample, and samples per bottle distribution.

Sequential



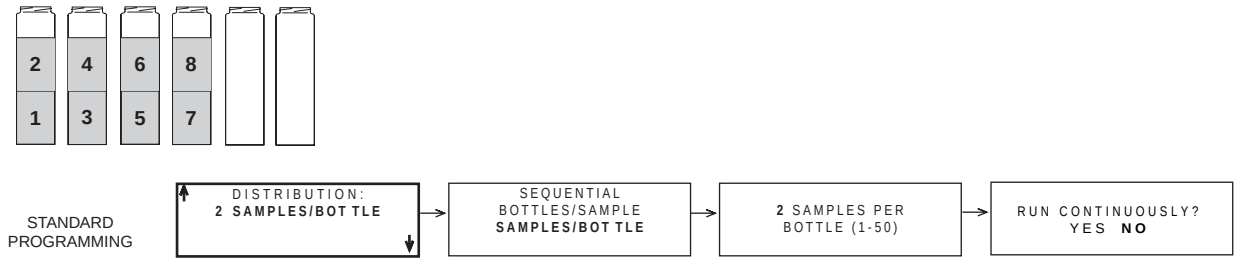
Each bottle receives one sample from one sample event.

Bottles-per-Sample



Multiple bottles receive a sample from one sample event.

Samples-per-Bottle



Each bottle receives a sample from multiple sample events.

Figure 4-1 Sample Distribution

4.6 Start Times

It is important to understand the difference between the time at which you run a program and the program's start time. Running a program simply means selecting RUN from the sampler's main menu. The start time is the time at which the sampler begins the program's first sample interval countdown. The start time is controlled by your selections from the start time screens.

Each program contains start-time settings that tell the sampler when to begin the program. When programming the sampler, you can select one of four start time options: NO DELAY TO START, DELAYED START, CLOCK TIME, or WAIT FOR PHONE CALL.

- Select NO DELAY TO START when you want the sampler to start as soon as you select RUN.
- Select DELAYED START when you want the sampler to delay from 1 to 999 minutes before starting the program.
- Select CLOCK TIME when you want the sampler to begin the program at a specific time on at least one day of the week.
- Select WAIT FOR PHONE CALL when you want the sampler to begin the program after receiving a remote command to start (optional modem required).

4.6.1 How Do Start Times Work?

As soon as you select RUN from the main menu, the sampler checks the program's start time settings. With a "DELAYED START" setting, the sampler starts a countdown to the start time. The period between the time you select RUN and the start time you've specified in the program is called the "delay to start time."

When you run a program with "CLOCK TIME" settings, the sampler also starts a countdown to start time until the day of week and clock times are met.

The sampler may not collect a sample at the start time. The sampler must be enabled, and the pacing selected must call for a sample at start. In any event, the sampler checks the pacing settings and begins the pacing-interval countdown.

Delayed Start Screen

1
NO DELAY TO START
DELAYED START
CLOCK TIME
WAIT FOR PHONE CALL

• Select DELAYED START.

2
FIRST SAMPLE
AFTER A
___MINUTE DELAY
(1-999)

- Enter the number of minutes to delay the countdown to the first sample.

3
START FLOW COUNT
AFTER A
__MINUTE DELAY
(1-999)

- The sampler uses this screen for flow paced programs.

Clock Start Time Menu

1
NO DELAY TO START
DELAYED START
CLOCK TIME
WAIT FOR PHONE CALL

• Select CLOCK TIME.

2
FIRST SAMPLE AT
06:00

• Enter the time of day.

3
SELECT DAYS:
SU **MO TU WE TH FR** SA

DONE

- Press an arrow key until the cursor is on the correct day. Press↵.
- Repeat until each day you want is blinking.
- Press an arrow until DONE blinks. Press ↵.

4.6.2 Sampler Enable/Disable

Teledyne Isco flow meters and flow loggers have a programmable sampler-enable feature that lets them enable (start) or disable (stop) a program according to certain monitored conditions. For example these conditions can be level, flow rate, pH, temperature, percent, rainfall, I/O; or a combination of two conditions.

The 1640 Liquid Level Actuator can also be used, as well as any other instrument that can ground the input to pin F. Grounding the input disables the sampler.

The sampler disregards disable signals during the delay to start time. However, when the sampler detects a disable signal at the start time, it suspends the program until it is enabled. The diagram in Figure 4-2 shows the sampler's responses.

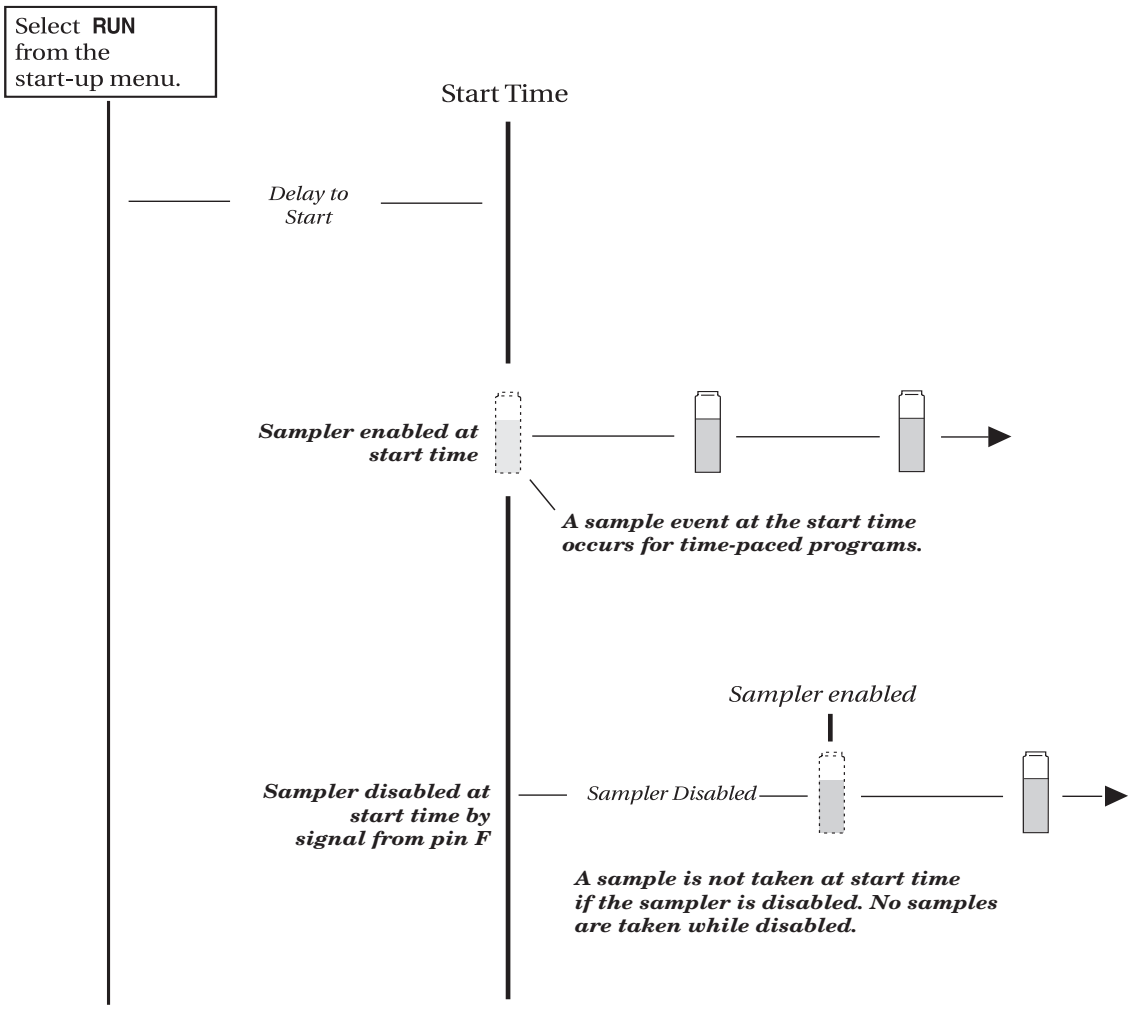


Figure 4-2 Start Time Diagram

4.7 Running Programs

To run a program, select RUN from the main menu. You may also select YES at the RUN THIS PROGRAM NOW? screen at the end of the programming screens.

4.7.1 Run Time Screens

While running a sampling program the sampler displays a variety of messages that report the program's status. For example, if the sampler has not yet reached the programmed start time, it displays the scheduled start time as well as the current time.

Once the program reaches the start time, you can determine the time of the next sample, the next bottle to receive a sample, sample distribution, and other information. Other messages appear while the sampler runs through a sampling cycle and takes a sample. When the sampler needs to report multiple messages, it alternates them, displaying each for one to three seconds.

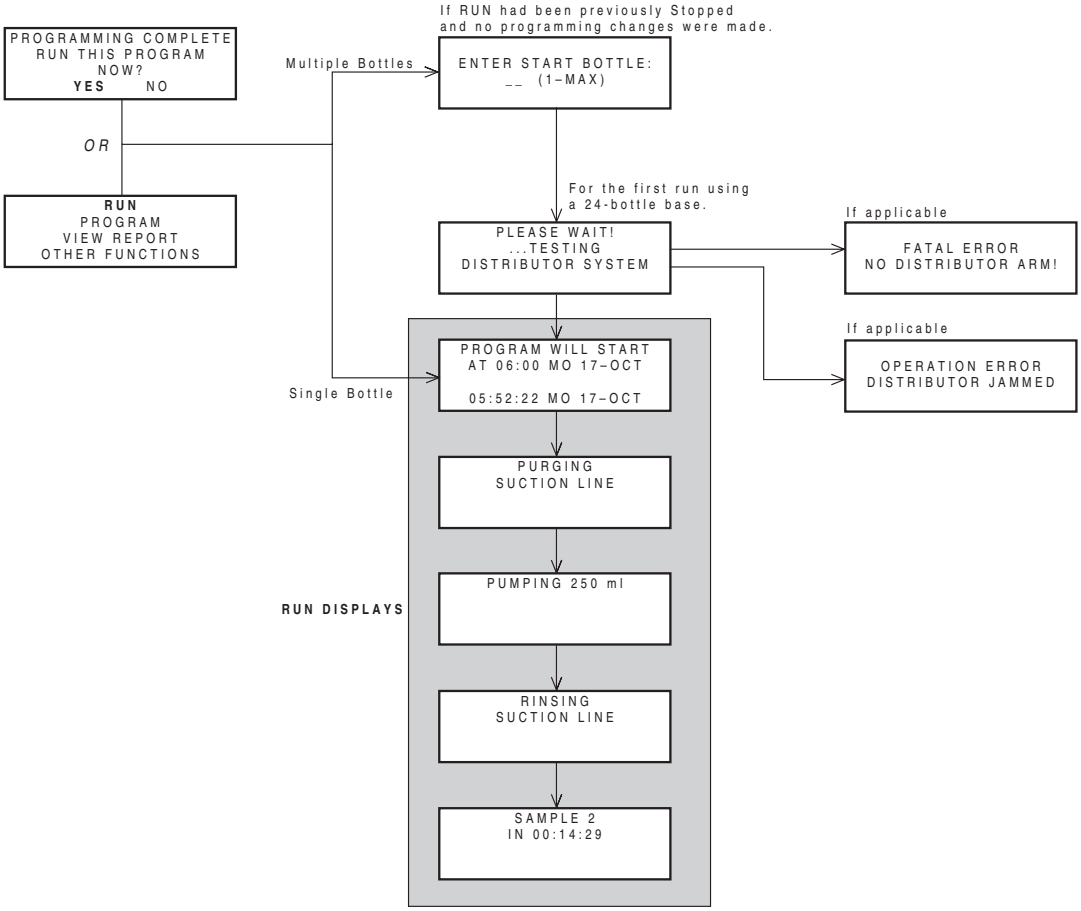
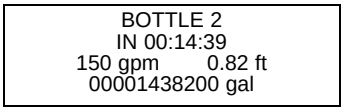


Figure 4-3 Running a Program

4.7.2 Module Readings

Samplers with an attached module display the module's readings: pH and temperature for the pH module; level, percentage, or flow rate for the 4-20 mA module; level, flow rate, and flow volume readings for the flow modules; level, velocity, flow rate, and positive flow volume readings for the area velocity module. Some module screens will alternate with the sampler screens.



The Module readings are updated:

- Every second when displaying the reading during programming.
- Every minute otherwise.

An * (asterisk) appears next to the reading if the module was unable to take a reading. If an asterisk appears, the reading displayed is the last available reading. Flow rates will be reported as zero flow if the error persists for more than five minutes (for a level or velocity reading that flow is calculated from).

```
BOTTLE 2
IN 00:12:00
***** gpm      5.73 ft
00001457600 gal
```

If an entire reading is filled with asterisks, the value exceeds the number of characters that can be displayed. The sampler stores the actual reading in memory, so it may be collected later.

For those programs that have delayed or scheduled start times, the readings will be displayed while waiting for the start time. Keep in mind that any totalizer values will be reset at the start time. Module and sonde readings are also displayed after a program is complete, until a key is pressed.

It is not necessary to run a program to view module or sonde readings. Real time data can be viewed on the display by selecting "VIEW REPORT" from the main menu.

4.8 Interrupting a Running Program

You can interrupt a sampling program by pressing the Stop key while the sampler is waiting for the next sample event. Pressing Stop places the sampler into *Manual Paused* operation and records a manual pause in the sample event log.

In this state, the sampler allows you to access several functions. You can modify the program, reset alarms, take a grab sample, etc., without adversely affecting the running program. Modifying the program is limited to adjusting the pacing intervals, enable conditions and sample volume. The basic program structure, such as the type of pacing, can not be changed.

While in the manual paused state, the sampling program continues to operate as normal, with the exception of taking samples. If a sample was to be taken, it is skipped. The sampler records "sample skipped" in the sample event log and continues to operate as normal.

The manual paused state displays a scrolling menu with several options (see example below). Use the Arrow keys to scroll through the manual paused options and the ↵ key to make a selection. Return to the running program by selecting resume program or pressing the Stop key. If you do not make a selection, the sampler automatically resumes the original sampling program five minutes after the last key was pressed.

```
← STOP PROGRAM
RESUME PROGRAM
VIEW DATA
GRAB SAMPLE →
```

Manual Paused Screen

4.8.1 Stop Program

This option terminates the running program and records program stopped in the sample event log. The program cannot be resumed.

4.8.2 Resume Program

Selecting this option will cause the sampler to exit the manual paused state and return to normal program operation. A manual resume event will be logged.

4.8.3 View Data

This option allows you to view the data recorded by the sampler. See *Reports* on page 4-19 for more information.

4.8.4 Grab Sample

When selected, you will be asked to enter the volume to be pumped. A sample will then be taken as if it is to be *placed into a container outside the sampler base*. Do this by removing the pump tubing from the bulkhead fitting. See *Grab Samples* on page 4-15. A grab sample event will be logged.

4.8.5 Pump Tube Alarm

If the pump tube is changed, this option should be selected to reset the pump counts on the counter. This will remove the "WARNING: REPLACE PUMP TUBING" message that may appear while the program is running. A pump tube replaced message is logged. See Replacing The Pump Tube in Section 7, Maintenance.

4.8.6 Calibrate Volume

When selected, you will be asked to enter the volume to be pumped. A sample will then be taken as if it is to be *placed into a container outside the sampler base*. Do this by removing the pump tubing from the bulkhead fitting.

After the sample has been pumped, you will then be asked to enter the amount actually delivered. Once you have entered the delivered volume and accepted the calibration, a volume delivered event will be logged.

4.8.7 Cal/Adj Parameters

When the sampler is configured for operation with a module, this option becomes available. Selecting this option will display the appropriate level adjustment screens and/or the calibration screens. If the level is adjusted, an adjusted level event is logged. If a parameter is calibrated, an appropriate event is logged.

Calibrating a parameter probe will temporarily "turn off" the partition data storage and the sample enable/disable functions. These functions are disabled during the calibration and for five minutes after the program is resumed. During this time, parameter data normally collected at the data storage interval will be logged as a 252 error message.

4.8.8 Adjust Pacing

This option is available when the running program is paced by Time, Flow Pulses or Flow Volume. If you select this option, you are asked to enter a new pacing interval. The sampler logs an interval changed event.

The original pacing interval continues to count down until you return the sampler to the running program (select resume program). If the new pacing interval is less than the original count remaining, the new interval is used.

If the original count remaining is less than the new pacing interval, the original count will continue to count down to the next sample event. Subsequent samples are then paced by the new interval.

4.8.9 Adjust Volume

Select this option to change the sample volume within the limits of the currently programmed sample distribution. If you change a sample volume, a volume changed event is logged.

4.8.10 Power Used

The 6712 has a "fuel gauge" that gives an indication of power usage. The controller keeps track of how much power has been consumed since the last time it lost power. If the controller is powered by an external battery, this fuel gauge can help you estimate the condition of the battery.

Keep in mind that the sampler has no idea as to how much charge was originally stored in the battery (or even if a battery is being used), and therefore has no idea as to the *remaining capacity* of its power source.

4.9 Other Functions

Other Functions Menu

RUN PROGRAM
VIEW REPORT
OTHER FUNCTIONS

• Select OTHER FUNCTIONS.

MAINTENANCE
MANUAL FUNCTIONS
PROGRAMMING STYLE

In Standard Programming, the "Other Functions" menu screen includes options for:

- Maintenance (see Section 8).
- Manual Functions (see below).
- Programming Style (see Section 3).

4.10 Manual Functions

The manual functions programming screens let you:

- Take grab samples.
- Calibrate sample volumes.
- Operate the pump manually.
- Move the distributor arm.

4.11 Grab Samples

Taking a Grab Sample

1 | **GRAB SAMPLE**
CALIBRATE VOLUME
OPERATE PUMP
MOVE DISTRIBUTOR

- Select GRAB SAMPLE

2 | SAMPLE VOLUME:
___ ml (10-9990)

- Enter the desired volume

3 | GRAB SAMPLE
PRESS ↵ WHEN READY!

4 | PURGING
SUCTION LINE

5 | PUMPING 200 ml

6 | PURGING
SUCTION LINE

7 | GRAB SAMPLE
CALIBRATE VOLUME
OPERATE PUMP
MOVE DISTRIBUTOR

- Press STOP to return to main menu.

Grab samples let you take a single sample on demand, collecting the sample in an external container (Figure 4-4). Keep in mind:

When the sampler delivers a grab sample, it runs through a complete sampling cycle, using the current settings for volume and for line rinses or retries. If it is a two-part program, the sampler uses the settings for part A.

To take a grab sample while the sampler is running a program, you must interrupt the program by pressing the Stop key. Restart the program by running it again.

To take a grab sample:

1. Disconnect the pump tube from the bulkhead fitting.
2. Place the end of the tube over a collection container.
3. Follow the steps in *Taking a Grab Sample* at left.
4. Reconnect the pump tube to the bulkhead fitting.

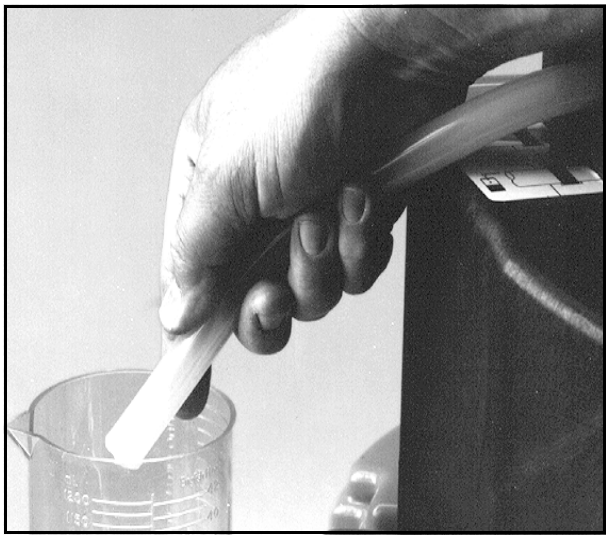


Figure 4-4 Taking a Grab Sample

4.12 Calibrate Volume

The sampler delivers accurate sample volumes without calibration. If you find that sample volumes vary significantly from the programmed values, first check the suction line for proper installation. Be sure it slopes continuously downhill to the liquid source and drains completely after each sampling cycle. Then, compare the actual length of the suction line to the suction line length settings in the program to see that they match. Also check the pump tube for excessive wear and replace it if necessary.

You may want to calibrate when:

- A new pump tube is installed. Run the pump for five minutes before calibrating.
- The sample source is above the sampler.
- Sampling from pressurized lines (15 PSI Maximum).

4.12.1 Calibration Tips

- For the best results, calibrate the sampler after it's installed on site.
- Use a graduated cylinder for volume measurement.
- The sampler clears the previous calibration setting when you reinitialize the sampler.
- You cannot calibrate while the sampler is running a program.
- When the sampler delivers the sample, it runs through a complete sampling cycle, using the current settings for volume line rinses and retries. If it is a two part program, the sampler uses the volume setting for part A.

To calibrate:

1. Disconnect the pump tube from the bulkhead fitting.
2. Place the end of the tube over a collection container.
3. Follow the steps in Calibrating Sample Volumes in the margin.
4. Reconnect the pump tube to the bulkhead fitting.

Calibrating Sample Volumes

1
RUN
PROGRAM
VIEW REPORT
OTHER FUNCTIONS

- Select OTHER FUNCTIONS

2
MAINTENANCE
MANUAL FUNCTIONS
MODULE
HARDWARE

- Select MANUAL FUNCTIONS

3
GRAB SAMPLE
CALIBRATE VOLUME
OPERATE PUMP
MOVE DISTRIBUTOR

- Select CALIBRATE VOLUME

4
SAMPLE VOLUME:
___ ml (100-9990)

- Enter the desired volume

5
CALIBRATE VOLUME
PRESS ↵ WHEN READY!

6
PURGING
SUCTION LINE

7
PUMPING 200 ml

8
PURGING
SUCTION LINE

9
VOLUME DELIVERED:
____ml

- Measure the volume delivered and enter the amount here.

10
200 ml
ARE YOU SURE?
YES NO

This screen appears when the amount you entered in step 9 was more than twice, or less than half, the programmed volume.

- Select YES when the volume delivered matches the volume displayed on this screen.
- Select NO to enter the volume delivered.

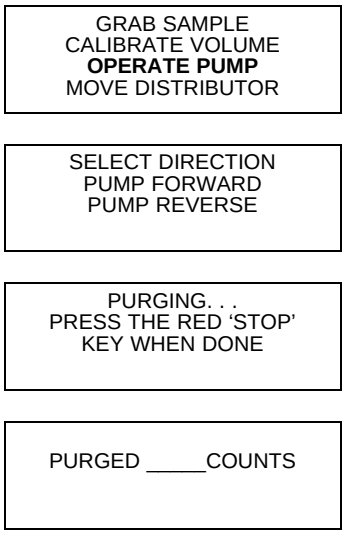
4.13 Operating the Pump

You can manually operate the sampler's pump in the forward or reverse direction. You can do this to test the pump, draw a large sample, or purge the suction line.

When you run the pump manually, the sampler reports the number of pump counts during the pump's operation. Use this feature to obtain an estimate of the pump counts required to purge a nonstandard suction line.

You can also manually run the pump from the main menu. Press the "1" key and then ↵ to run the pump in reverse. Press the "3" key and then ↵ to run the pump forward.

Operating the Pump



⚠ CAUTION

Tests indicate that the pump produces sound levels in excess of 85db at one meter. PROLONGED EXPOSURE TO THIS SOUND LEVEL COULD RESULT IN HEARING LOSS AND REQUIRES THE USE OF PROTECTIVE EAR PLUGS.

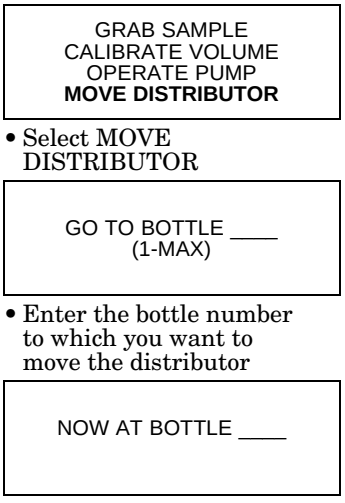
4.14 Moving the Distributor Arm

The sampler lets you reposition the distributor arm. Use this feature to verify a bottle location when installing a bottle kit. You cannot move the distributor arm while the sampler is running a program.

⚠ CAUTION

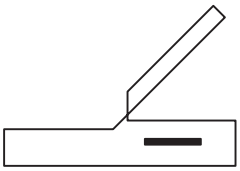
DO NOT rotate the distributor arm manually; this will severely damage the distributor drive gears.

Moving the Distributor Arm



- Select MOVE DISTRIBUTOR
- Enter the bottle number to which you want to move the distributor

4.15 Reports



Interrogator

The 6712 records a variety of data while running a sampling program. It uses the data to produce four reports:

- The Program Settings report, listing the program settings.
- The Sampling Results report, listing the program settings, time of samples and other program events.
- The Combined Results report, combining the sample event times with rainfall or module data.
- The Summary report, listing daily summaries of data collected. The Summary report may be rainfall and/or module data.

The sampler stores the data for each report in memory where they remain until you select RUN. Selecting RUN clears the memory so that it can store the data from the next program.

4.15.1 Collecting Reports

There are a number of ways to collect the reports:

View reports (program settings, sampling results, and abbreviated summary reports) on the sampler's display.

Collect the reports (except for summary reports) with a Teledyne Isco 581 RTD and use a computer running flowlink or samplink to transfer the reports from the RTD to a file on the computer.

581 RTD

Collect the reports (except for summary reports) with an IBM PC or compatible computer running flowlink.

Collect the reports with and IBM PC or compatible computer running samplink.

4.15.2 Viewing the Data

Because the display area is small, the data on the reports will be displayed a little differently from the data that is transferred to and viewed on your computer.

- For the Sampling Report, the sampler displays each program event, one at a time.
- For the Module and Rainfall Data reports, it displays daily summaries, instead of the full reports available with the rtd, Flowlink, or Samplink.

If you select Sampling Report or Rainfall (step 3 in *Viewing Data*, shown in the margin), the sampler begins displaying the report data. The sampler advances automatically through the report items, displaying each item briefly. While the sampler advances automatically through the displays:

- Stop the automatic displays by pressing Stop once. Then, use the arrow keys to move manually through the report.
- Return to the main menu by pressing Stop twice.

At the end of the report, the sampler leaves the last item displayed until you press:

- the arrow keys to move forward or backward manually through the report.
- Stop to return to the main menu.

- ↵ to start the automatic displays again.

Viewing Data

1
RUN
PROGRAM
VIEW REPORT
OTHER FUNCTIONS

• Select VIEW REPORT.

2
VIEW DATA
SYSTEM IDs
CONFIGURE REPORTS

• Select VIEW DATA.

3
SELECT DATA TO VIEW:
SAMPLING REPORT
MODULE DATA
RAINFALL DATA

• Select a report or data type.

4
VIEW:
DAILY SUMMARY
CURRENT READINGS

• Select DAILY SUMMARY to view the stored data, or CURRENT READINGS to view real-time data.

If you select Module Data in step 3, the sampler displays the screen shown in step 4. Select the Daily Summary option and the sampler displays the stored data just as the Sampling Report was described above. Selecting the Current Readings option causes the sampler to display real-time readings. When there are multiple screens, they will be displayed alternately. You can quickly advance through the screens by pressing an arrow key or ↵. Pressing Stop exits the Current Readings mode.

4.15.3 Configuring Reports

Configuring Reports

1
RUN
PROGRAM
VIEW REPORT
OTHER FUNCTIONS

• Select VIEW REPORT.

2
VIEW DATA
SYSTEM IDs
CONFIGURE REPORTS

• Select CONFIGURE REPORTS

3
SAMPLINK REPORT
FLOWLINK REPORT
CUSTOM REPORT
ALL REPORTS

• Select the option that matches your data collection software, or tailor the output according to the reports needed.

The Configure Reports option lets you specify which of the Sampling Reports will be included in any output request. Each sampler is shipped with the option Flowlink Report selected.

The Samplink Report and Flowlink Report options allow you to tailor the output to the Teledyne Isco software used to collect the reports. The Samplink Report option provides the Sampling Reports, but disables the output of the detailed partition data.

Flowlink Report provides the Sampling Reports and the detailed partition data. Selecting the Flowlink Report option enables the output of the detailed partition data so Flowlink can add the data to the site's database file.

When you are familiar with the available Sampling Reports, you may want to specify an output containing only the specific data you require. The Custom Report option will allow selection of detailed data. Data collection time and storage space may be optimized using this option.

4.15.4 Sampling Results Report

As the sampler runs a program, it records the program's events. Program events include such items as sample events, program enables and disables, power losses, and so on. Table 4-3 lists each event with a short description. You can view the report by following the steps in *Viewing the Data* on page 4-19 or print the log as the Sampling Results report.

In the text file version of the report, sample-event entries include the time of the event as well as the sample and bottle numbers.

The sample column contains the sample number deposited into the bottle. This information reflects the distribution selected for the program.

The letters in the Source columns are codes for the cause of the event. The letters in the Error column are codes for the causes of missed samples. The source and error codes appear with explanations at the end of the report. A list of codes appears in Table 4-3.

The last column in the Sampling Results report records the pump counts for the sample event. Large variations in pump counts from event to event indicate fluctuating heads, a relocated suction line, or a temporarily clogged strainer.

4.15.5 Combined Results Report

At the time of each sample event, the sampler records the readings from each connected module, rain gauge, or SDI-12 sonde. The Combined Results Report presents the event time, sample and bottle number, and the respective readings from the device.

For flow modules, the readings are level and flow rate. For the pH module, the readings are temperature and pH. For the rain gauge and SDI-12 Sonde, the readings vary according to the selections enabled during the hardware setup in extended programming. When recording four or more sonde parameters, the Combined Results report will exceed the standard 40 character width. To read the additional columns, the data must be collected with Flowlink 4 for Windows software.

4.15.6 Summary Report

This report summarizes the rain gauge or module data. The types of readings are the same as those available to the Combined reports. The sampler compiles the data to present a daily total, the day's average, maximum, and minimum reading, and a listing of hourly averages. The sampler then graphs the day's readings.

Table 4-3 Reports: Program Events, Source Codes, and Error Codes	
* Indicates events and codes that occur in Standard Programming	
Program Events (listed in the order that they most likely would occur)	
*Program Run	The sampler ran the sampling program.
*Program Started	The sampler started the sampling program.
*Program Enabled (Disabled)	The sampler was enabled or disabled according to program settings or an external instrument.
'A'/'B' Enabled (Disabled)	Program part 'A' or 'B' was enabled or disabled according to the program's settings.
Sample	A sample was taken as programmed. (See Source Codes and Error Codes in this table.)
*Sample Switch Time	A sample was taken at programmed switch time.
*Program Done	The sampler finished the sampling program.
'A'/'B' Done	The sampler finished program part 'A' or 'B'.
*Manual Pause	Stop was pressed during the program to enter the Manual Paused state.
*Program Stopped	You selected Stop from the manual paused options, terminating the program.
*Grab Sample	A grab sample was taken while in the Manual Paused state.
Pump Tube Replaced	The pump tube alarm was reset while in the Manual Paused state.
Calibrate Volume	The volume was calibrated.
Calibrate SDI Parameter	An SDI-12 sonde or module parameter was calibrated.
*Adjusted Pacing	The pacing interval was changed while in the Manual Paused state.
*Volume Changed	Sample volume was changed while in the Manual Paused state.
Adjust Enable	Sampler enable thresholds were changed while in the Manual Paused state.
Reset Rain History	The rain history was reset.
Adjust Suction Head	The suction head was changed while in the Manual Paused state.
*Manual Resume	The resume program option was selected from the Manual Paused state.
Program Paused (Resumed)	The program reached a programmed pause or resume time.
'A'/'B' Paused (Resumed)	Program part 'A' or 'B' reached a programmed pause or resume time.
*Power Failed	The power source was disconnected.
*Power Restored	The power source was reconnected.
Alarm Occurred	An alarm occurred.
Alarm Acknowledged	An alarm was acknowledged.
*Missed Password	The password was missed.

Table 4-3 Reports: Program Events, Source Codes, and Error Codes (Continued)

(The Source and Error Codes Listed below refer to why a sample was taken and what happened while it was being taken.)

Source Codes		
*C	Calibrate sample	Sample volume delivered during calibration.
*D	Disable	Sample event at disable time.
*E	Enable	Sample event at enable time.
Ev	Event	Event-paced sample event.
*F	Flow	Flow-paced sample event.
*G	Grab sample	Sample volume delivered as a grab sample.
M	Command driven sample	A command driven sample.
PH	Phone command	Phone command sample.
R	Resume	Sample event at resume time.
*S	Start	Sample event at start time.
Sw	Switch time	Sample event at switch time.
TO	Time Override	Sample event at bottle-switch time.
*T	time	Time-paced sample event.
Error Codes		
*DJ	Distributor Jammed	The distributor jammed.
*IP	sample in progress	Sample in progress when report was printing.
*L	pump latch open	Unable to take sample because the pump band was opened.
*ND	no distributor arm	There is no distributor arm or the stop is damaged.
*NL	No Liquid Detected	The sampler was unable to detect liquid.
LF	Not enough flow	Not enough flow for the minimum sample volume entered for samples with volumes proportional to flow.
*NM	No More Liquid	After the sampler detected liquid and while the sample was being taken, the liquid detector stopped detecting liquid.
M	Bottle Full	The composite bottle is full.
*O	Sampler Shut Off	The sampler was turned off with the On-Off key during the sample event.
Ov	Probable Overflow	The sampler was directed to take a sample that would not fit into the bottle. Occurs for flow paced, time override programs only.
*P	Power Failed	The power supply failed during the sample event. Note: Power failures during five consecutive sample events results in a LOW BATTERY shut-down.
*PJ	Pump Jammed	The pump jammed.
*Sk	Sample Skipped	Sample not taken.
*US	User Stopped	You pressed the Stop key during the sample event.

Figures 4-5, 4-6, 4-7, 4-8, and 4-9 show examples of reports configured to show program settings, sampling results, combined results, and a summary report.

```
SAMPLER ID# 3687447734  06:32 19-DEC-02
  Hardware: A0      Software: 1.02
*********** PROGRAM SETTINGS ***********
     ----------

 SITE DESCRIPTION:
    "FACTORY051"

     ----------
   UNITS SELECTED:
   FLOW RATE: cfs
 FLOW VOLUME: Mgal

     ----------
   BUBBLER MODULE:
        WEIR
        90
      V-NOTCH
     ----------
  24,  1000 ml BTLS

 10 ft SUCTION LINE

     ----------
      PACING:
    TIME, EVERY
 0 HOURS, 15 MINUTES

     ----------
    DISTRIBUTION:
     SEQUENTIAL


     ----------

   200 ml SAMPLES


     ----------

  5 MINUTE DELAY TO
    FIRST SAMPLE

----------------------------------------
```

Figure 4-5 Report: Program Settings

```
SAMPLER ID# 3687447734  06:32 19-DEC-02
  Hardware: A0      Software: 1.02
*********** SAMPLING RESULTS ***********
   SITE: FACTORY051
Program Started at 15:03 WE 18-DEC-02
Nominal Sample Volume =  200 ml
                                      COUNT
                                        TO
SAMPLE  BOTTLE TIME  SOURCE ERROR LIQUID
------- ------ ----      -- --    ------
               15:03  PGM ENABLED
  1,1     1    15:03      S           250
  1,1     2    15:18      T           247
  1,1     3    15:33      T           247
  1,1     4    15:48      T           249
  1,1     5    16:03      T           247
  1,1     6    16:18      T           247
  1,1     7    16:33      T           247
  1,1     8    16:48      T           248
  1,1     9    17:03      T           237
  1,1    10    17:18      T           236
  1,1    11    17:33      T           237
  1,1    12    17:48      T           241
  1,1    13    18:03      T           238
  1,1    14    18:18      T           236
  1,1    15    18:33      T           237
  1,1    16    18:48      T           236
  1,1    17    19:03      T           242
  1,1    18    19:18      T           237
  1,1    19    19:33      T           235
  1,1    20    19:48      T           238
  1,1    21    20:03      T           237
  1,1    22    20:18      T           237
  1,1    23    20:33      T           236
  1,1    24    20:48      T           230
               20:48  PGM DONE 19-DEC


   SOURCE S  ==> START
   SOURCE T  ==> TIME
   ----------------------------------------
```

Figure 4-6 Report: Sampling Results

```
SAMPLER ID# 3687447734  06:32 19-DEC-02
  Hardware: A0      Software: 1.02
 BUBBLER MODULE: 2215419583
  Hardware: A00000  Software: 1.07
*********** COMBINED RESULTS ***********
   SITE: FACTORY051
Program Started at 15:03 WE 18-DEC-02
Nominal Sample Volume =  200 ml

                                FLOW         TOTAL
                       LEVEL   RATE          FLOW
SAMPLE  BOTTLE TIME      ft    cfs           Mgal
------- ------ ----  -----  ----- -------------
  1,1     1   15:03  0.009  2.495    000000.000
  1,1     2   15:18  0.012  2.576    000000.017
  1,1     3   15:33  0.012  2.666    000000.035
  1,1     4   15:48  0.012  2.773    000000.053
  1,1     5   16:03  0.012  2.773    000000.072
  1,1     6   16:18  0.012  2.798    000000.091
  1,1     7   16:33  0.012  2.798    000000.109
  1,1     8   16:48  0.012  2.798    000000.128
  1,1     9   17:03  0.012  2.751    000000.147
  1,1    10   17:18  0.012  2.773    000000.166
  1,1    11   17:33  0.009  2.798    000000.185
  1,1    12   17:48  0.012  3.728    000000.207
  1,1    13   18:03  0.012  3.728    000000.232
  1,1    14   18:18  0.012  3.728    000000.257
  1,1    15   18:33  0.009  3.728    000000.282
  1,1    16   18:48  0.012  5.273    000000.317
  1,1    17   19:03  0.012  5.239    000000.353
  1,1    18   19:18  0.012  6.651    000000.397
  1,1    19   19:33  0.009  6.651    000000.442
  1,1    20   19:48  0.009  6.651    000000.486
  1,1    21   20:03  0.012  6.651    000000.531
  1,1    22   20:18  0.012  6.651    000000.576
  1,1    23   20:33  0.009  3.404    000000.612
  1,1    24   20:48  0.012  3.425    000000.634
-----------------------------------------------
```

Figure 4-7 Report: Combined Results

```
SAMPLER ID# 3687447734  06:32 19-DEC-02
  Hardware: A0      Software: 1.02
*********** COMBINED RESULTS ***********
   SITE: FACTORY051
Program Started at 15:03 WE 18-DEC-02
Nominal Sample Volume =  200 ml
                        FR-TEMP
SAMPLE  BOTTLE TIME           C
------- ------ ----        ----
                    NO FR-TEMPERATURE
----------------------------------------



SAMPLER ID# 3687447734  06:32 19-DEC-02
  Hardware: A0      Software: 0.01.0127
*********** COMBINED RESULTS ***********
   SITE: FACTORY051
Program Started at 15:03 WE 18-DEC-02
Nominal Sample Volume =  200 ml
SAMPLE  BOTTLE TIME
------- ------ ----------- ------ ----
                    NO RAIN GAUGE
----------------------------------------



SAMPLER ID# 3687447734  06:32 19-DEC-02
  Hardware: A0      Software: 0.01.0127
SDI-12 DATA
*********** COMBINED RESULTS ***********
   SITE: FACTORY051
Program Started at 15:03 WE 18-DEC-02
Nominal Sample Volume =  200 ml


                    NO SDI-12 SONDE
----------------------------------------
```

Figure 4-8 Report: Combined Results (continued)

```
SAMPLER ID# 3687447734   16:41 20-DEC-02
   Hardware: A0      Software: 1.02
  BUBBLER MODULE: 2215419583
   Hardware: A00000  Software: 1.07
    SITE: FACTORY051

   Summary Report for 19-DEC-02 (TH)
         Day's Flow:     000000.054 Mgal
       Average Flow Rate:     0.4437 cfs
 07:20 Minimum Flow Rate:     0.0237 cfs
 13:25 Maximum Flow Rate:     7.0207 cfs
        Hourly Average Flow Rate:
       00:00-01:00:        NO DATA
       01:00-02:00:        NO DATA
       02:00-03:00:        NO DATA
       03:00-04:00:        NO DATA
       04:00-05:00:        NO DATA
       05:00-06:00:        NO DATA
       06:00-07:00:        NO DATA
       07:00-08:00:        NO DATA
       08:00-09:00:     2.519 cfs
       09:00-10:00:     2.747 cfs
       10:00-11:00:     2.791 cfs
       11:00-12:00:     3.456 cfs
       12:00-13:00:     5.385 cfs
       13:00-14:00:     6.651 cfs
       14:00-15:00:     2.591 cfs
       15:00-16:00:     1.593 cfs
       16:00-17:00:        NO DATA
       17:00-18:00:        NO DATA
       18:00-19:00:        NO DATA
       19:00-20:00:        NO DATA
       20:00-21:00:        NO DATA
       21:00-22:00:        NO DATA
       22:00-23:00:        NO DATA
       23:00-24:00:        NO DATA

             *---+---+---+---+---+---+*
       8.00  +                       +
             I                       I
             I                       I
             I             #         I
             I             #         I
       6.00  +             #         +
             I             #         I
             I            ##         I
             I            ##         I
             I            ##         I
       4.00  +            ##         +
             I           ###         I
             I           ###         I
             I         #####         I
             I        ########       I
       2.00  +        ########       +
             I        ########       I
             I        #########      I
             I        #########      I
             I        #########      I
       0.00  +        #########      +
             *---+---+---+---+---+---+*
 Hour Ending:       08:     16:     24:
             Units are 'cfs'
```

Figure 4-9 Report: Summary

4.16 System IDs

System IDs

RUN
PROGRAM
VIEW REPORT
OTHER FUNCTIONS

• Select VIEW REPORT.

VIEW DATA
SYSTEM IDs
CONFIGURE REPORTS

• Select SYSTEM IDs.

SAMPLER
6712 ID _____
HARDWARE: __
SOFTWARE: __

• Displayed briefly

[*MODULE TYPE*]
[*MODEL #*] ID: _____
HARDWARE: __
SOFTWARE: __

• Displayed briefly

SOFTWARE OPTIONS

[*Options List*]

• Press STOP to return to the main menu.

In addition to viewing report data and configuring reports, the View Report option on the main menu lets you view system identification information.

The sampler reports the sampler model number, ID (identification number), and software version number as system identification notes. The sampler also reports the same information for an attached module.

The model and ID numbers remain unchanged through the life of the sampler. The ID numbers appear on the sampler's reports and in files created by flowlink and samplink when they interrogate the sampler. The software packages use the ID number to make sure that data from different samplers is not combined in the same file.

The software version number changes when your sampler's software is updated.

The system will also list any software options that you have activated on your unit. These software options are discussed in Section 5.

4.17 Programming for 700 Series Modules

The bay on the controller's side accepts any of Teledyne Isco's 700 Series Modules. These modules are optional accessories that are not required for operation of the 6712. However, the modules offer an economical way to combine flow-rate or parameter monitoring with sampling.

The programming of these modules is integrated with the programming of the sampler, so attachment of a module will cause different screens to be displayed, depending on the type of module and the selections you make while programming.

Two modules that are commonly used are the 730 Bubbler Module, which monitors a flow stream's level and flow rate, and the 750 Area Velocity Module for monitoring a flow stream's level, velocity, and flow rate. The following sets of screens give you an example of what screens you might see while programming the sampler and module. Refer to Table 4-1 (which does not have a module attached) at the beginning of this section to compare the sequence of screen displays.

⚠ CAUTION

Most Teledyne Isco accessories and interfacing equipment are not certified for us in hazardous locations as defined by the National Electrical Code. Check applicable guidelines, codes, and regulations of federal, state, city, and county agencies. Refer to Appendix C in the back of this manual for more safety information.

Table 4-4 Programming Example With 730 Module Installed

1	MODULE INSERTED--- DOWNLOAD DATA NOW OR LOSE ALL DATA! DONE	With the sampler off, insert the module in the bay on the controller. Turn the sampler on by pressing the On/Off key. Press ↵. Download stored data, if you want to keep it. Pressing DONE erases it and advances to the next screen.
2	6712 SAMPLER STANDARD PROGRAMMING For HELP at any screen press ? key.	This screen will now appear for 8 seconds.
3	RUN **PROGRAM** VIEW REPORT OTHER FUNCTIONS	The option PROGRAM will be blinking. Press ↵.
4	SITE DESCRIPTION: "FACTORY051" CHANGE? YES **NO**	The option NO will be blinking. Press ↵. For the purposes of this example, it isn't necessary to change the description.
5	SELECT UNITS FOR FLOW RATE: **cfs** gps gpm Mgd lps m3s m3h m3d	Select the desired units for the flow rate. For this example, choose cfs. Press ↵.
6	SELECT UNITS FOR FLOW VOLUME: cf gal **Mgal** m3 lit	Select the desired units for the flow volume. For this example, choose Mgal. Press ↵.
7	PROGRAM MODULE? **YES** NO	Select YES to program the module.

Table 4-4 Programming Example With 730 Module Installed (Continued)

8	MODE OF OPERATION: FLOWMETER LEVEL ONLY	If you choose Flowmeter, proceed to screen #9 below. If you choose LEVEL ONLY, proceed to screen #12.
9	**WEIR** FLUME DATA POINTS EQUATION MANNING FLOW-INSERT	When you select Flowmeter, you will have several options for performing the flow conversion. For this example, choose Weir. Press ↵.
10	**V-NOTCH** RECTANGULAR CIPOLLETTI	For this example, choose V-Notch. Press ↵.
11	V-NOTCH WEIR ANGLE: 120 **90** 60 45 30 22.5	For this example, choose a Weir angle of 90. Press ↵.
12	CURRENT LEVEL IS __.__ ft ADJUST LEVEL TO __.__ ft	The current level will be displayed. Enter an adjustment if needed. If the adjustment is different by more than 0.50 ft, you will be prompted "ARE YOU SURE? YES NO" Choose NO to re-enter; select YES if correct. Press ↵.
13	NUMBER OF BOTTLES: 1 2 4 8 12 **24**	Select the number of bottles in your bottle kit by pressing either arrow key until the correct number blinks. Press ↵. For this example, select 24.
14	BOTTLE VOLUME IS 1000 ml (300-30000)	Type the volume for the bottles in your kit. For this example, 1000 is correct, so simply press ↵.
15	SUCTION LINE LENGTH IS 10 ft (3-99)	Type the length of the suction line, then press ↵. If you change the length, the sampler will display a message, "PLEASE WAIT!. . . GENERATING PUMP TABLES."
16	TIME PACED **FLOW PACED**	Select FLOW PACED. If the module is being used as a flowmeter, you will see screen #17a. If the module is being used for level only, you will see screen #17b.
17a	FLOW BETWEEN SAMPLE EVENTS: **0.075 Mgal** (0.001 - 99999)	If the module is being used as a flowmeter, choose the amount of flow between sample events.

Table 4-4 Programming Example With 730 Module Installed (Continued)

17	FLOW BETWEEN SAMPLE EVENTS: **2** PULSES (1-9999)	If the module is being used for level only, enter the number of pulses between sample events.
18	SEQUENTIAL **BOTTLES/SAMPLE** SAMPLES/BOTTLE	Select BOTTLES/SAMPLE.
19	**2** BOTTLES PER SAMPLE EVENT (1-24)	Enter 2.
20	RUN CONTINUOUSLY? YES **NO**	Select NO.
21	SAMPLE VOLUME: **250** ml (10-1000)	Enter 250.
22	NO DELAY TO START DELAYED START **CLOCK TIME** WAIT FOR PHONE CALL	Select CLOCK TIME.
23	START FLOW COUNT AT: 06:00	Enter 6, then enter 0. This is the time at which the sampler will start the pacing countdown.
24	SELECT DAYS: SU **MO** TU **WE** TH **FR** SA DONE	Select MO, WE, and FR. Use the arrow keys and ↵ to select MO, WE, and FR. When the correct days are blinking, select DONE and press ↵.
25	PROGRAMMING COMPLETE RUN THIS PROGRAM NOW? YES **NO**	Select NO.

Table 4-5 Programming Example With 750 Module Installed

1	MODULE INSERTED--- DOWNLOAD DATA NOW OR LOSE ALL DATA! DONE	With the sampler off, insert the module in the bay on the controller. Turn the sampler on by pressing the On/Off key. Press ↵. Download stored data, if you want to keep it. Pressing DONE erases it and advances to the next screen.
2	6712 SAMPLER STANDARD PROGRAMMING For HELP at any screen press ? key.	This screen will now appear for 8 seconds.
3	RUN **PROGRAM** VIEW REPORT OTHER FUNCTIONS	The option PROGRAM will be blinking. Press ↵.
4	SITE DESCRIPTION: "FACTORY051" CHANGE? YES **NO**	The option NO will be blinking. Press ↵. For the purposes of this example, it isn't necessary to change the description.
5	SELECT UNITS FOR FLOW RATE: **cfs** gps gpm Mgd lps m3s m3h m3d	Select the desired units for the flow rate. For this example, choose cfs. Press ↵.
6	SELECT UNITS FOR FLOW VOLUME: cf gal **Mgal** m3 lit	Select the desired units for the flow volume. For this example, choose Mgal. Press ↵.
7	SELECT UNITS FOR VELOCITY: **fps** mps	Select the desired units for the flow velocity. For this example, choose fps. Press ↵.
8	PROGRAM MODULE? **YES** NO	Select YES to program the module.
9	MODE OF OPERATION: **FLOWMETER** LEVEL AND VELOCITY	The 750 can have two different modes of operation: Flowmeter or Level and Velocity. For this example, choose Flowmeter. Press ↵.
10	FLOW CALCULATION: **AREA * VELOCITY** LEVEL TO FLOW RATE	When you select Flowmeter, you will have two options for performing the flow conversion: Area * Velocity or Level to Flow Rate. For this example, choose Area * Velocity. Press ↵.
11	LEVEL TO AREA: **CHANNEL SHAPE** DATA POINTS	For this example, choose Channel Shape. Press ↵.
12	**ROUND PIPE** U-CHANNEL RECTANGULAR CHANNEL TRAPEZOIDAL CHANNEL	For the channel shape, select Round Pipe. Press ↵.

Table 4-5 Programming Example With 750 Module Installed (Continued)

13	ROUND PIPE DIAMETER = 2.00 ft	Enter the diameter of the round pipe. Press ↵.
14	CURRENT LEVEL IS __.__ ft ADJUST LEVEL TO __.__ ft	The current level will be displayed. Enter an adjustment if needed. If the adjustment is different by more than 0.50 ft, you will be prompted "ARE YOU SURE? YES NO" Choose NO to re-enter; select YES if correct. Press ↵.
15	ZERO LEVEL OFFSET: _.___ ft	Enter the amount of zero level offset. Press ↵.
16	MAXIMUM DEPTH FOR VELOCITY MEASUREMENT 2" 3" 4"	(This screen is applicable for standard-sized probes only.) Select the maximum depth for the velocity measurement. Press ↵.
17	NUMBER OF BOTTLES: 1 2 4 8 12 **24**	Select the number of bottles in your bottle kit by pressing either arrow key until the correct number blinks. Press ↵.
		From this point forward, the screens will be the same as in Table 4-2.

6712 Portable Sampler

Section 5 Extended Programming

The 6712 Sampler has two sets of programming screens. The first set, called standard programming screens, lets you set up typical sampling programs easily and efficiently. The second set, extended programming screens, lets you create sophisticated programs for complex sampling applications.

All of the sampling features available with standard programming screens, discussed in Section 4, are available with extended programming screens. However, the extended screens provide several additional features and some screen display differences which are discussed in this section. The menu flowcharts for both sets of programming screens are in *Appendix A, Menu Flowcharts*.

> ☑ ***Note***
>
> This section assumes that you have read, and are familiar with, the instructions in Section 4, Standard Programming!

5.1 Extended and Standard Mode

The sampler is shipped with factory default settings in standard programming mode when you first turn the sampler on. The start-up screen tells you which programming mode the sampler is currently using. You can switch between programming modes by entering a numerical command at the main menu:

At the main menu type **6712.2** to enter extended programming mode.

At the main menu type **6712.1** to enter standard programming mode.

RUN “EXTENDED 1”
PROGRAM
VIEW REPORT
OTHER FUNCTIONS

Main Menu for Extended Mode

5.2 One-Part and Two-Part Programs

Extended programming lets you set up a “one-part” program or a “two-part” program. One-part programs let you fill all bottles of the tub with one set of pacing, distribution, and enable settings. Two-part programs add an additional set of extended pacing, distribution, and enable screens to the sampling program. Each set of screens is called a program part. The program parts are simply called part ‘A’ and part ‘B’. Both parts share the program settings for suction-line length, suction head, and rinses and retries. They also share one start-time setting.

Each part has its own group of bottles. Because settings for each part are independent of each other, the sampler, when running a two-part program, fills each bottle group as if they were being filled by two different programs. Two-part programs finish when both parts are done.

Two-part programming is ideal for sampling storm events. Many storm-water run-off monitoring permits require a first-flush grab sample within the first 30 minutes of the storm event and flow-paced samples during the remainder of the event. With a two-part program, you can set up part 'A' for the first-flush sample and part 'B' for the remainder. Table 5-2 shows a storm-water sampling program.

5.3 Storage for Extended Programs

The sampler stores five sampling programs: one standard and four extended. Program storage eliminates the need to reprogram the sampler with frequently used settings. This feature is especially useful for complex extended programs such as two-part programs or programs with many nonuniform-time settings.

Teledyne Isco ships the sampler to you with factory programs that you can modify to suit your own needs. All four extended programs are identical to each other.

The stored programs will also save your 700 Series Module program settings and any sampler enable conditions using rain gauge data or SDI-12 sonde parameters. These program settings remain as long as you do not change the type of module, or change the rain gauge or SDI-12 Hardware Setup.

5.3.1 Selecting a Stored Program

When the sampler is in extended programming mode, it always has one current and three noncurrent programs, each occupying a permanent location in memory. The first time you access the extended mode, the current program is "EXTENDED 1," one of the factory extended programs. The name of the current extended program appears in quotations on the first line of the main menu.

The factory programs are named "EXTENDED 1," "EXTENDED 2," "EXTENDED 3," and "EXTENDED 4." You can rename them with more descriptive names, making them easier to identify. The program name is one of the extended program's settings.

After selecting a stored program, review the settings with the quick view screens. Each sampling program stores all the settings required by the sampler to run a program. These settings include the bottle-kit information (number of bottles and the bottle volume), the suction-line length, the site description, start times, and so on.

If you use the same program at two sites — each requiring different bottle configurations, suction line lengths, or other details — always check these settings before running a program. You may need to make minor changes to the program to make sure the settings match your equipment.

The current program is the program you see when you select PROGRAM from the main menu and page through the programming screens. It is the program the sampler uses when you select RUN from the main menu.

You cannot delete programs, but you can modify them as often as necessary. To run a program with different settings without losing the settings in your current program, select a stored program and modify its settings.

For example, assume you have been running the current program, named "EXTENDED 1," at site A for several weeks. This program contains all the settings you need for site A, and you don't want to lose those settings.

Nevertheless, you need another program because you want to move the sampler to site B, so you select "EXTENDED 2" and modify it for site B. The settings in "EXTENDED 1" are preserved automatically. When you return the sampler to site A, you won't need to reprogram the sampler. Merely select "EXTENDED 1" again, double-check the program settings, and run the program. To select an extended program, follow the steps in Table 5-1.

Table 5-1 Selecting a Stored Extended Program

1	6712 SAMPLER, EXTENDED PROGRAMMING For HELP at any screen, press ? key.	Press the On/Off key to turn the sampler on. Press ↵ to clear the start-up message. If the words "STANDARD PROGRAMMING" appear on the second line of the start-up message, the sampler is using the standard programming screens. To see the extended screens, type **6712.2** at the main menu shown in step 2.
2	RUN "EXTENDED 1" **PROGRAM** VIEW REPORT OTHER FUNCTIONS	Select PROGRAM from the main menu.
3	PROGRAM NAME: **"EXTENDED 1"** SITE DESCRIPTION: "_____"	Select PROGRAM NAME: "EXTENDED 1" from the quick view menu.
4	**SELECT NEW PROGRAM** CHANGE PROGRAM NAME	Select SELECT NEW PROGRAM to change the program. You can go through QUICK VIEW screens quickly by pressing ↵ at each screen. You can also change settings in quick view screens; see *Changing Settings in a Quick View Screen* on page 3-4.
5	"EXTENDED 1" **"EXTENDED 2"** "EXTENDED 3" "EXTENDED 4"	Select the name of the extended program you want to use. Each program's name appears on the same line. If you inadvertently give two programs identical names, you can still identify them by their location on the screen.
6	PROGRAMMING COMPLETE RUN THIS PROGRAM NOW? YES **NO**	To run the program immediately, select YES. To run the program later, select NO.
7	**RUN "EXTENDED 2"** PROGRAM VIEW REPORT OTHER FUNCTIONS	

5.4 Programming for 700 series Modules

The bay on the controller's side accepts any of Teledyne Isco's 700 Series Modules. These optional accessories are not required to operate the 6712. However, the modules offer an economical way to combine flow-rate or parameter monitoring with sampling.

The programming of these modules is integrated with the programming of the sampler, so attachment of a module will cause different screens to be displayed, depending on the type of module and the selections you make while programming.

Two modules that are commonly used are the 730 Bubbler Module, which monitors a flow stream's level and flow rate, and the 750 Area Velocity Module for monitoring a flow stream's level, velocity, and flow rate. Section 4 contains two examples of programming for modules. Module programming is the same in Extended as it was in Standard programming.

5.5 Programming SDI-12 Sondes

As an option, the 6712 accepts up to 16 parameters from up to ten sensors with SDI-12 addresses from 0 - 9. The data parameters used by the sonde and sampler must match. Certain vendors' sondes, such as Hydrolab and YSI, have enhanced commands that facilitate "plug and play" setup. These Teledyne Isco Ready sondes can tell the 6712 what values they have, their order, and units of measure. Other sondes can be used, but require manual setup to identify proper data types for each data value reported.

For more information about programming SDI-12 sondes, refer to Section 6.

5.6 Programming Examples

In addition to the features available with standard programming, and discussed in Section 4, extended programming offers:

- Nonuniform time pacing
- Random interval pacing
- Event pacing
- Multiple bottle compositing
- Time switched bottles or bottle sets
- Programmable sampler enable
- Pauses and resumes
- Two-part programming
- Automatic or user-defined suction head
- Suction line rinses
- Sampling retries

This manual provides several programming examples. Some, demonstrating simple tasks, appear in the margins. Others, demonstrating more complex tasks, appear as examples. Table 5-2 on the following pages steps you through a storm water runoff sampling using extended programming.

5.6.1 Storm Water Runoff Sampling

Storm water runoff sampling is an ideal application for two-part programming. Typical monitoring permits require that a series of timed samples be taken during the initial portion of the storm event, followed by flow paced samples during the remainder of the event.

This example assumes that a Rain Gauge and a Bubbler Flow Module are connected to the sampler.

> ☑ ***Note***
>
> To enable the Bubbler Module programming screens, insert the module before turning on the sampler

Using a 24-bottle kit, it divides the bottles into two groups, with six bottles assigned to part 'A' and 18 to part 'B.' The sampler will begin taking samples after being enabled according to programmable enable controls; that is, when the rain gauge detects 0.15 inches of rainfall in 30 minutes, and the module detects a flow stream level of more than 0.25 feet. Because both program parts use the same enable settings, the sampler will enable both parts at the same time. A list of settings for the program follow:

- Program type: Extended.
- Program name: STORM.
- Site description: SITE 54.
- Units: Length – Ft, Flow Rate – gpm, Flow Volume – gal
- Mode of Operation: Flowmeter, Flow-Insert, Round, 12"
- Bottle kit: 24, 1000-milliliter bottles.
- Suction-line length: 5 feet.
- Suction head: Auto suction head.
- Line rinses: None.
- Sampling retries: None.
- Part 'A' and 'B' bottle assignments: Bottles 1 - 6 to part 'A', bottles 7 - 24 to part 'B'.
- Part 'A' pacing: Time pacing, sampling every 5 minutes.
- Part 'A' distribution: Sequential, 1 sample per bottle.
- Part 'A' sample volume: 800 milliliters.
- Part 'A' enable: At least 0.15 inches of rainfall in 30 minutes and a flow stream level of more than 0.25 feet; once enabled, stay enabled, sample taken when the sampler is enabled.
- Part 'A' pause and resumes: None.
- Part 'B' pacing: Flow pacing, sampling every 2,500 gallons.
- Part 'B' distribution: Sequential, 1 sample per bottle.
- Part 'B' sample volume: 500 milliliters.
- Part 'B' enable: At least 0.15 inches of rainfall in 30 minutes and a flow stream level of more than 0.25 feet;

once enabled, stay enabled, no sample taken when the sampler is enabled; first sample taken 20 minutes after the sampler is enabled.

- Part 'B' pause and resumes: None.
- Start time: Delayed start of 1 minute.
- 730 Bubbler Module: Installed

Table 5-2 Storm Water Runoff Sampling

1	6712 SAMPLER EXTENDED PROGRAMMING For HELP at any screen press ? key.	This screen will appear briefly.
2	RUN "EXTENDED 1" **PROGRAM** VIEW REPORT OTHER FUNCTIONS	Select PROGRAM. Note: If the start-up screen displayed "STANDARD PROGRAMMING", type **6712.2** at this menu before selecting PROGRAM.
3	PROGRAM NAME: "EXTENDED 1 " CHANGE? **YES** NO	Select YES. Note: If the quick view screen shows up, press STOP then select OTHER FUNCTIONS, SOFTWARE OPTIONS, QUICKVIEW/CHANGE, NORMAL. Then press STOP and go back to step 2.
4	SELECT NEW PROGRAM **CHANGE PROGRAM NAME**	Select CHANGE PROGRAM NAME.
5	NAME: "**STORM** " ABCDEFGHIJKLMNOPQRST UVWXYZ-& 0123456789 BACK-UP DONE	Enter the word "STORM" for the program name.
6	SITE: DESCRIPTION "FACTORY051" CHANGE? **YES** NO	Select YES.
7	SITE: "**SITE 54** " ABCDEFGHIJKLMNOPQRST UVWXYZ-& 0123456789 BACK-UP DONE	Enter "SITE 54" for the site description.
8	SELECT UNITS FOR LENGTH: **ft** m	Select ft.
9	SELECT UNITS FOR FLOW RATE cfs gps **gpm** Mgd lps m3s m3h m3d	Select gpm.
10	SELECT UNITS FOR FLOW VOLUME cf **gal** Mgal m3 lit	Select gal.

Table 5-2 Storm Water Runoff Sampling (Continued)

11	PROGRAM MODULE? **YES** NO	Select YES
12	MODE OF OPERATION **FLOWMETER** LEVEL ONLY	Select FLOWMETER
13	WEIR FLUME DATA POINTS EQUATION MANNING **FLOW-INSERT**	Select FLOW-INSERT.
14	WEIR/ORIFICE TYPE V-NOTCH **ROUND**	Select ROUND.
15	FLOW INSERT SIZE: 6" 8" 10" **12"**	Select 12.
16	NEW MODULE SETUP-- DOWNLOAD DATA NOW OR LOSE ALL DATA! DONE	Select DONE. Note: Partition memory status message will be displayed briefly.
17	CURRENT LEVEL IS ___.___ ft. ADJUST LEVEL TO ___.___ ft.	Press ENTER.
18	DATA STORAGE INTERVAL IN MINUTES 1 2 **5** 10 15 30	Select 5. (If the data storage interval is different from the current program, you will be informed that the storage interval has changed, and that the stored data will be lost. Download stored data (if desired) and select DONE.
19	NUMBER OF BOTTLES: 1 2 4 8 12 **24**	Select 24.
20	BOTTLE VOLUME IS 1000 ml (300-30000)	Enter 1000.
21	SUCTION LINE LENGTH IS 5 ft (3-99)	Enter 5. The 6712 calculates new pump tables.
22	**AUTO SUCTION HEAD** ENTER HEAD	Select AUTO SUCTION HEAD.

Table 5-2 Storm Water Runoff Sampling (Continued)

23	0 RINSE CYCLES (0-3)	Enter 0.
24	RETRY UP TO 0 TIMES WHEN SAMPLING (0-3)	Enter 0.
25	ONE-PART PROGRAM **TWO-PART PROGRAM**	Select TWO-PART PROGRAM.
26	24 BOTTLES AVAILABLE ASSIGN BOTTLES 1 THRU **6** TO PART 'A' (1-23)	Enter 6. Screen will say "Beginning Part A" before proceeding with screen 27.
27	**UNIFORM TIME PACED** FLOW PACED EVENT PACED NONUNIFORM TIME	Select UNIFORM TIME PACED.
28	TIME BETWEEN SAMPLE EVENTS: 0 HOURS, **5** MINUTES	Enter 0 for hours, 5 for minutes.
29	**1** BOTTLES PER SAMPLE EVENT (1- 6)	Enter 1.
30	SWITCH BOTTLES ON: **NUMBER OF SAMPLES** TIME	Select NUMBER OF SAMPLES.
31	SWITCH BOTTLES EVERY **1** SAMPLES (1-50)	Enter 1.
32	RUN CONTINUOUSLY? YES **NO**	Select NO.
33	DO YOU WANT SAMPLE VOLUMES DEPENDENT ON FLOW? YES **NO**	Select NO.
34	SAMPLE VOLUME **200** ml (10-1000)	Enter 800.

Table 5-2 Storm Water Runoff Sampling (Continued)

35	ENABLE: **RAIN** LEVEL FLOW NONE	Select RAIN. Note: All valid enable options will appear here, so your screen may differ.
36	ENABLE: RAIN **AND** OR DONE	Select AND.
37	ENABLE: RAIN AND **LEVEL** FLOW NONE	Select LEVEL.
38	"RAIN" SET POINT: **0.15** INCHES PER __HOURS, __MINUTES	Enter 0.15 for inches, then enter 30 minutes.
39	ENABLED WHEN: **ABOVE SET POINT** BELOW SET POINT	Select ABOVE SET POINT.
40	RESET RAIN HISTORY? **YES** NO	Select YES.
41	"LEVEL" CONDITION: **SET POINT** RANGE RATE OF CHANGE	Select SET POINT.
42	"LEVEL" SET POINT **0.25** ft (0.001-30.000)	Enter 0.25.
43	ENABLED WHEN: **ABOVE SET POINT** BELOW SET POINT	Select ABOVE SET POINT.
44	ONCE ENABLED, STAY ENABLED? **YES** NO	Select YES.
45	SAMPLE AT ENABLE? **YES** NO	Select YES.
46	PAUSE RESUME 1. HH:MM DD HH:MM DD 2. HH:MM DD HH:MM DD CLEAR **DONE**	Select DONE. Screen will say "End of Part A" then "Beginning Part B."
47	UNIFORM TIME PACED **FLOW PACED** EVENT PACED NONUNIFORM TIME	Select FLOW PACED.

Table 5-2 Storm Water Runoff Sampling (Continued)

48	PACED BY: FLOW PULSES **FLOW MODULE VOLUME**	Select FLOW MODULE VOLUME.
49	FLOW BETWEEN SAMPLE EVENTS: 2500 gal (0.001-99999)	Enter 2500.
50	SAMPLE AT START? **YES** NO	Select YES. This will cause the first sample to be taken 20 minutes (the delay to start of sampling specified in Step 67) after the enable for Part B.
51	1 BOTTLES PER SAMPLE EVENT (1- 18)	Enter 1.
52	SWITCH BOTTLES ON: **NUMBER OF SAMPLES** TIME	Select NUMBER OF SAMPLES.
53	SWITCH BOTTLES EVERY **1** SAMPLES (1- 50)	Enter 1.
54	RUN CONTINUOUSLY? YES **NO**	Select NO.
55	SAMPLE VOLUME: **200** ml (10-1000)	Enter 500.
56	ENABLE: **RAIN** LEVEL FLOW 'A' DONE NONE	Select RAIN.
57	ENABLE: RAIN **AND** OR DONE	Select AND.
58	ENABLE: RAIN AND **LEVEL** FLOW 'A' DONE DONE	Select LEVEL.
59	"RAIN" SET POINT: **0.15** INCHES PER __HOURS, __MINUTES	Enter 0.15 for inches, then enter 30 minutes.
60	ENABLED WHEN: **ABOVE SET POINT** BELOW SET POINT	Select ABOVE SET POINT.

Table 5-2 Storm Water Runoff Sampling (Continued)

61	RESET RAIN HISTORY? **YES** NO	Select YES.
62	"LEVEL" CONDITION: **SET POINT** RANGE RATE OF CHANGE	Select SET POINT.
63	"LEVEL" SET POINT **0.25** ft (0.100-30.000)	Enter 0.25.
64	ONCE ENABLED, STAY ENABLED? **YES** NO	Select YES.
65	SAMPLE AT ENABLE? YES **NO**	Select NO.
66	START OF SAMPLING AFTER A 15 MINUTE DELAY (1-999)	Enter 20.
67	PAUSE RESUME 1. HH:MM DD HH:MM DD 2. HH:MM DD HH:MM DD CLEAR **DONE**	Select DONE. Screen will say "End of Part B."
68	NO DELAY TO START **DELAYED START** CLOCK TIME WAIT FOR PHONE CALL	Select DELAYED START.
69	START "STORM" AFTER A 72 HOUR "DRY" PERIOD? YES **NO**	Select NO. (Option for samplers using a 0.01 inch tip rain gauge. See Dry Period Option, described on page 5-26.)
70	START "STORM" AFTER A 1 MINUTE DELAY (1-999)	Enter 1.
71	PROGRAMMING COMPLETE RUN THIS PROGRAM NOW? YES **NO**	Select NO.

The above example presented several screens that are not available in standard programming. Descriptions of features available in extended programming follow.

5.7 Suction Head

Extended Screen for Suction Head Settings

```
AUTO SUCTION HEAD
ENTER HEAD
```

If you choose AUTO SUCTION HEAD, the head will be determined for you. If you select ENTER HEAD, the screen below will be displayed so you can enter the suction head.

```
SUCTION HEAD OF
___ ft
(min - max)
```

Suction head is the vertical distance between the surface of the liquid source and the sampler's pump. At each sample event, the sampler determines the suction head automatically.

In extended programming, you can manually enter the suction head if you want. Select ENTER HEAD only when the head remains stable and you can measure it accurately.

5.8 Rinses and Retries

Screens for Line Rinses and Sampling Retries

```
__RINSE CYCLES
(0-3)
```

```
RETRY UP TO __ TIMES
WHEN SAMPLING
(0-3)
```

Rinses and retries are extended programming features. You can program the sampler to rinse the suction line automatically. During a line rinse cycle, the sampler draws liquid through the line to the liquid detector. As soon as it detects liquid, the sampler reverses the pump to purge the line.

The sampling retries feature lets you set the number of times, from 0 to 3, that the sampler tries to detect liquid in the line before skipping the sample.

5.9 Pacing

Extended Pacing Screen

```
UNIFORM TIME PACE
FLOW PACED
EVENT PACED
NONUNIFORM TIME
```

Sample pacing is the rate at which the sampler takes samples. Depending on the type of pacing you select, the rate is controlled by the sampler's internal clock or by inputs received from connected instruments.

Standard programming provides time pacing and flow pacing, which are described in Section 4. Extended programming provides additional pacing types, so its pacing screen (see example in margin) has four items listed instead of two.

"Uniform time" pacing is identical to "time" pacing in standard programming. "Flow paced" is the same for both types of programming. Event paced and nonuniform time pacing are described below.

5.9.1 Event Pacing

To program the sampler for event pacing, select event paced. Refer to Table 5-3 for an example of event paced sampling that uses three event conditions.

Up to fourteen event conditions can be defined (for two-part programs, up to fourteen event conditions can be defined for each part). An event will occur when any of the programmed event

conditions becomes true. The default distribution setting for event-paced sampling is sequential (each time an event occurs, the sampler takes one sample, placing it in one bottle). However, any distribution setting may be used.

If you have programmed multiple conditions, and more than one condition comes true at the same time (within your measurement interval), one sample will be taken and all conditions that caused the event will be noted on reports.

Table 5-3 uses **rate of change** for the event condition (see step 7). This feature enables the event condition under specific circumstances.

In the example below, a rate of change is set so that if the level rises more than one foot in a two hour time period, the event condition would be enabled and a sample taken.

In determining if the rise occurs in this example, the sampler looks back at the previous two hour time period to see if there is a rise of more than one foot between any valley (low point) or peak (high point) within that time period.

Once the condition becomes true (a rise of more than one foot is noted), the event condition is enabled. It will not be enabled again unless the condition becomes false, and then true again, within the two hour time window.

In event pacing, up to three different rate of change event conditions can be programmed (for two-part programs, a total of six rate of change event conditions can be defined, three for each part).

5.9.2 Event Paced Sampling

This example uses a sampler with an attached 730 Bubbler Flow Module, Rain Gauge, and an SDI-12 sonde at address 5 with four parameters.

Table 5-3 Event Paced Sampling

1	UNIFORM TIME PACED FLOW PACED **EVENT PACED** NONUNIFORM TIME	Select EVENT PACED.
2	EVENT01: RAIN **LEVEL** FLOW TEMP5 pH5 SP_CO5 DO5 DONE	Select the parameters that will trigger the event. Use the arrow keys to move through the parameters. To define the first event for this example, select LEVEL.
3	"LEVEL" CONDITION: **SET POINT** RANGE RATE OF CHANGE	Choose SET POINT.
4	"LEVEL" SET POINT: **1.000** ft (0.001 - 30.00)	Enter a set point of 1 foot.

Table 5-3 Event Paced Sampling (Continued)

5	ENABLED WHEN: **ABOVE SET POINT** BELOW SET POINT	Select ABOVE SET POINT.
6	EVENT02: RAIN **LEVEL** FLOW TEMP5 pH5 SP_CO5 DO5 DONE	Select LEVEL again.
7	"LEVEL" CONDITION: SET POINT RANGE **RATE OF CHANGE**	Choose RATE OF CHANGE.
8	CONDITION IS TRUE WHEN "LEVEL" **RISES** FALLS	Choose RISES. This will enable the event condition if a rise occurs within the time frame and above the amount specified in screen #9.
9	"LEVEL" RISES **1.000** ft __HOURS, __MINUTES	Enter 1 ft and press ↵. Then enter 2 hours.
10	EVENT03: RAIN LEVEL FLOW TEMP5 **pH5** SP_CO5 DO5 DONE	Select pH.
11	"pH5" CONDITION: SET POINT **RANGE** RATE OF CHANGE	Select RANGE.
12	"pHx" RANGE: LOWER: **4.00** UPPER: **10.00** (0.00 - 14.00)	Enter 4 for the lower range and 10 for the upper range.
13	ENABLED WHEN: **INSIDE RANGE** OUTSIDE RANGE	Choose INSIDE RANGE.
14	EVENT04: RAIN LEVEL FLOW TEMP5 pH5 SP_CO5 DO5 DONE	You will not be entering a fourth event condition, so use the arrow keys to scroll down, and then select DONE.
15	PACING: EVENT PACED 3 EVENT CONDITIONS	Proceed with the rest of the programming steps.

5.9.3 Nonuniform Time Pacing

The extended time pacing options are uniform time and nonuniform time. "Uniform time" pacing is identical to "time" pacing in standard programming. Nonuniform time pacing uses an irregular interval between sample events; each interval is individually programmable. There are three types of nonuniform time pacing:

- Nonuniform clock time pacing.
- Nonuniform interval pacing.
- Random interval pacing.

5.9.4 Nonuniform Clock Time Pacing

For clock time pacing, enter specific times for each sample event (see screen 2). You can enter as many as 99 clock times, but the interval between times cannot be greater than 24 hours. (Remember to use a 24-hour clock when entering times.) The sampler takes a sample at the start time.

5.9.5 Nonuniform Interval Pacing

For nonuniform interval pacing, enter the number of sample events spaced at intervals of minutes: 12 samples at 5 minute intervals, 6 samples at 10 minute intervals, and so on. The sampler accepts as many as 99 nonuniform interval entries. The sampler takes a sample at start time.

5.9.6 Random Interval Pacing

Time Pacing Screens

1
```
NONUNIFORM TIME:
CLOCK TIMES
INTERVALS IN MINUTES
RANDOM INTERVALS
```

CLOCK TIMES

2
```
TAKE SAMPLES AT:
1. START TIME
2. HH:MM
3. HH:MM
```

INTERVALS IN MINUTES

3
```
FIRST SAMPLE AT
START TIME,
THEN . . .
```

4
```
QUANTITY AT INTERVAL
1. __ AT ___ MIN
2. __ AT ___ MIN
3. __ AT ___ MIN
```

RANDOM INTERVALS

5
```
PROGRAM RUN TIME:
__ HOURS, __ MINUTES
```

To program the sampler for random interval pacing, enter the length of time you want to sample. The run time is the only random programming setting you'll need to enter because the sampler derives the number of sample events required for the program from the distribution settings. (You can combine random pacing with any distribution.) Each time you run the program, the sampler generates a new set of random intervals. This makes each sample event unpredictable from run to run.

In both nonuniform clock time pacing and nonuniform interval pacing, the sampler takes a sample at the start time. For random pacing, however, it takes the first sample at the end of the first interval, not at the start time.

5.10 Distribution

Distribution describes how the sampler is to deposit samples. A sample is the volume of liquid deposited in a bottle. A sample event includes the full sampling cycle and may deposit a sample into more than one bottle. You can program the sampler for five distribution methods:

- Sequential
- Bottles per sample
- Samples per bottle
- Composite
- Multiple Bottle Compositing

5.10.1 Sequential

In sequential distribution, the sampler deposits one sample in each bottle. A sequential sample represents a "snapshot" of the flow stream at a point in time.

5.10.2 Bottles Per Sample

In bottles per sample distribution, the sampler deposits a sample in each of a set of bottles. A bottle set includes at least two bottles but may include all bottles. Use bottles per sample when the volume to be collected is larger than the amount one bottle can hold or when you need identical samples.

5.10.3 Samples Per Bottle

In samples per bottle distribution, the sampler deposits samples from several sample events in a single bottle before moving to the next bottle. Use samples per bottle distribution to collect a series of small composite samples.

5.10.4 Composite

For single bottle configurations, samples per bottle distribution is known as composite sampling. A composite sample represents an average of the flow stream's characteristics during the sampling period.

5.10.5 Multiple Bottle Compositing

Multiple bottle compositing is a combination of bottles-per-sample and samples-per-bottle. At each sample event, the sampler deposits a sample into a set of bottles. It moves to a new bottle set only after each bottle of the first set contains the programmed number of samples. Use multiple-bottle compositing to collect identical sets of composite samples or a composite sample that is larger than the capacity of a single bottle. Multiple bottle compositing is available only in extended programming.

5.10.6 Time Switching

In extended programming, the sampler offers an additional distribution feature, time switching. This feature determines when the sampler fills the next bottle or bottle set, and may be used with time-paced or flow-paced sample programs. Time switching distribution occurs at regular intervals (as programmed in screen 3 in the margin). The switch times are relative to the programmed "FIRST SWITCH TIME" (screen 4).

Switch times occur regardless of the state of the sampler. Be aware that the sampler may leave empty bottles if it becomes disabled. Pause and resumes are an exception; the sampler will not switch bottles during a pause if the current bottle is empty.

Time Switched Distribution

1 2 BOTTLES PER SAMPLE EVENT (1-max)

- Enter the number of bottles that should receive samples at each sample event.

2 SWITCH BOTTLES ON: NUMBER OF SAMPLES **TIME**

- Select TIME.

3 SWITCH BOTTLES EVERY __ HOURS, __ MINUTES

- Enter the time between bottle switches.

4 FIRST SWITCH TIME AT: __:__

- Enter the first bottle switch time.

If the program settings instruct the sampler to take a sample at the start time, the sampler also draws a sample at the switch time. When this occurs, the pacing will also be reset at the switch time.

Time switching is normally used with flow-paced programs that do not take a sample at start. These programs will place a sample in the current bottle if it is empty at the switch time, and then move to the next bottle/set. Pacing intervals are reset at every switch time.

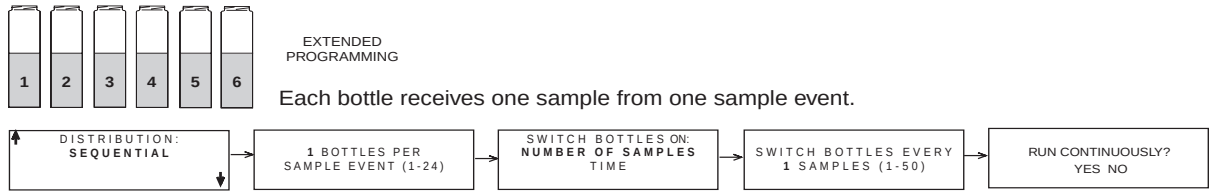
When you use the time switching feature, the volume in each bottle or bottle set may vary. Sample volumes that would exceed the bottle capacity are not taken and a "PROBABLE OVERFILL" message is logged.

5.10.7 Continuous Sampling

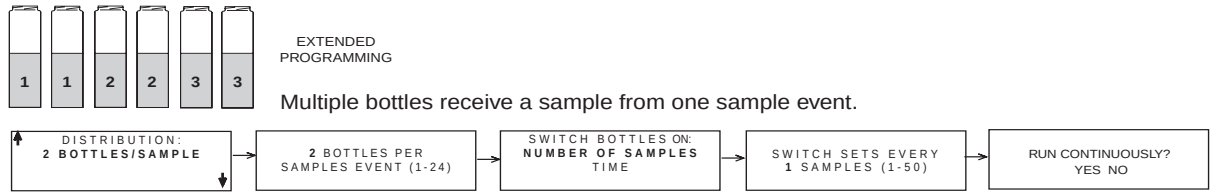
Sample programs can be run indefinitely by selecting "YES" at the "RUN CONTINUOUSLY?" screen. Continuous sampling resets the distribution when the distribution sequence is complete. That is, when the last bottle/set is reached, the next bottle/set is the first bottle/set. All pacing modes except RANDOM are supported.

When running a program continuously, the bottles must be serviced at regular intervals to prevent overfilling the bottles. The sampler assumes that the next bottle/set is empty and ready to receive samples. If you are using this feature with two-part programming, keep in mind that the parts will most likely reset at different intervals.

Sequential

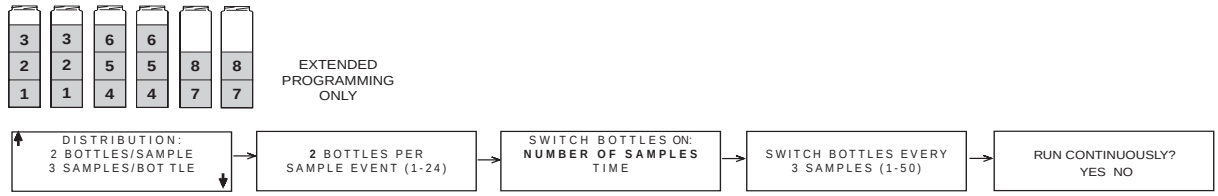


Bottles-per-Sample



Samples-per-Bottle

Multiple Bottle Compositing



Time Switched (Flow-paced, No sample at start)

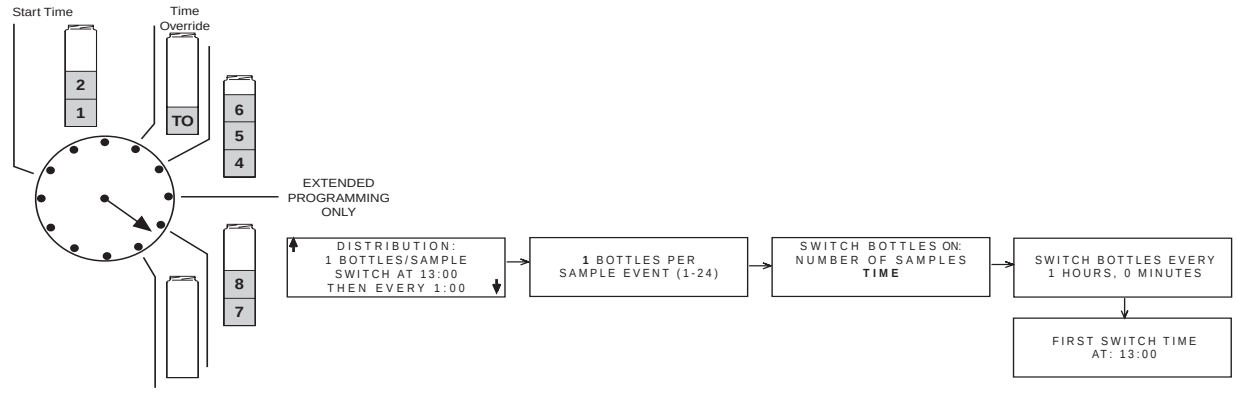
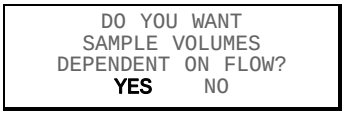


Figure 5-1 Sample Distribution

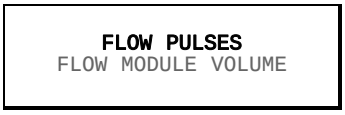
5.11 Flow Proportional Sample Volumes

The 6712 can collect flow proportional sample volumes. For some sampling protocols, these flow-weighted, variable-volume samples can be more representative of the stream. This is because stream characteristics often change as the flow fluctuates.

Variable-volume sampling is possible when the sampler is programmed for Uniform Time pacing. To enable this feature, select YES at the display asking "DO YOU WANT SAMPLE VOLUMES DEPENDENT ON FLOW?"

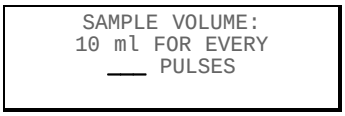


After answering YES, the sampler displays screens to program the flow proportional volumes. If the sampler has a 700 Series Flow Module inserted, you will be asked which flow measurement should be used to determine the volumes.



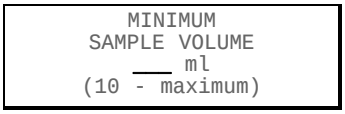
To base the volumes on an external flow measurement device attached to the Flow Meter connector, select FLOW PULSES. To base the volumes on the 700 Series Flow Module readings, select FLOW MODULE VOLUME.

Next, the sampler asks for the SAMPLE VOLUME to collect at each time interval. This volume is expressed as 10 ml for every *X* number of pulses, or if using a flow module, for every volume unit.



Refer to section 5.11.1, *Calculating Variable Sample Volume Settings*, for a more detailed discussion on this setting.

The final screen used to program variable-volume sampling is the MINIMUM SAMPLE VOLUME. If the number of flow pulses or flow module volume is not sufficient enough to collect this minimum volume, the sample is skipped and the flow count carries over to the next sample time. This setting ranges from 10 ml to a maximum determined by the bottle volume.



5.11.1 Calculating Variable Sample Volume Settings

The entry for the SAMPLE VOLUME display can be calculated based on expected flow rates and collection volume requirements.

The number of pulses or flow module volume that you enter should ensure that the minimum volume of liquid required for analysis is collected without exceeding the bottle volume capacity of the sampler. You may find it helpful to determine a range of values by calculating both possibilities. The number you enter would be selected from this range. This range is illustrated in Figure 5-2.

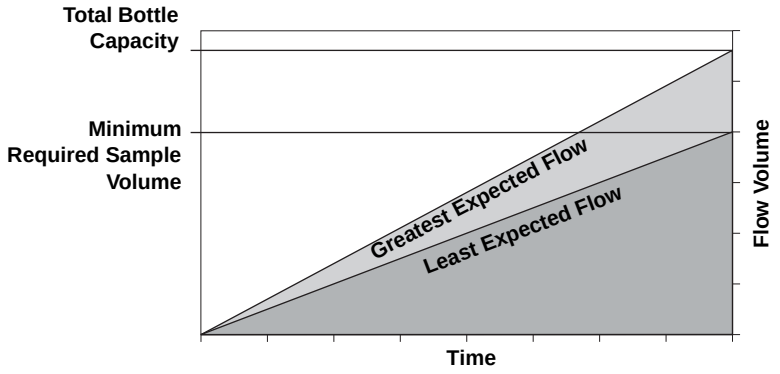


Figure 5-2 Factors Affecting Flow-Weighted Variable-Volume Samples

In other words, at the greatest expected flow, this SAMPLE VOLUME value should be set to prevent filling the bottle before the end of the program. An early full-bottle condition would result in a composite sample that is not representative of the flow stream.

At the lowest expected flow, the SAMPLE VOLUME value should be set to ensure that enough sample is collected. If too little sample liquid is collected, there may not be enough for analysis although it is a representative composite sample.

For example, consider an NPDES sampling program used to collect a flow-proportional composite sample for BOD, TSS, and NH_3-N analysis. The laboratory requires at least 1,000 ml for BOD, 100 ml for TSS, and 400 ml for NH_3-N tests. The minimum composite volume needed for analysis is then 1,500 ml, but to allow for duplicates and spillage, this volume is doubled to 3,000 ml. The samples are to be collected over an eight hour period at 15 minute intervals into a 9,400 ml composite bottle. Flow rates at the site range from 1.5 to 2.0 mgd, the equivalent volume of 500,000 and 666,667 gallons respectively over the eight hour period. This flow is measured by an external flow meter that sends a flow pulse every 100 gallons. Figure 5-3 depicts this scenario.

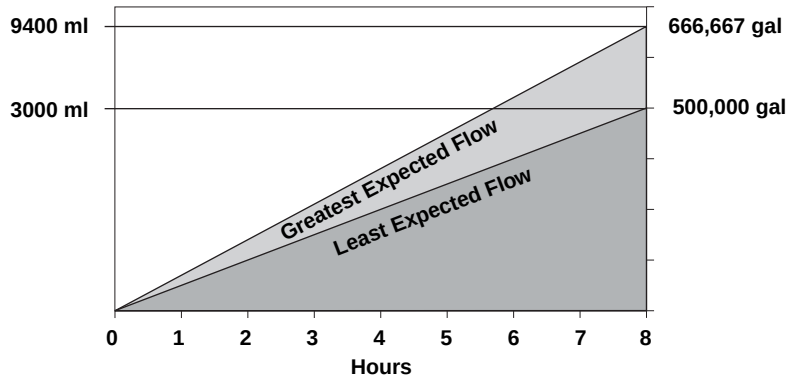


Figure 5-3 Variable-Volume Scenario

5.11.2 Calculations when Using an External Flow Meter

```
SAMPLE VOLUME:
10 ml FOR EVERY
___ PULSES
```

The highest possible SAMPLE VOLUME value is determined by the minimum volume required for analysis and the least expected flow rate over the sampling duration. To calculate the number of pulses at this high end of the range, you should know:

- the least expected flow volume that will pass the flow measurement point
- the flow volume interval between each flow pulse from the external flow meter
- the minimum composite sample volume required for analysis. Allow for duplicates and spillage.

These factors would be applied to the following equation.

$$\text{10 ml for every \_\_ pulses} = \frac{\text{(Least Total Flow Vol) / (Flow Pulse Vol)}}{\text{(Minimum Required Vol) / (10 ml per unit)}}$$

From the scenario we can apply the factors for the equation.

$$\text{10 ml for every 16.7 pulses} = \frac{\text{(500,000 gallons) / (100 gallons per pulse)}}{\text{(3,000 ml / 10 ml)}}$$

Because the SAMPLE VOLUME entry must be in whole numbers, 16.7 is rounded down to 16. It is important to note that this number is inversely proportional to the amount of volume collected. Rounding up would result in less volume collected.

The lowest possible SAMPLE VOLUME value is dependent upon the highest expected flow and the available bottle volume. To calculate the number of pulses or volume at this low end, you should know:

- the greatest expected flow volume that will pass the flow measurement point
- the flow volume interval between each flow pulse from an external flow meter
- the available bottle volume for sample collection.

These factors would be applied to the following equation.

$$\text{10 ml for every \_\_ pulses} = \frac{\text{(Greatest Total Flow Vol) / (Flow Pulse Vol)}}{\text{(Total Bottle Vol) / (10 ml per unit)}}$$

From the scenario we can apply the factors to the equation.

$$\text{10 ml for every 7.0 pulses} = \frac{\text{(666,667 gallons / 100 gallons)}}{\text{(9,400 ml / 10 ml)}}$$

At high flow rates, a number below 7 would overfill the bottle. At low flow rates, a number greater than 16 would collect too little sample. Therefore, a value should be selected between 7 and 16 pulses.

5.11.3 Calculations when Using a 700 Series Flow Module

The same principles discussed in Section 5.11.2 apply. However, the equations differ slightly because the flow module directly measures the stream's flow volumes. The equation for the high end of the range is:

$$\text{10 ml for every \_\_ units} = \frac{\text{(Least Total Flow Vol)}}{\text{(Minimum Required Vol) / (10 ml per unit)}}$$

Using the same scenario the calculations would be:

```
SAMPLE VOLUME:
10 ml FOR EVERY
___ Gallons
```

$$\text{10 ml for every 1667 gallons} = \frac{\text{500,000 gallons}}{\text{(3,000 ml) / (10 ml per gallon)}}$$

The equation for the low end of the range is:

$$\text{10 ml for every \_\_ units} = \frac{\text{(Greatest Total Flow Vol)}}{\text{(Total Bottle Vol) / (10 ml per unit)}}$$

The scenario would be applied as:

$$\text{10 ml for every 709 gallons} = \frac{\text{666,667 gallons}}{\text{(9400 ml) / (10 ml per unit)}}$$

Therefore, a value should be selected between 709 and 1667 gallons for the given scenario.

5.12 Sampler Enable

Certain external instruments can enable (start) or disable (stop) a sampler by sending a signal to pin F of the sampler's flow meter connector. Teledyne Isco flow meters, flow loggers, and the Model 1640 Liquid Level Actuator have a programmable sampler-enable feature that lets them enable or disable the sampler. You can define the condition (such as level, flow rate, pH, temperature, percent, rainfall, and I/O) or combination of conditions that need to be true in order to enable the sampler. Refer to Figure A-12 in Appendix A for details on programming sampler enables.

When the sampler detects that it is disabled at start time, it suspends the program until it is enabled. Once enabled, the sampler collects a sample only when programmed to take a sample at the enable time. The diagram in Figure 5-4 shows the sampler's response when enabled or disabled at the start time.

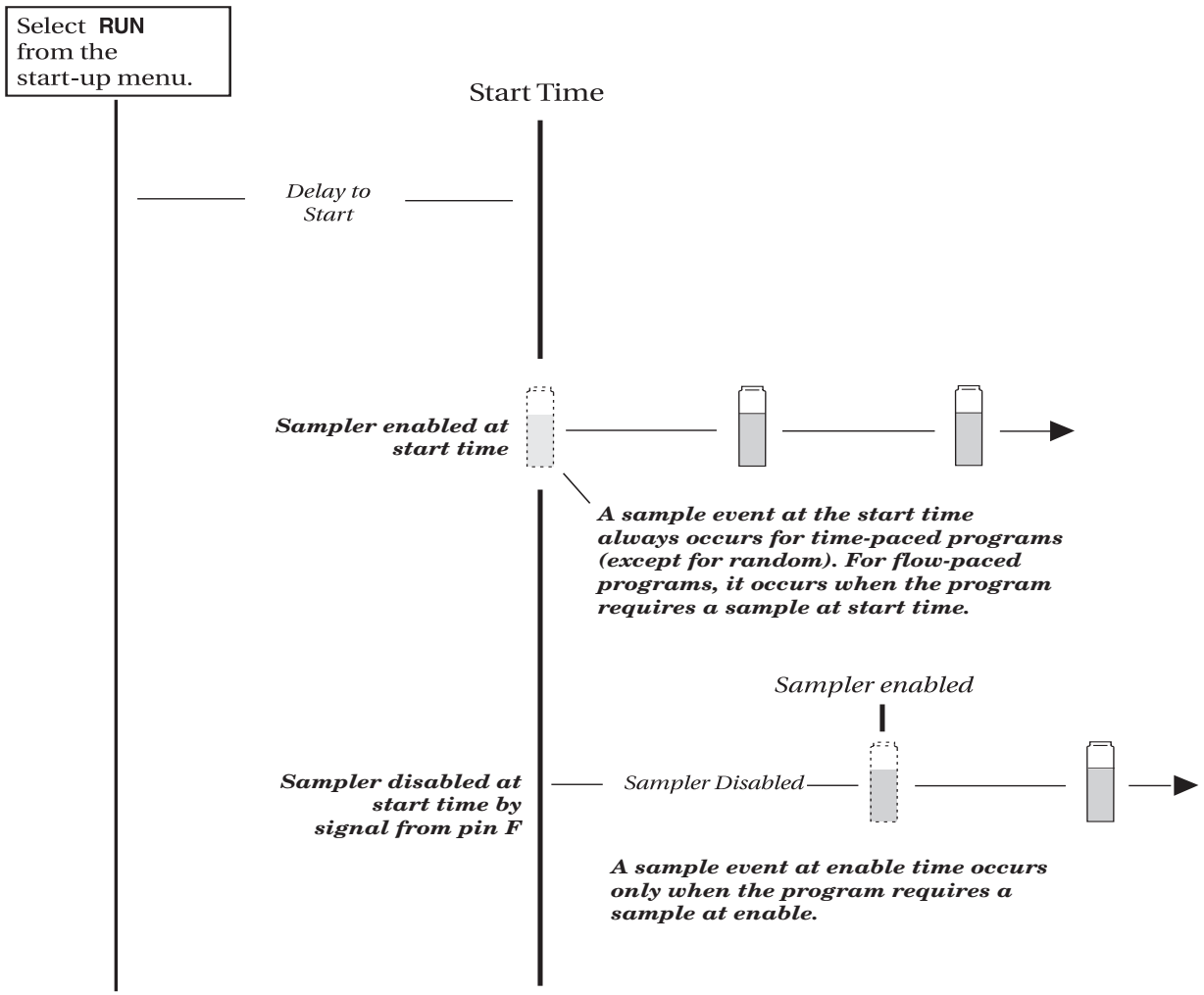


Figure 5-4 Start Time Diagram for Sampler Enable Settings

5.12.1 Sampler Enable

This example uses a sampler with an attached 730 Bubbler Flow Module, Rain Gauge, and an SDI-12 sonde at address 5 with four parameters.

Table 5-4 Sampler Enable

1	ENABLE: NONE PROGRAMMED	In this example, you will be enabling the sampler if it rains .5" in 2 hours and the level goes above 1 foot.
2	ENABLE: **RAIN** LEVEL FLOW TEMP5 pH5 SP_CO5 DO5 NONE	Select RAIN.
3	ENABLE: RAIN **AND** OR DONE	Choose AND.
4	ENABLE: RAIN AND **LEVEL** FLOW TEMP5 pH5 SP_CO5 DO5 DONE	Select LEVEL.
5	"RAIN" SET POINT: **.5** INCHES PER __HOURS, __MINUTES	Enter .5 for the inches of rain. Press ↵ . Enter 2 HOURS.
6	ENABLED WHEN: **ABOVE SET POINT** BELOW SET POINT	Select ABOVE SET POINT.
7	RESET RAIN HISTORY? **YES** NO	Select YES.
8	"LEVEL" CONDITION **SET POINT** RANGE RATE OF CHANGE	Select SET POINT.
9	"LEVEL" SET POINT: **+1** ft (0.001 - 30.00)	Enter 1 foot.
10	ENABLED WHEN: **ABOVE SET POINT** BELOW SET POINT	Select ABOVE SET POINT.
11	ENABLE: RAIN >0.50" / 2:00 AND LEVEL >1.000 ft	Your enable conditions will be summarized on the display. If correct, press ↵ to continue. If necessary, make changes to the enable conditions.

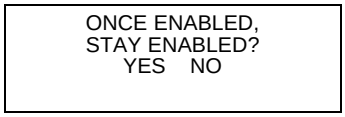
5.13 Sampler Enable Responses

In addition to programming enable conditions, extended programming lets you control the sampler's response to its enable state. You can:

- Stay enabled after the first enable.
- Set up a repeatable enable.
- Take a sample at enable or disable.
- Delay the start of sampling after the enable.
- Reset the sampling interval countdown each time the sampler is enabled.
- Control the sampling interval countdown while disabled.
- Enable Part B of a two-part program when Part A is done.

5.13.1 Once Enabled Stay Enabled

For certain monitoring programs, you may want the sampler to continue to sample, even though the conditions that enabled the sampler no longer exist. When you use the ONCE ENABLED, STAY ENABLED feature, after becoming enabled the sampler takes samples until it reaches the end of its program.



Note

The STAY ENABLED feature works only when the sampler becomes enabled following program start. If you need this feature with enable *prior* to program start, contact Teledyne Isco for details.

5.13.2 Repeatable Enable

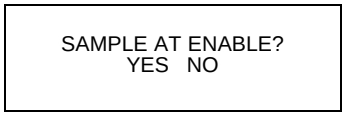
After enabling the sampler, the enabling instrument (or instruments) continues to monitor the conditions and disables the sampler when the conditions are no longer satisfied. If re-enabled, the sampler resumes the sampling program.

Note

Repeatable enable is called "sampler latching" in flow meters, flow loggers, and FLOWLINK. Latching a sampler produces the same results as selecting YES; the difference is that the external instrument controls the latching.

5.13.3 Sample at Enable or Disable

You have the option of directing the sampler to take a sample as soon as it receives the enable and/or disable signal. If you program the sampler to stay enabled and choose to take a sample at enable, the sample interval will be reset at the enable time. Samples at disable do not affect the sample intervals. Standard programs do not take a sample at the enable time.



5.13.4 Delay To Start Of Sampling

If you have selected ONCE ENABLED STAY ENABLED and have chosen to not sample at the enable, you have the opportunity to suspend the start of sampling. This choice is useful for storm programs that require a flow-paced sample taken after the initial grab sample.

```
START SAMPLING
AFTER A
___ MINUTE DELAY
(1-999)
```

5.13.5 "Dry Period" Option

For samplers used with a 0.01 inch tip rain gauge, you can cause the sampler to wait for a "dry" period of under 0.10 inches of rain over a 72-hour period before running the program. At RUN time, the sampler asks if you want to restart the 72-hour period. Select this choice if you want the sampler to disregard any "dry" period that took place prior to the program start. The sampler will wait for up to one year for the "dry" period to occur.

```
START "EXTENDED 1"
AFTER A 72 HOUR
"DRY" PERIOD?
YES   NO
```

5.13.6 Resetting the Sample Interval at Enable

```
RESET SAMPLE
INTERVAL AT ENABLE?
YES   NO
```

You may want the pacing countdown to start over each time the sampler becomes enabled. To accomplish this, select "YES" when asked if you want to reset the sample interval at enable. The next sample event will occur at the end of a full interval. Furthermore, if the sampler is enabled several times during the program, it resets the countdown each time.

Use the reset-interval feature carefully. For example, avoid resetting the interval when you sample with uniform-time pacing and want to take samples at specific times.

The effects of resetting the interval can be seen in this example: A sampler has been programmed to sample every 15 minutes and to reset the interval when enabled. It receives an enable signal at 10:03 and takes a sample. After resetting the interval, the sampler takes subsequent samples at 10:18 (not 10:15), 10:33 (not 10:30), and so on.

If you answer "NO" to the above screen, you will see:

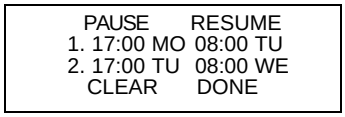
```
CONTINUE COUNTDOWN
WHILE DISABLED?
YES   NO
```

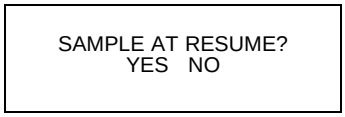
If you select "NO" when asked if you want to reset the sample interval at enable, you will be asked if you want to continue the countdown while disabled. You can have the sampler continue the countdown, repeating it as often as necessary while the sampler is disabled, or you may suspend the countdown while disabled, resuming the countdown as the sampler is enabled. The standard program allows the countdown to continue while disabled.

5.14 Pauses/Resumes

Pause and Resume Screens

Flowcharts containing the pause and resume screen appear in Appendix A.





Pause and resume settings, available in extended programming, create an intermittent sampling schedule. A program with pauses and resumes begins sampling at its programmed start time, continuing until the first pause time and day of the week. It then suspends sampling until the first resume time, when it begins sampling again. If the start time falls within a pause period, the sampler will not begin sampling until the next resume time. Pauses and resumes repeat weekly.

You can enter up to nine pairs of pause and resume times. The pause and resume times shown as examples to the left suspend the program between 5:00 p.m. Monday and 8:00 a.m. on Tuesday and between 5:00 p.m. Tuesday and 8:00 a.m. on Wednesday. If the start time is Monday at 8:00 a.m., the sampler takes samples between 8:00 a.m. and 5:00 p.m. Monday; between 8:00 a.m. and 5:00 p.m. Tuesday; and, continues after 8:00 a.m. Wednesday. To remove pause and resume settings from a program, select CLEAR.

A sampler running a pause/resume program resets the pacing interval at each resume time. You can program the sampler to take a sample at resume times (see screen at left).

5.15 Running Programs

To run an extended program, select run from the main menu. You may also select YES at the RUN THIS PROGRAM NOW? screen at the end of the programming screens.

Extended programs scheduled to start at a clock time will not start until the programmed clock time on or after the *first valid date*.

Note that if you have recently calibrated a parameter probe, the sampler may delay the start and display “PLEASE WAIT” until valid readings are expected from the probe. The delay accounts for the time typically required to install the probe, and lasts for five minutes after you complete the calibration.

5.15.1 Run Time Screens

Run time screens, which report the program’s status while running a program, are explained in Section 4.

5.15.2 Interrupting a Running Program

Interrupting a running program is also explained in Section 4. The scrolling menu that appears during the manual paused state can have two extra options when using extended programming:

Adjust Enable – This option is available for extended sampling programs that have programmed enable conditions. Selecting this option allows you to change the set-points or ranges for the enable conditions. The sampler displays all of the programming screens that define the thresholds of the programmed enables. You cannot change the type of enables used or the way they are combined.

If rain is an enabling condition, you also have the option of resetting the rain history.

Adjust Suction Head – If you have chosen to manually enter the suction head, and are in the manual paused state, the scrolling menu will have an option to adjust the suction head. If you make changes to the suction head value, the sampler logs a changed suction head event.

5.16 Sampling Reports

The 6712 records a variety of data while running a sampling program. Sample reports can be found in Section 4.

Section 4, Table 4-3 contains a list of source codes and program events that may be recorded when using either standard or extended programming.

5.17 Other Functions

Other Functions Menu

RUN "*PROGRAM NAME*"
PROGRAM
VIEW REPORT
OTHER FUNCTIONS

• Select OTHER FUNCTIONS.

MAINTENANCE
MANUAL FUNCTIONS
SOFTWARE OPTIONS
HARDWARE

In extended programming, the "Other Functions" menu screen includes options for:

- Maintenance (see Section 7)
- Manual Functions (see Section 4)
- Software Options
- Hardware

5.18 Software Options

The software option screens allow you to set up a number of different software options:

- Liquid Detector Enable
- Normal/Quick View Screens
- Measurement Interval
- Dual Sampler Mode
- Full Bottle Detection
- Display Backlighting
- Event Marks
- Pump Purge Counts
- Serial Output
- Remote Access
- Interrogator Connect Power

5.18.1 Liquid Detector Enable/Disable

USE LIQUID DETECTOR?
YES NO

Under some conditions (pressurized lines, sampling foam), a more repeatable sample volume may be delivered by disabling the liquid detector. Selecting NO will turn the Liquid Detector off.

If the Liquid Detector is off:

- you must enter the SUCTION HEAD
- no RINSES or RETRIES will be available
- you will not be able to CALIBRATE SAMPLE volumes
- the RESULTS report will read a COUNT TO LIQUID of 0
- A complete purge will occur between samples when using multiple bottles-per-sample distribution.

5.18.2 Programming Style

The sampler has two different styles of programming screens: normal and quick view. These are both explained in Section 3.

When you are in extended programming, the default style is Quick View, which allows you to move more quickly through the screens.

If you prefer a step-by-step display for the screens, switch to the Normal setting.

5.18.3 Measurement Interval

```
MEASUREMENT INTERVAL
5  15  30  SECONDS
1   2   5  MINUTES
STORAGE INTERVAL
```

If using a 700 Series module or SDI-12 Sonde parameter for enabling, the sampler will request a Measurement Interval. The Measurement Interval allows the sampler to compare the parameter to the enabling conditions at a rate faster than the Data Storage interval. If the Measurement Interval is equal to or greater than the Data Storage interval, the parameter will be checked at the rate of Data Storage interval.

Normally, there are two considerations when selecting the Measurement Interval: power consumption and duration of the enabling event. This setting for battery powered samplers will require some degree of balance between the need to conserve power yet detect the enabling event before it has passed.

5.18.4 Dual Sampler Mode

Dual Sampler Mode

```
DUAL SAMPLER MODE?
YES  NO
```

- Select YES to put the sampler in the dual sampler mode. When you no longer need dual samplers, return to this screen to turn the feature off.

Dual Sampler Mode lets you operate two samplers as a pair. The primary sampler disables the secondary one until the primary sampler completes its sampling program. The samplers then reverse roles with the second sampler becoming the primary one.

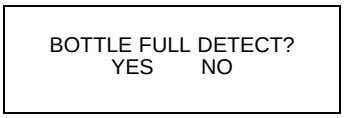
Setting Up Dual Samplers –

1. Turn on the dual sampler mode in both samplers.
2. Install the samplers.
3. Connect the samplers with the Dual Sampler Mode Interconnect Cable by attaching the cable to the sampler's flow-meter connectors. If your installation includes a flow meter or flow logger, use the Dual Sampler Mode to Flow Meter Cable instead.
4. Decide which sampler is to be the primary sampler; the primary sampler should be the sampler with the program you want to run first.
5. Turn the primary sampler on and run its sampling program by selecting RUN. After at least 5 seconds, turn the secondary sampler on and select RUN from its main menu.

How Does It Work? – The primary sampler sends a disable signal out its flow meter connector. The secondary sampler receiving the signal is held disabled until the primary sampler completes its program.

When using a flow meter or flow logger a Dual Sampler Mode to Flow Meter cable must be used. This cable is constructed so that the pacing instrument receives only the event marks. Therefore, a connected flow meter will not receive a bottle number signal, nor will it be able to control the sampler inhibit.

Bottle Full Detect



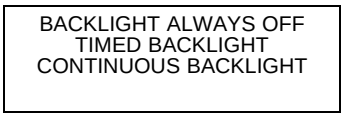
Bottle Full Detection – The sampler can detect a full bottle condition when collecting samples in a single bottle (composite sampling). When the sampler detects a full bottle, it stops the sampling routine.
A BOTTLE FULL condition will also stop a sampling routine that is set to RUN CONTINUOUSLY.

The Bottle Full Detect screen allows you to enable or disable this feature. Selecting "YES" enables the sampler to detect a full bottle and stop the sampling routine. Selecting "NO" disables this feature. The Bottle Full Detect setting is part of the sampling program. Because it is a program setting, full bottle detection can be enabled or disabled for each of the four extended programs. If the Bottle Full Detect setting is critical to your sampling program, always check this Software setting after you select a different Extended Program.

This feature relies on a post-purge after each sample. When using the Bottle Full Detect, make sure that post-sample purges greater than 100 are used.

Bottle Full Detect is always disabled in the Standard Programming mode.

Adjusting the Display Backlighting

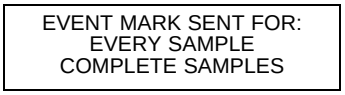


Display Backlighting – The display has a backlight that is adjustable so that the backlight is always off, timed or always on.

In the timed backlight mode the sampler turns the backlight off after detecting no key strokes within 60 seconds. Any keystroke (except ON-OFF) turns the backlighting on again. In this mode the backlight must be on before the sampler accepts a menu choice or number entry. If you press a key and a screen does not respond, it is because the keystroke turned the backlight on.

It is recommended that you use either BACKLIGHT ALWAYS OFF or TIMED BACKLIGHT when using a battery.

Event Marks



Event Marks – The sampler generates an event mark at each sample event, sending it through the flow meter connector to a connected instrument. The event mark may also control an external device; a connected solenoid relay, for example. When using the event mark for a data logger or to control external devices, you may need to adjust the mark by changing the factory settings.

The event mark is adjustable through the software setup screens. You can set up the sampler to generate an event mark for EVERY SAMPLE or for COMPLETE SAMPLES.

If you select COMPLETE SAMPLES, the sampler sends a three-second pulse only after it successfully collects a sample. The sampler will not send an event mark if an error occurs, such as "No Liquid Detected."

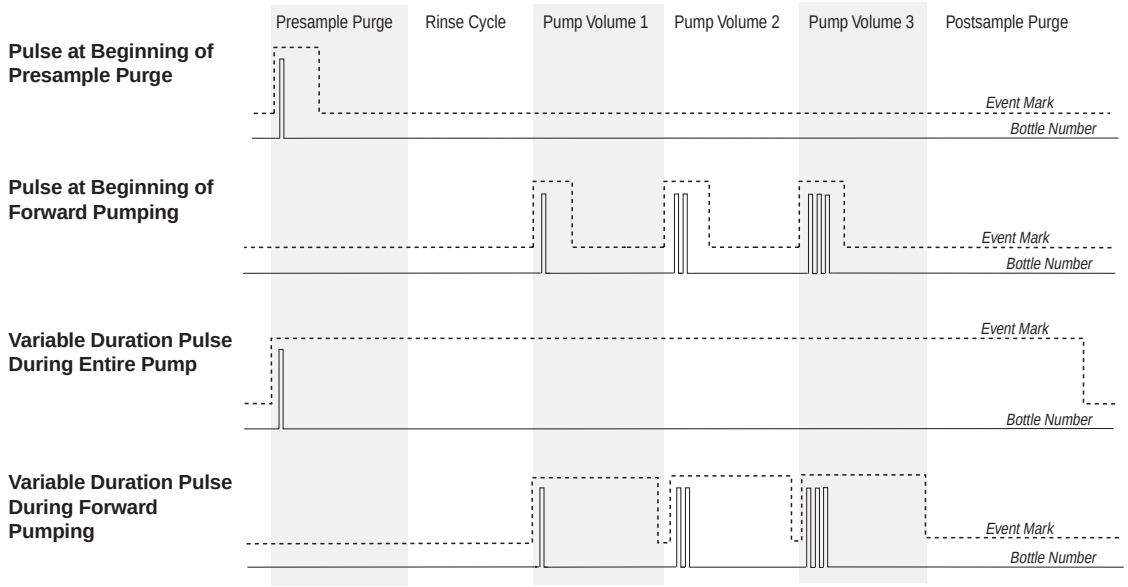
If you select EVERY SAMPLE, the sampler will send an event mark every time a sample is initiated. The event mark signal can be a:

- 3-second pulse at the beginning of the pre-sample purge.

- 3-second pulse at the beginning of forward pumping only, marking the time the sampler deposited the sample.
- Variable duration pulse generated during the pump cycle, from the beginning of the pre-sample purge to the end of the postsample purge.
- Variable duration pulse generated only during forward pumping.

Figure 5-5 shows event mark timing diagrams.

Bottle Number – Concurrent with the event mark, the sampler also sends a bottle number signal. The bottle number signal is a series of pulses. The number of pulses sent represents the bottle currently accepting a sample (see Figure 5-5).



This diagram shows the pulses sent for a bottles-per-sample distribution scheme

Figure 5-5 Event Mark Timing Diagram

5.18.5 Pre-sample and Post-sample Purge Counts

PRE-SAMPLE PURGE:
____COUNTS
(10-9999)

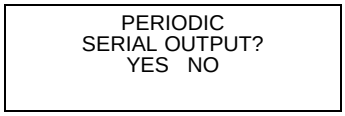
POST-SAMPLE PURGE:
DEPENDENT ON HEAD
FIXED COUNT

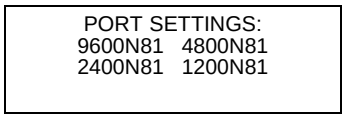
POST-SAMPLE PURGE:
____COUNTS
(10-9999)

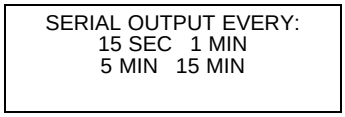
The pre-sample purge is when the pump runs in reverse clearing the strainer of any debris before taking a sample. The pre-sample purge is set at 200 pump counts. After the sample is taken a post-sample purge occurs to clear the liquid from the suction line. The duration of the post-sample purge is determined by the length of the suction line to maximize the battery life. The pre- and post-sample purge can also be manually set.

5.18.6 Serial Output

Programming the serial output







Serial ASCII data can be output through the controller's interrogator port. The output frequency is user-selectable: every 15 seconds, every minute, every 5 minutes, every 15 minutes, or by command.

To receive serial data as a *periodic output*:

1. Select YES at screen asking if you want periodic serial output.
2. Select the appropriate baud rate setting in screen . Note that at all baud rates the data is sent with no parity, eight data bits, and one stop bit. If you have difficulty with the connection, try a slower baud rate.
3. Select the desired output interval in screen.
4. Connect to the 6712 controller's interrogator connector using a standard interrogator cable.

To receive serial data by *command*:

1. Select NO at the screen asking for periodic serial output .
2. Connect your computer to the 6712 controller's interrogator connector with a standard interrogator cable, P/N 60-2544-040 (25 pin) or 60-2544-044 (9 pin).
3. Configure your communications software for a baud rate no higher than 19,200 kb, no parity, 8 data bits, and 1 stop bit.
4. From the computer's keyboard, type "?" repeatedly until the 6712 controller determines the baud rate. Once the baud rate is known, the 6712 returns an identification banner. This banner indicates that the connection is working properly.
5. Type DATA<CR> each time the data string is desired.

The serial data is in comma-separated-value format. Only the values that the sampler is set up to measure will be output in the data string. The string is terminated with a <CR><LF>. To read the data in the string, refer to Table 5-5. This serial data can also be accessed from a remote location using the optional dial-out modem (see Section 7).

☑ *Note*

The modem is disabled when an interrogator cable is connected to the sampler's Interrogator port. It cannot receive incoming calls, and the alarm dialout is rendered inoperative, while this cable is ocnnected. **Disconnect the interrogator cable in order to use the 4200T modem.**

Table 5 5 Serial Data Codes

Identifier	Parameter	Units
B?[1]	Bottle number and time	days since 1-Jan 1900
CR	Current day's rain	tips (rolls over every 256 tips)
CS[2]	Checksum	unsigned long
DE	Description	6712 Sampler
FL	Flow	cubic meters per second
ID	Unit specific identifier	10 digit unsigned long
LE	Level	meters
MO	Model	6712
PE	Percent	percent of full scale
PH	pH	none
PR	Previous day's rain	tips (rolls over every 256 tips)
RA	Rain	tips (rolls over every 256 tips)
RTE	Refrigerator Temperature	degrees celsius
SS	Sampler enable state	logical
TE	Temperature	degrees celsius
TI	Current time	days since 1-Jan-1900
VE	Velocity	meters per second
VO	Volume	cubic meters
VSI	Velocity signal strength	percent
VSP	Velocity spectrum strength	percent
CO_a[3]	Conductivity	milliseimens per centimeter
DO_a	Dissolved oxygen	milligrams per liter
PH_a	pH	none
SA_a	Salinity	parts per thousand
SP_a	Specific Conductance	milliseimens per centimeter
TD_a	Total Dissolved Solids	grams per liter
TE_a	Temperature	degrees Celsius
OR_a	Oxidation reduction potential	millivolts
LE_a	Level	meters
MM_a	Ammonium-nitrogen	milligrams nitrogen per liter
MA_a	Ammonia-nitrogen	milligrams nitrogen per liter
NI_a	Nitrate-Nitrogen	milligrams nitrogen per liter
TB_a	Turbidity	nephelometric turbidity units

Table 5-5 Serial Data Codes (Continued)

Identifier	Parameter	Units
CL_a	Chloride	milligrams per liter
CP_a	Chlorophyll	micrograms per liter
FL_a	Flow rate	cubic meters per second
VO_a	Flow volume	cubic meters
xxD_a[4]	Other data not listed above	

- The three most recent samples will have entries as B?. The "?" will be the first bottle number in the set. If the sample is a grab sample, it will be shown as B0.
- An "a" in the identifier indicates an SDI-12 address.
- "xx" matches the data label for the SDI-12 parameter.
- The checksum does not include the checksum, carriage return, and linefeed.
- The string is terminated with <CR><LF>.

5.18.7 Program Lock

The specialized software option Program Lock (P/N 60-9003-532) may be purchased from Teledyne Isco.

Once activated, the purchased option is always available, even if the software is upgraded at a later time. **The option must be installed at the factory. Consult the factory for further details.**

To view which software options have been activated, select VIEW REPORT>SYSTEM IDs. A Software Options screen will list a code for each active option. The code for Program Lock is **1108**.

PROGRAM LOCK DISABLED

ENABLE PROGRAM LOCK?
YES NO

CHANGE PASSWORD TO

REENTER NEW PASSWORD

The Program Lock adds password security to the 6712 sampling programs. With this option activated, a user-selected password (up to five digits) must be entered before any program changes or run time modifications can be made. Run time modifications include accessing the Manual Pause menu options and shutting off the sampler. You will still be able to run the current program, view reports, and interrogate the sampler without the knowledge of the password.

If three consecutive attempts to enter the password fail, a five minute "time-out" will follow in which most keys are deactivated.

The user-selected password defaults to "6712" and may be changed in the Software options that are available in the Extended Program mode (see example at left). While the password may only be changed in the Extended Program mode, the program lock works for both Standard and Extended programs.

Should you forget your password, a key code can be obtained from Teledyne Isco's Customer Support department for a nominal fee.

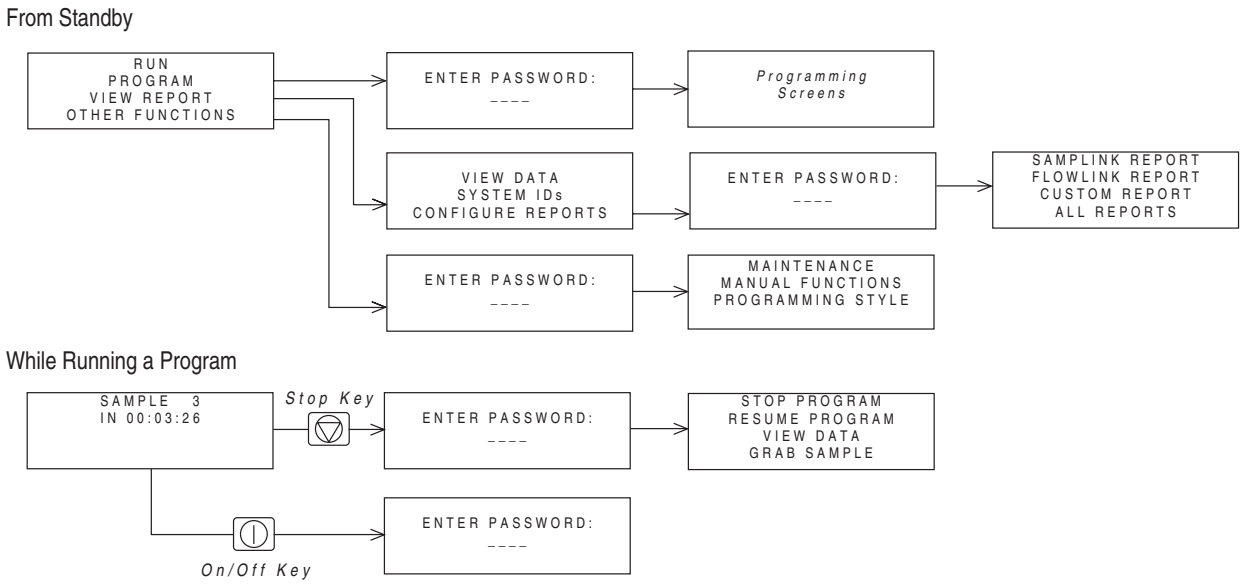


Figure 5-6 Password Protected Functions

5.19 Hardware Setup

The hardware setup screens make adjustments to the sampler's hardware-based features:

RUN "*PROGRAM NAME*"
PROGRAM
VIEW REPORT
OTHER FUNCTIONS

• Select Other Functions

MAINTENANCE
MANUAL FUNCTIONS
PROGRAMMING STYLE
HARDWARE

• Select Hardware

- Rain Gauge Setup
- SDI-12 Sonde Setup
- I/O Pin Programming
- Analog Outputs
- Dialout Alarms

5.19.1 SDI-12 Sonde Setup

The 6712 supports SDI-12 sondes. For more information on setting up sondes, refer to Section 6.

5.19.2 Rain Gauge Setup

With standard programming, the sampler does not record rain gauge readings. However, with extended programming, recording the rain gauge readings and the rain enable option can be turned on or off. Enter the hardware setup and follow the screens to the left in the margin.

When asked if you have a rain gauge connected, select YES to record the rain gauge readings and add RAIN as a sampler enable option. Select the appropriate tip for the rain gauge. The sampler will then create a rain memory partition and update the available sampler enable conditions.

Select NO to disable the readings and the sampler enable option. When you select NO, the sampler removes the rain memory partition, leaving the memory space available for other reading types.

```
DO YOU HAVE A
RAIN GAUGE CONNECTED?
YES  NO
```

- Select YES.

```
RAIN GAUGE:
0.01 inch TIP
0.1 mm TIP
```

- The rain gauges are set up to tip on either .01 inch or .1 mm. Select the desired tip.

5.19.3 I/O Pin Programming

Pins C, H, and I on the Rain Gauge Connector are user-configured as I/O1, I/O2, and I/O3 (Input/Output pins) respectively. Each pin can be either an input for sampler enabling, or an output for alarms.

☑ Note

The state of the I/O lines is not defined when the sampler is OFF.

The enable input requires a pulse signal of 5 to 15 volts. Teledyne Isco offers optional interface modules for converting from a 4-20 mA analog or pulse duration signal.

The alarm output can be set for any RUNNING PROGRAM or RUN ERROR state. In addition, the CONDITIONS output can report alarm conditions using the parameters the 6712 is configured to measure. You can set thresholds for one or two conditions and the CONDITIONS output can then trigger alarms when the measured parameters exceed the threshold.

The alarm output requires an alarm interface module. Teledyne Isco offers a module designed to provide one, two, or three contact closures. The alarm module can interface the sampler with a large number of non-Teledyne Isco devices. For more information about the alarm module, contact your Teledyne Isco sales representative.

5.19.4 Refrigerator Temperature

Teledyne Isco offers a temperature sensor intended for use with the 6712FR Refrigerated Sampler. The optional sensor connects to the Rain Gauge port and uses I/O3 to transmit its temperature readings to the 6712.

☑ Note

If alarms are being used, the temperature sensor is simply plugged into the panel mount on the one- or two-alarm output module. Because the temperature sensor uses I/O3, it cannot be used with a three-alarm output module.

To configure an attached temperature sensor, select "FR-TEMP" as the input for I/O3. The 6712 will display the NEW HARDWARE SETUP screen. Select DONE and the 6712 reconfigures its memory partitions to record the temperature readings.

Temperature readings are updated approximately every 2.5 seconds. The readings are stored as FR-TEMP readings at the data storage interval. You can retrieve a history of temperature readings through the 6712's reports. The temperature data also can be used as a sampler enable condition.

5.19.5 Analog Output

Teledyne Isco offers three analog outputs as a factory installed option. The option is installed inside the controller and includes a six-pin connector to interface with external devices.

The analog outputs can be programmed for either 0-to-20 mA or 4-to-20 mA operation. With the exception of rain, any parameter that the 6712 sampler is currently measuring can be used to control any (or all) of the analog output channels. Programming the outputs requires parameter levels at each end of the analog range and then assumes a linear relationship between those points. MANUAL CONTROL of each output is also available.

Flowcharts for analog output screens appear in Appendix A.

5.19.6 Dialout Alarms

Dialout alarms require the sampler to be equipped with the factory-installed 2400 baud talking modem. The dialout alarm allows the sampler to notify a contact list when an "alarm" condition exists (is true).

At the transition to the true state, any programmed I/O output can cause the sampler to warn of the alarm condition. As many as three telephone numbers can be entered. The sampler tries each telephone number in succession until the alarm is acknowledged. For each alarm condition, the sampler will attempt each telephone number entered a maximum of five times, at user specified intervals.

Example: Dialout Alarms

If the controller is equipped with a dialout modem, it can be programmed to notify a telephone or pager contact list when an alarm condition is true.

Before proceeding the I/O conditions must be defined. Refer to section 5.19.6. These steps program a dialout alarm when the condition defined for I/O1 is true.

1. Select YES to enable the dialout alarm.

```
DIALOUT WHEN IO1
 BECOMES TRUE?
   YES    NO
```

   The controller asks the same question for IO2 and IO3. Select NO.

```
DIALOUT WHEN IO2
 BECOMES TRUE?
   YES    NO
```

```
DIALOUT WHEN IO3
 BECOMES TRUE?
   YES    NO
```

2. Using the number entry keys, enter as many as 3 telephone numbers to the contact list.

```
    DIALOUT NUMBERS:
1. 9,55555550001
2. 9,55555550002
3. P5550003
```

   If the phone number requires extended characters, or if you need to designate a number as a pager, press the decimal key. The controller displays:

```
      SELECT CODE
  ,   #   *   PAGER
```

   Use an arrow key to select a code and press Enter to insert it in the number on the DIALOUT NUMBERS screen.

3. Enter the delay time between each attempt. A delay will allow time between attempts so you can return a call to the controller to acknowledge the alarm condition.

```
      __ MINUTE
DELAY BETWEEN CALLS

      (0-99)
```

Note: Numbers may be removed from the list by advancing the cursor to the very end of the number with the right arrow key, then pressing the left arrow key to erase the number.

When the call is answered, the sampler's talking modem announces the alarm condition and the sampler's three-digit ID number. To acknowledge the call, press the ✱ (star) key, and the three-digit ID number on your phone. The sampler will reply with an acknowledgment when the keyed entry is correct.

A record of alarms and acknowledgements is available in the Sampling Report. When the sampler detects the alarm condition, it records the type of alarm and the time it occurred. Acknowledgements are a separate Sampling Report entry, recording the time and telephone number that responded to the call.

As mentioned previously, as many as three telephone numbers may be entered. The internal modem can dial up to 25 digits. Enter numbers using the numeric keys on the Avalanche keypad. When entering telephone numbers longer than 17 digits, the display will scroll.

Extended characters, the Comma (,), Pound (#), and Star (*), also may be included in the 25 digits. To enter an extended character, press the Decimal Point key on the Avalanche keypad. The Avalanche displays a screen used to select and enter the extended characters. Each comma entered will cause the modem to pause for two seconds before proceeding with the remaining digits.

Phone numbers that are no longer needed can be removed. Advance the cursor to the end of the telephone number and then press the Left Arrow key to erase the preceding character. If the cursor is not at the end of the telephone number, the Left Arrow key will only shift the cursor without erasing any characters.

Dialout telephone and pager numbers are included in the Program Settings Report.

> ☑ ***Note***
>
> Connecting either the serial output or the standard interrogator cable to the Avalanche disables the internal dial-out modem. The interrogator or serial output cable must be disconnected before you can use the modem.

5.19.7 Pager Numbers

The extended character screen contains a pager option that designates the phone number as a pager. When programmed as a pager number, an identification string will be sent seven times after the pager number is dialed, with a three second delay between strings.

An example identification string would be “828-1”, meaning “Alarm condition #1 exists at sampler 828”. If more than one alarm condition exists, the string would read similar to “828-1-3.

5.19.8 Digital Modem Text Messaging

The sampler can also send alarms in the form of text messages containing the same information as that found in voice messages.

To use this option, you must have:

- a cellular phone with text messaging capabilities
- an external digital modem
  recommended: Teledyne Isco’s AnyDATA modem
  part # 60-5314-489

> ☑ ***Note***
>
> If an internal voice modem is installed, the sampler will use that modem, and text messaging will be disabled.

When you enter each of the (up to three) phone numbers for the sampler to call, if text messaging is active, a request for the TAP (Telocator Alphanumeric Protocol) server number and communications parameters will be made.

As with voice messaging, the sampler will dial each telephone number up to five times per alarm condition, until the message is acknowledged.

5.20 Memory

The 6712 Sampler contains 512 kilobytes of battery backed RAM (Random Access Memory) that stores:

- Five sampling programs
- The sampling results from the most recent program
- The rainfall data collected from rain gauges
- The data from a refrigerator temperature sensor
- The data collected from a 700 Series module
- Parameter data collected from an SDI-12 Sonde
- Calculated flow information from the current flow module

The sampling results memory stores up to approximately 1004 events (the actual number is dependent on the number of SDI-12 parameters). The program run and start time information is logged as four events. These four entries are held for the duration of the program. The remaining 1000 are for logging sample events, program events, and errors from the currently running program. If the running program exceeds 1000 events, the data will "roll over." That is, the sampler will replace the oldest stored event with the newest event. When using an SDI-12 sonde, the sampler logs additional entries at each sample event.

Module, sonde, refrigerator temperature, and rain gauge readings are stored in memory partitions. The storage capacity depends on the reading types, the number of bytes per reading, and the data storage interval.

The sampler clears the sampling results memory when the site description changes. It is important to collect the sampling results before changing the site description – the data can not be retrieved afterwards. Keep in mind that the description may change when selecting an extended program.

The partition data is cleared when the sampler automatically creates and sizes the memory partitions. This occurs when you:

- Select a new program with a different storage interval
- Change the Data Storage Interval in the current program
- Change the programming mode
- Install a new 700 Series Module
- Change 700 Series Module mode of operation
- Add or remove a rain gauge with the Hardware Setup
- Add or remove a refrigerator temperature sensor as I/O3

- Add or remove a SDI-12 sonde parameter with the Hardware Setup
- Reinitialize the sampler

The stored data is lost as the sampler reformats its memory. As a precaution, before clearing the memory, the sampler display will show the following message:

```
INTERVAL CHANGED --
DOWNLOAD DATA NOW
OR LOSE ALL DATA!
DONE
```

If you want to keep the stored data, download it before proceeding. When DONE is selected, the sampler clears the stored data and reformats the memory partitions. The sampler then displays the new capacity of the partition memory.

```
PARTITION MEMORY
WILL LAST 13 DAYS
```

If the duration is too short, try changing the data storage interval or eliminating unnecessary reading types in the Hardware or Module Setup. For example, a sampler configured with a 730 Bubbler Module and a rain gauge storing data at a one-minute interval, creates level and rainfall partitions that hold 100 days of readings. Changing the storage interval to two minutes extends the storage capacity to 201 days.

The sampler does not have to be running a program to store readings. When the sampler is on, it stores readings at the selected data storage interval. Once the partition is filled, the readings roll over.

When the sampler is running a program, the partitions become “triggered” by the programmed start time or the first enable time, whichever is later. A triggered partition continues to log readings at the selected interval, but will not replace any readings taken after the trigger event. The sampler fills the partition and then stops recording to preserve the data. The first reading preserved in a full partition is one hour before the trigger event. A full partition can be reset by starting another program or changing storage parameters.

If you need continuous readings for analysis, be sure to collect the readings before the partition fills or rolls over to avoid gaps in the data.

5.21 Pressurized Lines

The sampler can obtain samples from pressurized lines, as long as the line pressure remains below 15 PSI (pounds per square inch). Pressures greater than 15 PSI may prevent the sampler from purging the suction line; moreover, extreme pressures can force liquid past the pump, even when the pump is not running.

For more consistent sample volumes from lines under constant pressure, calibrate the samples.

For information about sampling with line pressures greater than 15 PSI, contact Teleydne Isco.

5.22 Command Driven Operation

The 6712 controller can be used as a slave to an external controller. The external controller is responsible for determining when to take a sample, how much volume to pump, and where to put the sample. The external controller directly interfaces to the sampler via an RS-232 communications port at 2,400-19,200 baud, 8 data bits, no parity, and 1 stop bit. A comma-separated-value protocol is used by the external controller to make requests, and by the sampler to report results. Use a standard computer connect cable (see Appendix E) to connect the sampler's interrogator port and the external controller.

For information on serial data codes and their meanings, refer to Table 5-5 Serial Data Codes in this section.

The 6712 Sampler will respond to three commands: Turn Sampler On, GET STATUS, and TAKE SAMPLE. All commands must include the instruction set. The checksum value is optional.

The available commands are:

1. Turn Sampler On: STS,2,CS,582<CR>

- "582" is the byte-by-byte sum of the ASCII values in the string "STS, 1,CS".
- "<CR>" is a carriage return signifying the end of the command.
- If the sampler is OFF, this command will turn it ON before returning status info.

2. Get Status: STS,1,CS,581<CR>

"STS,1" instructs the sampler to return the current status.

- "CS,581" is the optional checksum value. The byte-by-byte sum of the ASCII values in the string "STS,1,CS" is 581.
- "<CR>" is a carriage return signifying the end of the command.

3. Take Sample: BTL,2,SVO,100,CS,1039<CR>

The TAKE SAMPLE command is only valid if the sampler is WAITING TO SAMPLE.

- "BTL,2" instructs the sampler to place the sample in bottle 2.
- "SVO,100" instructs the sampler to take a 100 ml sample.
- "CS,1039" is the optional checksum value. The byte-by-byte sum of the ASCII values in the string "BTL,2,SVO,100,CS," is 1039.
- "<CR>" is a carriage return signifying the end of the command.

5.23 Command Driven Sampler Responses

The 6712 Sampler's response string is the same for each of the three commands. A sample response string is shown below:

MO,6712,ID,2424741493,TI,35523.50000,STS,1,STI,35523.41875,BTL,2,SVO,100,SOR,0,CS,xxxx<CR>

Note that the sampler's response is a series of alphabetical and numerical pairs. The alphabetical characters are headings that describe the following numerical value or code. A complete description of each pair is listed below.

MO,6712, is the model number of the sampler.

ID,2424741493, is the sampler's unique identification number.

TI,35523.50000, is the sampler's current time.

STS,1, is the sampler's current status. The possible states are:

1 = WAITING TO SAMPLE.

4 = POWER FAILED (for short time after power is restored).

5 = PUMP JAMMED (must be resolved before continuing).

6 = DISTRIBUTOR JAMMED (must be resolved before continuing).

9 = SAMPLER OFF.

12 = SAMPLE IN PROGRESS.

20 = INVALID COMMAND.

- identifier code is not supported.
- bottle requested is not in current configuration
- sample volume requested is outside its range (10 - 9990 ml)
- day (Set_Time) must be 5 digits and more recent than 1977

21 = CHECKSUM MISMATCH.

22 = INVALID BOTTLE. (bottle requested is not in the current configuration)

23 = VOLUME OUT OF RANGE. (the sample volume requested is outside its range (10-9990 ml)

STI,35523.41875, is the most recent sample time.

BTL,2, is the bottle receiving the most recent sample.

SVO,100, is the most recent sample's volume.

SOR,0, is the results of attempting the most recent sample. The possible results are:

0 = SAMPLE OK.

1 = NO LIQUID FOUND.

2 = LIQUID LOST (not enough liquid to satisfy requirements.)

3 = USER STOPPED (using the Stop Key).

4 = POWER FAILED.

5 = PUMP JAMMED.

6 = DISTRIBUTOR JAMMED.

8 = PUMP LATCH OPEN.

9 = SAMPLER SHUT OFF (while sampling).

11 = NO DISTRIBUTOR.

12 = SAMPLE IN PROGRESS.

CS,xxxx is the byte-by-byte sum of the entire string “MO,...,CS,”

For commands that are not understood (INVALID COMMAND or CHECKSUM MISMATCH) or when no samples have been taken, the most recent bottle information is left off the response string.

6712 Portable Sampler

Section 6 SDI-12 Sondes

In order to provide you with the flexibility to use the water parameter sensors that best meet your needs, Teledyne Isco has implemented support for SDI-12 protocol. Support of this standard allows you to use SDI-12 compatible devices in conjunction with your 6712 sampler in Extended Programming mode.

6.1 SDI-12 Data Parameters

The 6712 Sampler can accept up to 16 parameters from up to ten sensors with SDI-12 addresses from 0 - 9 (refer to chart in Figure 6-1). This data can be used in different ways. Data can be logged at user selectable time intervals for later download and processing by Teledyne Isco's Flowlink™ program. You can set up sampling programs that will be enabled to run only if conditions based on parameters monitored by the connected SDI-12 devices are met. The sampler can also be programmed to take samples each time certain parameter limits are exceeded.

The data parameters used by the sensing device (sonde) and recording device (sampler) must match. Otherwise, the equipment could record the data values for one parameter as another's, such as reporting a pH value as being temperature.

Certain vendors' sondes (such as Hydrolab and YSI) have enhanced commands that facilitate "plug and play" setup. These Teledyne Isco Ready sondes can tell the 6712 what values they have, their order, and units of measure.

Other SDI-12 compatible sondes can be used, but require manual setup to identify proper data types for each data value reported.

This section shows you how to set up both Teledyne Isco Ready and other SDI-12 sondes for use with the 6712.

⚠ WARNING

SDI-12 Sondes have not been approved for use in hazardous locations as defined by the National Electrical Code.

⚠ CAUTION

Before you install any sonde, you must take the proper safety precautions. Refer to Appendix C in the back of this manual. Additional safety considerations may be required. Check applicable guidelines, codes, and regulations of federal, state, city, and county agencies.

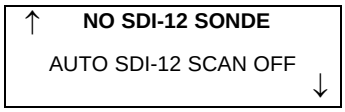
SDI-12 Sonde Data Units:	Parameter	Range	Resolution	Storage Bytes
	Temperature	-40 - 100 °C	0.1 °C	2
	Conductivity	0 - 100 mS/cm	0.01 mS/cm	2
	Specific Conductance	0 - 100 mS/cm	0.01 mS/cm	2
	Total Dissolved Solids	0 - 90 g/l	0.01 g/l	2
	Salinity	0 - 70 ppt	0.1 ppt	2
	Dissolved Oxygen	0 - 20 mg/l	0.1 mg/l	1
	pH	0 - 14	0.1	1
	ORP	-999 - 999 mv	0.1 mv	2
	Level	0 - 6.5279 m	0.0001 m	2
	Ammonium-Nitrogen	0 - 200 mgN/l	0.1 mgN/l	2
	Ammonia-Nitrogen	0 - 200 mgN/l	0.1 mgN/l	2
	Nitrate-Nitrogen	0 - 200mgN/l	0.1 mgN/l	2
	Turbidity	0 - 5000 NTU	0.1 NTU	2
	Chloride	0 - 1000 mg/l	0.1 mg/l	2
	Chlorophyll	0-400 ug/l	0.1 ug/l	2
	Other	-99999.0-99999.0	0.0001	4

Figure 6-1 SDI-12 Sonde Parameters

6.2 Scanning For Sondes

You must be in Extended Programming to use a sonde with the 6712. The sampler can automatically scan for the presence of sondes if you enable that option:

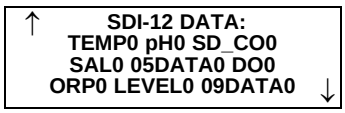
- From the main menu, select OTHER FUNCTIONS.
- Select HARDWARE.
- As you press ↵ to move through the hardware screens, you will see one that looks like the following:



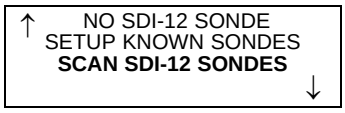
Select “NO SDI-12 SONDE” to scan for sondes. If one is found, you can set it up, and the “AUTO SDI-12 SCAN” option will be switched to yes.

Select the “AUTO SDI-12 SCAN” option to manually turn on (or off) automatic scanning for sondes when the sampler is turned on.

If a sonde has already been connected and set up, the hardware screen will instead display a screen similar to the following:



Press the arrow keys until "SDI-12 DATA" is blinking, then press ↵. You will see the screen below:



Select "SCAN SDI-12 SONDES" and press ↵. The system will scan to see what sondes are connected. If it detects a different sonde, it will indicate so, and advance to the setup screens.

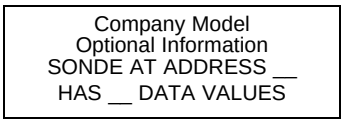
6.3 Teledyne Isco Ready Sondes

Connecting a Teledyne Isco Ready Sonde

1

- Select the address you want to set up.

2



- Wait a few seconds for the above display to disappear, or press ↵.
- You will then be asked if you want to store the parameter data. Refer to "SONDE SETUP - STORING PARAMETER DATA" on page 6-4.

If the 6712 scans for sondes and finds one that is Teledyne Isco Ready, it will automatically recognize the sonde's data types and units. You can then use Hardware options to setup the definitions for data storage and calibrate the sonde.

Even with a Teledyne Isco Ready sonde, the 6712 may find a parameter that is not on its list of supported parameters (Figure 6-1). It can still work with such a parameter. Such a parameter will be identified as something like "05DATA1" and you will have to mentally associate the appropriate data type with that label. However, once such data is brought into Flowlink™, data sets can be manually changed so that reports show the appropriate labels.

6.4 Other SDI-12 Sondes

If you have connected an SDI-12 sonde that is not Teledyne Isco Ready, you will need to define the sonde's data values.

When you select the address of the sonde you want to set up (see screens in the margin), the company model and other information will be displayed along with the number of data values the sonde has.

When you advance to the next screen (see #3 below), the data types will be listed as "OTHER" because you have not defined them yet. Move between the data types using the arrow keys. Select one to change by pressing ↵.

A list of possible parameters will be displayed (see #4 below). Use the arrow keys to move through the options. When the one you want is blinking, press ↵. Repeat the process until you have defined all of the data parameters for your sonde.

Use the arrow key to move to "DONE" and press ↵. You will then be asked if you want to store the parameter data.

Connecting Other SDI-12 Sondes

3
```
SELECT ADDRESS OF
SONDE TO SETUP:
__ __ DONE
```

- Select the address of the sonde you want to set up.

4
```
Company Model
Optional Information
SONDE AT ADDRESS __
HAS __ DATA VALUES
```

- You can wait a few seconds, or press ↵ to advance to the next screen:

5
```
DATA FROM SONDE __
 1 = OTHER
 2 = OTHER
 3 = OTHER              --->
```

- Press an arrow key until the cursor is on the data you want to identify. Then, press ↵. A scrolling screen listing possible parameters will appear.

6
```
    SONDE ___ ,   DATA 1:
<--  pH
    TEMPERATURE (ºC)
    TEMPERATURE (ºF)   --->
```

- Make your selection and press ↵.

3
```
    DATA FROM SONDE __
<--  1 = TEMPERATURE(ºC)
     2 = OTHER
     3 = OTHER              --->
```

- Repeat the process until you have defined all the data. Press "DONE" when finished.

4
```
    DATA FROM SONDE __
<---  4 = pH
      5 = LEVEL
          DONE
```

- You will then be asked if you want to store the parameter data. Refer to "SONDE SETUP - STORING PARAMETER DATA" in the following paragraphs.

6.5 Sonde Setup - Storing Parameter Data

Whether you are using a Teledyne Isco Ready sonde or other SDI-12 compatible sonde, you will need to tell the 6712 if you want to store all of the parameter data or data from selected parameters.

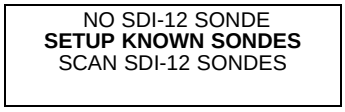
Data is stored in memory partitions. A fixed amount of memory is available to store data. If you are using some parameters to simply trigger an event or enable condition, it is not necessary to store the data.

If **all** of the parameters' data will fit in memory, you will be asked if you want to store all of the parameter data. Answering "NO" will still allow you to selectively store parameter data; otherwise, all data will be stored.

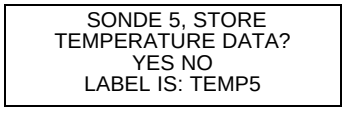
You will be asked to store parameter data during the setup process. You can also manually change the setup using options in the Hardware menu.

To access the setup option in the Hardware menu, select Other Function from the main menu, then choose Hardware. Advance through the screens until you see one that displays SDI-12 DATA.

Select this screen to display the following:



Select "SETUP KNOWN SONDES" and then indicate the address of the sonde you want to setup. A screen containing the sonde model and number of data values will appear briefly. Then you will be asked to verify, parameter by parameter, what data you want to store. The screens will look similar to the one below:



Indicate if you want to store the data for that particular parameter and then advance through the rest of the parameter screens. Once you have defined your data storage options, select "DONE."

You will be prompted that you have entered a new hardware setup and asked if you want to erase the stored data. Indicate "YES" or "NO." A partition memory status message will be displayed and (if a parameter exists that can be calibrated) you will then advance to the calibration screen (refer to "SONDE CALIBRATION AND VALIDATION" on this page). If you do not want to calibrate or validate, select "DONE" to return to the Hardware Options screens.

6.6 Sonde Calibration and Validation

It is recommended that calibration of your sonde be done in the lab, according to manufacturer's recommendations. However, for your convenience, the 6712 allows for field calibration of pH, Dissolved Oxygen (DO), and Oxidation Reduction Potential (ORP).

Field calibrations are stored in the sampler, NOT the sonde, and are used to modify readings from the sonde until a new sonde is connected. When a sonde is moved to another sampler, it will retain calibration constants set in the lab, but will not retain any that were set in the field.

Although field calibration is limited to three parameters, you can validate any of the available parameters. Validation allows you to immerse the sonde in a known solution, note the readings, and see if the sonde is functioning properly. The validation process does not modify any readings like calibration does; it merely alerts you to inaccurate ones.

No data will be stored, nor will enable conditions be updated, while calibrations or validations are being performed.

6.6.1 The Calibration Screens

To access the calibration screens from the main menu, select Other Functions, Hardware. Advance through the screens until you see one that displays "SDI-12 DATA." Select this screen to display the following:

```
NO SDI-12 SONDE
SETUP KNOWN SONDES
SCAN SDI-12 SONDES
```

Select "SETUP KNOWN SONDES" and then select "DONE." You will see a screen similar to the following that will list the parameters you can calibrate.

```
SELECT PARAMETER
TO CALIBRATE:
pH5 DO5 ORP5 DONE
```

The sonde's address will appear after the parameter (such as pH0 and pH5). If you have multiple sondes attached, use the arrow key to select the correct one to calibrate.

Depending upon the parameter you selected, a series of screens will be displayed to step you through the calibration process.

- pH - You will be given the choice of three different pH solutions: 4.00, 7.00, and 10.00. After making your selection, rinse the probe and place in the pH buffer. If the reading is off by more than 0.5 pH units, you will asked to verify if the reading is correct.
- DO - For dissolved oxygen, you can choose between two methods: DO Standard and Saturation. The saturation method requires a temperature reading between 0.0° and 47.0° C. You will also need to enter your altitude and barometric pressure.
- ORP - You will asked to enter the value of your calibration standard.

When calibration is complete, select "DONE" to proceed to the validation screen. If you do not want to validate any parameters, select "DONE" again to return to the Hardware options screens.

6.6.2 The Validation Screen

The validation screen appears after you select "DONE" on the calibration screen. It will be similar to the screen shown below.

```
SELECT PARAMETER
TO VALIDATE:
<--    SAL5   05DATA5  DO5
  ORP5   LEVEL5        -->
```

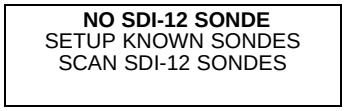
Use the arrow keys to select the desired parameter to validate. Any parameter can be validated. You will be prompted to place the probe in your validation standard. When stable, press ↵. The reading will be displayed at the bottom of the screen.

When you are done validating, select "DONE" to return to the Hardware options screens.

6.7 Disconnecting Sondes

When you have disconnected all sondes, and have interrogated the sampler for all its data, you can indicate that there is no SDI-12 sonde.

From the main menu, select Other Functions, Hardware. Advance through the screens until you see one that displays "SDI-12 DATA." Select this screen to display the following:



Select "NO SDI-12 SONDE." You will advised that you have a new hardware setup:

If you have collected all the data, select "DONE." A partition memory message will be displayed briefly, and you will be returned to the Hardware options screens.

If you do not have a sonde attached, you may want to turn off automatic scanning for sondes. This will eliminate the time taken to scan for sondes whenever the sampler is turned on.

6712 Portable Sampler

Section 7 Remote Operation

The 6712 controller can be operated remotely from external devices. External controlling devices may be a computer via RS-232 serial communications or a telephone via touch-tone commands. Remote telephone operation requires the factory-installed 2400 baud talking modem.

7.1 Computer Operation

The 6712 controller can be operated from a remote location using a computer. There are two different levels of computer control. One level—menu control—is used to start and stop the current sampler program (or programs if in Extended programming mode) and to access other menu commands. This level of remote operation relies on the sampler program for much of its capabilities.

The second level—external program control—relies on external programmatic control to drive the operation of the sampler. The external controller can turn on the sampler, take a sample, and request sampler status data. When under external program control, the sampler controller program and current operation state are ignored. The pump, distributor, and serial data output simply respond to the external commands.

Each level of operation is discussed in the following sections. However, before using either level of control you must first establish RS-232 serial communication between the computer and the 6712 controller. To do so:

1. Connect your computer to the 6712 controller's interrogator connector with a standard interrogator cable, P/N 60-2544-044 (for 9-pin serial ports).
2. Configure your communications software (HyperTerminal, for example) for:
   - a baud rate no higher than 19,200
   - no parity
   - 8 data bits
   - 1 stop bit
   - VT100 terminal emulation.
3. Using your communications software, connect to the sampler. Press "?" on the computer keyboard until the sampler returns its banner string. A ">" prompt will appear on the screen when it is ready to accept commands.

7.1.1 Menu Control

Menu commands can be entered from a remote location using a computer. The menu commands are listed in Table 7-1.

To access the menu commands, type MENU at the ">" prompt and press ENTER. The screen will return a list of the available options. Note that the current state of the controller will determine the available menu options. Then, type the desired command(s), confirming with ENTER.

Table 7-1 6712 Remote Menu Commands

Menu Command	Description
0 or START	This command will start immediately any program that has been run and is currently waiting to start.
1 or RUN1	This command will load Program 1 as the sampler's current Extended program, reset partition if the storage interval has been changed, and run the program. RUN1 is valid when the sampler is in standby, or when it is waiting for a start command. RUN1 will also run the current program while in Standard programming.
2 or RUN2 3 or RUN3 4 or RUN4	These commands will load the selected program number as the sampler's current Extended program, reset partition data if the storage interval has changed, and run the program. They are valid when the sampler is in standby, or when it is waiting for a start command. The commands are available for Extended programming only.
5 or DISABLE	This command is similar in functionality to a pin F low signal (a signal typically used to enable or disable the sampler from a flow meter). At run time, the sampler starts with the sampler in the enabled state. DISABLE is valid while a program is running. If successful, a display of REMOTE ENABLE IS FALSE will be returned. A Remote Disable is the highest priority disable. If the sample is disabled with this command, no condition other than menu command 6, ENABLE, will allow the program to become enabled again.
6 or ENABLE	This command is used to re-enable a disabled sampler. ENABLE is valid while a program is running. If successful, a display of REMOTE ENABLE IS TRUE will be returned.
7 or TAKE_SAMPLE	This command causes the sampler currently running a program to take a sample. The sample will count as one of the program's samples and is placed in the current bottle (Part A's current bottle when using two-part programming). TAKE_SAMPLE is valid while the program is running, after the start time, but not while in the MANUAL PAUSE screens. If successful, a response similar to PUMPING XXML SAMPLE INTO BOTTLE ## will be returned. If not, a response similar to NO SAMPLE, PROGRAM WAITING START will be returned.
ST or STATUS	This command causes the sampler to return its status information and current parameter data.
SD or SCREEN_DUMP	This command causes the sampler to return the information currently displayed on the sampler's screen. The remote screen follows the sampler's display as the information is updated. This mode can be used to observe from a remote location while the sampler is programmed on-site.
P or PAUSE	This command causes a sampler currently running a program to enter the MANUAL PAUSE menu. While you are connected in this mode, the sampler keypad becomes disabled, and your computer's keypad will be redirected to simulate the sampler keypad. The following keys will be activated: <Enter>, decimal point, and number keys. <Esc>, S, or s = STOP. <Backspace>, L or l, and U or u = Left/Up arrows. R or r, and D or d = Right/Down arrows.

> **Note**
>
> You can retrieve the sampling reports at any time using the same serial connection. Type "Q" to exit the menu. Then at the > prompt, type "REPORT" and press Enter. The sampler controller will send reports as configured.

7.1.2 External Program Control

Under external program control, the pump and distributor operate according to received commands. An external program can be as simple as manually-entered commands to collect a sample when needed, or as complex as a user-developed process control program that directs sample collection according a system's needs.

The 6712 controller will respond to four commands:

Turn on the sampler – If the sampler is OFF, the sampler responds by placing itself in the ON state and returning a status string to report the new status. (See *Send Status* for a description of this string.)

The command to turn the sampler ON is:

```
STS,2
```

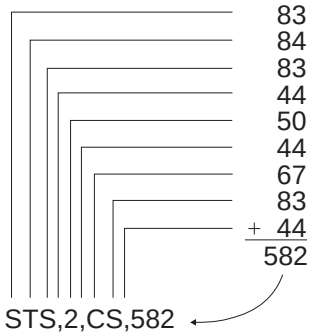
Note that commands and responses are comma-separated pairs. The first set of alpha-characters are an identifier; the second set of numeric characters indicate the value. The 6712 controller will not receive and process the command unless it is followed by a carriage return.

Checksum optional

Optionally, commands to the sampler can be validated using a checksum. Checksum validation can avoid problems caused by faulty program control or communication lines. When using the checksum, add the CS identifier and a comma at the end of the command. and the checksum value of the string up to the last comma. For example, the command with checksum validation to turn the sampler on would appear as:

```
STS,2,CS,582
```

The numeric value of each character is its ASCII equivalent expressed in decimal format. The checksum of "582" was calculated as shown below.



Take a Sample – This directs the sampler to take a sample. The command specifies how much volume to take, and which bottle to place the sample in. The sampler responds by taking a sample and returning a status string that reports the new status. A command to take a sample would appear as:

BTL,2,SVO,100,CS,1039

This example instructs the sampler to place the distributor arm over bottle 2 (BTL,2) and take a 100 ml sample (SVO,100).

While most settings of the sampler program (start times, enables, distribution schemes, etc.) are ignored when responding to external commands, the sampler does rely on two program settings that "configure" the sampler. These settings are:

- Number of Bottles–is used to determine the distributor arm position and the acceptable range for the BTL values.
- Suction Line Length–Used with liquid detection to deliver correct sample volumes according to the SVO value.

Send Status – When receiving this command, the sampler returns a data string that identifies the controller and lists its current status.

The status is received as pairs of comma-separated identifiers and values. A complete description of each pair is listed below.

MO,6712, is the model number of the sampler.

ID,2424741493, is the sampler's unique ID number.

TI,35523.50000, is the sampler's current time.

STS,1, is the sampler's current status. The possible states are:

1 = WAITING TO SAMPLE.

4 = POWER FAILED (for short time after power is restored).

5 = PUMP JAMMED (must be resolved before continuing).

6 = DISTRIBUTOR JAMMED (must be resolved before continuing).

9 = SAMPLER OFF.

12 = SAMPLE IN PROGRESS.

20 = INVALID COMMAND. Possible causes may be:

· identifier code is not supported.

· bottle requested is not in current configuration

· sample volume requested is outside its range (10 - 9990 ml)

· day (Set_Time) must be 5 digits and more recent than 1977

21 = CHECKSUM MISMATCH.

22 = INVALID BOTTLE. (bottle requested is not in the current configuration)

23 = VOLUME OUT OF RANGE. (the sample volume requested is outside its range (10-9990 ml)

STI,35523.41875, is the most recent sample time.

BTL,2, is the bottle receiving the most recent sample.

SVO,100, is the most recent sample's volume.

SOR,0, is the results of attempting the most recent sample. The possible results are:

- 0 = SAMPLE OK.
- 1 = NO LIQUID FOUND.
- 2 = LIQUID LOST (not enough liquid to satisfy requirements.)
- 3 = USER STOPPED (using the Stop Key).
- 4 = POWER FAILED.
- 5 = PUMP JAMMED.
- 6 = DISTRIBUTOR JAMMED.
- 8 = PUMP LATCH OPEN.
- 9 = SAMPLER SHUT OFF (while sampling).
- 11 = NO DISTRIBUTOR.
- 12 = SAMPLE IN PROGRESS.

CS,xxxx is the byte-by-byte sum of the entire string "MO,...,CS,"

Note

For commands that are not understood (INVALID COMMAND or CHECKSUM MISMATCH) or when no samples have been taken, the most recent bottle information is left off the response string.

Send Data – When receiving this command, the sampler returns the Send Status appended with data from any module, rain gauge, or SDI-12 device. Refer to Table 7-2 to interpret the returned string.

Table 7 2 Serial Data Codes

Identifier	Parameter	Units
B?[1]	Bottle number and time	days since 1-Jan-1900
CR	Current day's rain	tips[2]
CS[3]	Checksum	unsigned long
DE	Description	6712 Sampler
FL	Flow	cubic meters per second
ID	Unit specific identifier	10 digit unsigned long
LE	Level	meters
MO	Model	6712

Table 7-2 Serial Data Codes (Continued)

Identifier	Parameter	Units
PE	Percent	percent of full scale
PH	pH	none
PR	Previous day's rain	tips[2]
RA	Rain	tips[2]
RTE	Refrigerator Temperature	degrees celsius
SS	Sampler enable state	logical
TE	Temperature	degrees celsius
TI	Current time	days since 1-Jan-1900
VE	Velocity	meters per second
VO	Volume	cubic meters
VSI	Velocity signal strength	percent
VSP	Velocity spectrum strength	percent
CO_ [4]	Conductivity	milliseimens per centimeter
DO_ [4]	Dissolved oxygen	milligrams per liter
PH_ [4]	pH	none
SA_ [4]	Salinity	parts per thousand
SP_ [4]	Specific Conductance	milliseimens per centimeter
TD_ [4]	Total Dissolved Solids	grams per liter
TE_ [4]	Temperature	degrees Celsius
OR_ [4]	Oxidation reduction potential	millivolts
LE_ [4]	Level	meters
MM_ [4]	Ammonium-nitrogen	milligrams nitrogen per liter
MA_ [4]	Ammonia-nitrogen	milligrams nitrogen per liter
NI_ [4]	Nitrate-Nitrogen	milligrams nitrogen per liter
TB_ [4]	Turbidity	nephelometric turbidity units
CL_ [4]	Chloride	milligrams per liter
CP_ [4]	Chlorophyll	micrograms per liter
FL_ [4]	Flow rate	cubic meters per second
VO_ [4]	Flow volume	cubic meters

Table 7-2 Serial Data Codes (Continued)

Identifier	Parameter	Units
xxD_ [4, 5]	Other data not listed above	

[1] The three most recent samples will have entries as B?. The "?" will be the first bottle number in the set. If the sample is a grab sample, it will be shown as B0.

[2] Rainfall tips roll over every 256 counts.

[3] The checksum does not include the checksum, carriage return, and linefeed. The string is terminated with <CR><LF>.

[4] A "_" in the identifier indicates an SDI-12 address.

[5] "xx" matches the data label for the SDI-12 parameter.

7.1.3 Remote Control of Sampler Keypad

To control the sampler keypad remotely, type CONTROL at the ">" prompt and press ENTER. The sampler display is mirrored on your computer monitor as you step through the programming screens. While in this mode, the computer keys will be redirected to simulate the sampler's keypad, which will be disabled to avoid any conflict. The active keys and their corresponding functions are given in Table 7-3.

Table 7-3 Remote Control of Sampler Keypad

Computer	Sampler
<Esc>, S, s	STOP
L,l,U,u, <Backspace>	Left / Up
R, r, D, d	Right / Down
O, o	ON
<Enter>, arrows, decimal, numbers	Same
You will not be able to turn the sampler off remotely.	

7.2 Telephone Commands

6712 controllers equipped with an internal voice modem can be operated using telephone commands. This factory-installed option includes a 12 ft (3.6 m) modem cable.

After connecting to the sampler from a touch-tone telephone, command numbers may be entered from the telephone's keypad, followed by the [#] (pound) button. The commands are listed in Table 7-4.

To use telephone commands:

1. Dial the sampler's telephone number. When the sampler connects, it answers with "Teledyne Isco Sampler Site [number]." If the sampler does not receive a touch-tone command in five seconds, it assumes that a computer modem has called and initiates the modem connect sequence. If this occurs you must hang up and try again.
2. Enter the command. For example, to run program 1, press [1] [#].

3. If the command is valid for its current state of operation, the sampler responds with "[command number], please acknowledge." If the command is not valid the sampler responds with the command number followed by three quick beeps. Enter a valid command.
4. Acknowledge the valid command by pressing the number. For the example, press [1].
5. If the number is incorrect, the sampler responds with your entry followed by three quick beeps. You must re-enter the command (step 2).
6. After the command is confirmed, the sampler replies with "[command number] acknowledge" and executes the command.

To enter additional commands, repeat steps two through five. The sampler will hang up after ten seconds of quiet time.

Table 7-4 6712 Remote Commands

Phone Command	Name	Description
[0] [#]	Start	This command will start immediately any program that has been run and is currently waiting to start.
[1] [#]	Load and Run Program 1	This command will load Program 1 as the sampler's current Extended program, reset partition if the storage interval has been changed, and run the program. RUN1 is valid when the sampler is in standby, or when it is waiting for a start command. RUN1 will also run the current program while in Standard programming.
[2] [#] [3] [#] [4] [#]	Load and Run Program 2, 3, or 4	These commands will load the selected program number as the sampler's current Extended program, reset partition data if the storage interval has changed, and run the program. They are valid when the sampler is in standby, or when it is waiting for a start command. The commands are available for Extended programming only.
[5] [#]	Disable	This command is similar in functionality to a pin F low signal (a signal typically used to enable or disable the sampler from a flow meter). At run time, the sampler starts with the phone enable in the enabled state. PHONE DISABLE is valid while a program is running. If successful, a reply of REMOTE ENABLE IS FALSE will be returned. A Remote Disable is the highest priority disable. If the sample is disabled with this command, no condition other than command 6#, ENABLE, will allow the program to become enabled again.
[6] [#]	Enable	This command is used to re-enable a phone-disabled sampler. PHONE ENABLE is valid while a program is running. If successful, a reply of REMOTE ENABLE IS TRUE will be returned.
[7] [#]	Grab Sample	This command causes the sampler currently running a program to take a sample. The sample will count as one of the program's samples and is placed in the current bottle (Part A's current bottle when using two-part programming). TAKE_SAMPLE is valid while the program is running, after the start time, but not while in the MANUAL PAUSE screens. If successful, a response similar to PUMPING XXML SAMPLE INTO BOTTLE ## will be returned. If not, a response similar to NO SAMPLE, PROGRAM WAITING START will be returned.

6712 Portable Sampler

Section 8 Maintenance

This section describes how to maintain and troubleshoot your 6712 sampler. If you think your unit requires repair, or if you have questions concerning its operation or maintenance, contact Teledyne Isco's Technical Service Department:

Phone: (800) 228-4373
(402) 464-0231
FAX: (402) 465-3022

E-mail: IscoService@teledyne.com

8.1 Maintenance Checklist

- Inspect the pump tube for wear. Replace it if necessary.
- Clean the pump tubing housing.
- Change the suction line if necessary.
- Clean the bottles, suction line, strainer and pump tube.
- Check the humidity indicator.
- Check the controller's internal battery status and replace the battery every five years.
- If the keypad label has bubbles under it, the air inside the controller has expanded. To release this pressure, unscrew the flow meter cable or connector cap on the back of the controller. Push down on the label to force the air out, then re-tighten the cable connector or cap.

8.2 Cleaning Guidelines

8.2.1 Controller, Top Cover, Center Section, Retaining Ring, and Tub

Clean the top cover, center section, retaining ring, and tub with warm soapy water or by spraying them with a hose. Avoid using a high-pressure hose to clean the controller, especially around the control panel. Extreme pressures may force water past the control-panel seal.

When cleaning the controller and top cover, cap the connectors at the back of the controller tightly. Keep a power source connected to the power-source connector, or replace the protective cap (shipped with the sampler) over the power source connector, to protect the pins from moisture damage. Make sure the two pump drain holes (located on the bottom right-hand side of the pump, beneath the pump band) are open and free of debris or buildup.

8.2.2 Sample Bottles

The sample bottles have a wide mouth to facilitate cleaning. Wash them with a brush and soapy water, or use a dishwasher. You can autoclave the glass bottles.

8.2.3 Suction Line, Pump Tube, and Discharge Tube

Clean the suction line, pump tube, and discharge tube by placing the end of the suction line in a cleaning solution and pumping it through the delivery system. Rinse with clean water. If these items are severely contaminated, discard them. For critical sampling applications, refer to the following sections.

8.2.4 Strainer

Clean the strainer with a brush and soapy water.

8.3 Cleaning Protocols for Priority Pollutants

Clean sampling equipment is essential for valid laboratory analysis. Teledyne Isco recommends that you develop cleaning protocols in consultation with a laboratory analyst when designing the monitoring program. For example, to clean sample bottles, suction line, and pump tubes, Lair (1974) suggests these protocols used by USEPA Region IV Surveillance and Analysis field personnel engaged in NPDES compliance monitoring. The protocols are based on U.S. Environmental Protection Agency Publications EPA-600/4-77-039 (*Sampling of Water and Wastewater* by Dr. Phillip E. Shelley).

8.3.1 Teledyne Isco Glass Sample Bottles

1. One spectro-grade acetone rinse.
2. Dishwasher cycle (wash and tap water rinse, no detergent).
3. Acid wash with at least 20 percent hydrochloric acid.
4. Dishwasher cycle (wash and tap water rinse, no detergent).
5. Replace in covered Teledyne Isco tubs.

8.3.2 Vinyl Suction Line

- Use new suction line for each new sampling setup, therefore, no cleaning is required.
- Use Teflon suction line when sampling for organic compounds.

8.3.3 Teflon Suction Line

1. Rinse twice with spectro-grade acetone.
2. Rinse thoroughly with hot tap water using a brush, if possible, to remove particulate matter and surface film.
3. Rinse thoroughly three times with tap water.
4. Acid wash with at least 20 percent hydrochloric acid.
5. Rinse thoroughly three times with tap water.
6. Rinse thoroughly three times with distilled water.
7. Rinse thoroughly with petroleum ether and dry by pulling air through the line.
8. Dry overnight in a warm oven (use an oven temperature of lower than 150° F), if possible.
9. Cap ends with aluminum foil.

8.3.4 Teledyne Isco Pump Tube

1. Rinse by pumping hot tap water through the tube for at least 2 minutes.
2. Acid wash the tube by pumping at least a 20 percent solution of hydrochloric acid through the tube for at least 2 minutes.

3. Rinse by pumping hot tap water through the tube for at least 2 minutes.
4. Rinse by pumping distilled water through the tube for at least 2 minutes.

> **Note**
>
> For critical sampling applications, consider replacing the suction line, pump tube, and discharge tube. Replacement eliminates the possibility of any cross contamination from previous sampling sites.

8.4 Maintenance Screens

When you select OTHER FUNCTIONS from the main menu, and then select Maintenance, the following screen will be displayed:

```
SET CLOCK
PUMP TUBE ALARM
INTERNAL BATTERY
DIAGNOSTICS
```

Using these options, you can set the sampler's time and date, set the number of pump counts for the pump tube warning, reset the battery warning for the internal battery, and run a set of diagnostic tests for troubleshooting purposes.

8.4.1 Set Clock

Entering Times and Dates

```
ENTER TIME AND DATE:
HH:MM   DD-MON-YY
__:__   __-__-__
```

- Move from one field to another by pressing the arrow keys.
- Change a setting in a field by typing a number. Press ↵ to accept the new setting.

Teledyne Isco ships samplers from the factory with the clocks set to the correct Central Standard Time. Reset the clock when installing the sampler in a different time zone, for daylight savings time, or when needed.

When setting the clock and calendar, use a 24-hour clock for times and the day-month-year format for dates. The illustration at the left shows blanks for each position that accepts an entry. The positions are called fields. When this screen appears on your sampler, the fields will contain the sampler's current settings for the time and date.

- To move from one field to another without changing the setting, press the arrow keys. Use this technique when you want to change only one or two settings.
- Change the setting by typing a new number. Press ↵ to accept the new setting.

For example, to enter 2:00 p.m. (2:00 p.m is 14:00 on a 24-hour clock), type 14. Press ↵. Next, type 0 (zero) for the minutes, and press ↵. To enter a date, such as January 22, 2001, type: 22 ↵ 01 ↵ 01 ↵ .

Table 8-1 Setting the Clock and Calendar

1	RUN PROGRAM VIEW REPORT **OTHER FUNCTIONS**	Select OTHER FUNCTIONS.
2	**MAINTENANCE** MANUAL FUNCTIONS PROGRAMMING STYLE	Select MAINTENANCE.
3	**SET CLOCK** PUMP TUBE ALARM INTERNAL BATTERY DIAGNOSTICS	Select SET CLOCK.
4	ENTER TIME AND DATE: HH:MM DD-MON-YY **14:00 22-JAN-01**	Enter the time and date.
5	SET CLOCK PUMP TUBE ALARM INTERNAL BATTERY DIAGNOSTICS	Press STOP to return to the main menu.

8.4.2 Pump Tube Alarm

The sampler tracks the pump counts in both the forward and reverse cycles with a resettable counter. When the counter reaches the default count of 1,000,000 or the count you have entered, the sampler displays a message, "WARNING! REPLACE PUMP TUBE." The message appears each time you turn the sampler on or run a program until you reset the counter.

After replacing the pump tube (see page 8-8), reset the count to zero so the sampler can begin tallying the pump counts for the new tube. Replacing the pump tube does not reset the counter.

Experience may suggest a significantly different pump tube life. You can change the alarm count to represent the pump tube life for your application. The example below shows how to set the alarm count and reset the pump counts.

Table 8-2 Resetting the Pump Counter

1	RUN PROGRAM VIEW REPORT **OTHER FUNCTIONS**	Select OTHER FUNCTIONS.
2	**MAINTENANCE** MANUAL FUNCTIONS PROGRAMMING STYLE HARDWARE	Select MAINTENANCE.
3	SET CLOCK **PUMP TUBE ALARM** INTERNAL BATTERY DIAGNOSTICS	Select PUMP TUBE ALARM.
4	1024000 PUMP COUNTS, WARNING AT 1000000	The sampler displays this screen briefly to give you the current pump-count information. The first line shows you the pump counts tallied since the counter was last reset. The second line shows the current alarm setting.
5	1024000 PUMP COUNTS, RESET PUMP COUNTER? **YES** NO	To reset the counter to zero, select YES. Always reset the counter after replacing a pump tube. Select NO when merely checking the current count.
6	WARNING AT **10**00000 PUMP COUNTS (1 - 99)00000)	If necessary, change the pump-count alarm setting by typing the first two digits of the new setting. The sampler accepts entries between 1 and 99. For example, to increase the count to 1,500,000, enter 15.
7	SET CLOCK PUMP TUBE ALARM INTERNAL BATTERY DIAGNOSTICS	Press STOP to return to the main menu.

8.4.3 Internal Battery Warning

The internal lithium battery preserves the sampler's memory when power is removed. For an explanation of how to replace the lithium battery, go to Section 8.8.

Table 8-3 Checking and Replacing the Internal Battery

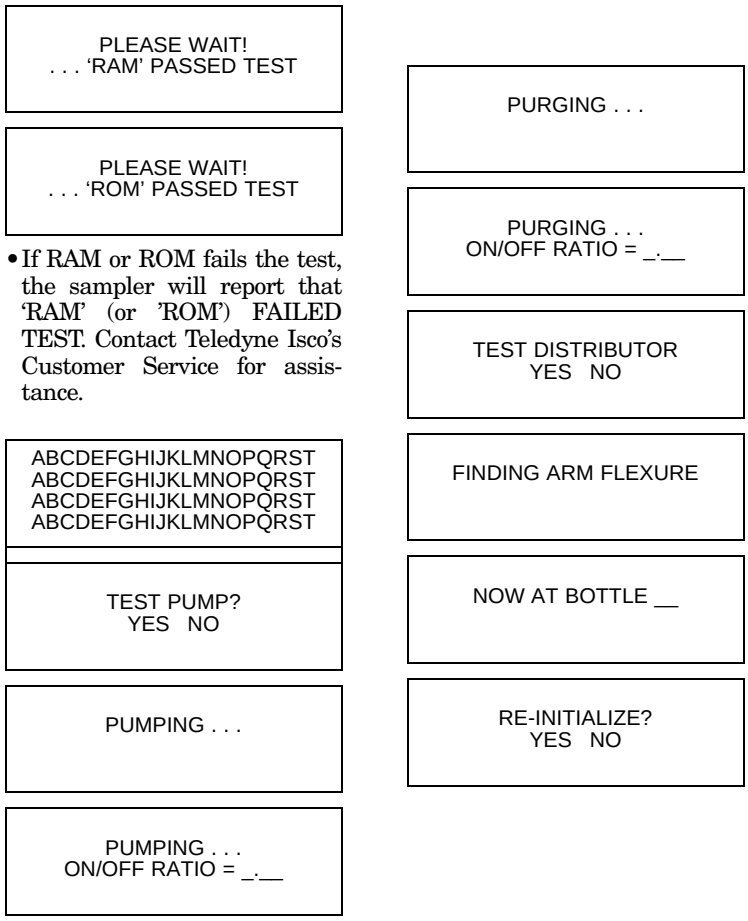
1	RUN PROGRAM VIEW REPORT **OTHER FUNCTIONS**	Select OTHER FUNCTIONS.
2	**MAINTENANCE** MANUAL FUNCTIONS PROGRAMMING STYLE HARDWARE	Select MAINTENANCE.
3	SET CLOCK PUMP TUBE ALARM **INTERNAL BATTERY** DIAGNOSTICS	Select INTERNAL BATTERY.
4	WARNING! REPLACE INTERNAL BATTERY BEFORE 17-OCT-97	The sampler displays this screen briefly to show you the expiration date.
5	DID YOU REPLACE THE INTERNAL BATTERY? YES NO	After replacing the battery, select YES. Select NO only if checking the expiration date. Resetting the alarm directs the sampler to calculate a new expiration date, five years in the future. If you reset the alarm without replacing the battery, the sampler will not be able to alert you to the battery's impending expiration.
6	SET CLOCK PUMP TUBE ALARM INTERNAL BATTERY DIAGNOSTICS	Press STOP to return to the main menu.

8.4.4 Diagnostics

The sampler has several self-diagnostic tests that check the memory (both the RAM and ROM), pump, and the distributor arm position. It also contains screens that let you reset the sampler's program settings and memory to factory settings.

You do not need to run the diagnostic tests on a routine basis. The diagnostic tests are a troubleshooting tool; Teledyne Isco's Customer Service department staff may ask you to run these tests when they work with you in diagnosing problems with your sampler.

Access the diagnostic screens by selecting Other Functions from the main menu, then Maintenance, and Diagnostics. The unit will automatically test the memory and display; you can choose whether it tests the pump and distributor, and whether it reinitializes the unit to its original factory settings.



- If RAM or ROM fails the test, the sampler will report that 'RAM' (or 'ROM') FAILED TEST. Contact Teledyne Isco's Customer Service for assistance.

Memory Test – Screens 1 and 2 at left show you the diagnostic tests for the unit's memory. If either screen shows you a message saying that the memory failed the test, contact Teledyne Isco's Customer Service.

Display Test – Screen 3 shows you the display test. You should see the test pattern illustrated in the screen. If the pattern does not match the illustration, the display or its circuitry require repair.

Pump Test – Screen 4 lets you start the pump test by selecting YES. As the sampler runs the test, it first runs the pump forward for a short period. Next, it displays an ON/OFF ratio number. After displaying the forward pumping ratio, the sampler reverses the pump to obtain a purge ratio. The acceptable range is between 0.80 and 1.25. If either ratio is outside the acceptable range, the pump requires repair. You do not need to pump liquid while running the test, and you can run the test with or without a tube in the pump.

⚠ CAUTION

Tests indicate that the pump produces sound levels in excess of 85db at one meter. Prolonged exposure to this sound level could result in hearing loss and requires the use of protective ear plugs.

Distributor Test – The distributor test is provided for factory personnel to verify the distributor's position as it rotates through the 24 positions. (screens 9 through 11). The distributor arm flexes slightly when it contacts the stop, and the sampler measures this flexure. The sampler uses this measurement to position the arm accurately over each bottle.

Reinitialize Controller – The sampler allows you to reset all the program settings to the settings shipped with the sampler (screen 12). Reinitializing also clears the memory that stores the sampler's event log and module data. **Use this option cautiously.**

8.5 Replacing the Pump Tube

Replace the pump tube only with Teledyne Isco's 6712 pump tubing. **Other pump tubes will not work**. The 6712 pump tubing is easily recognized by the blue alignment collars.

Improper pump tubes include those made for Teledyne Isco's other samplers (3700, GLS, etc.) and tubing from non-Teledyne Isco vendors. Also note that the discharge tube is not the same as the pump tube. You could experience several problems if you install the wrong pump tubing:

- The sampler will not pump the liquid.
- Pump jams
- Inaccurate sample volumes
- Faulty liquid detection

Inspect the pump tube periodically. Replace the tube when it cracks or appears worn. Inspect the tube frequently when the sample liquid contains a high percentage of suspended or abrasive solids.

☑ *Note*

The importance of regular tubing replacement cannot be overstated. The key is to replace the tube before failure, not after. When a pump tube ruptures, grit and other abrasive debris can be driven into the pump shaft seal. Over time, this abrasive material will degrade the pump seal, jeopardizing the NEMA 4x 6 rating of the controller.

Failure to maintain the pump tube may result in permanent damage to the sampler. Check the condition of the pump tube regularly and if the tube shows signs of fatigue or wear, replace it immediately. A properly maintained sampler will provide the years of reliable service that is expected of a Teledyne Isco Sampler.

8.5.1 Checklist For Replacing Pump Tube

1. Disconnect power from the sampler.

⚠ WARNING

The pump's safety lock prevents the sampler from running the pump when the pump band is open. DO NOT tamper with the safety mechanism. The pump is extremely powerful. The pump rollers can injure you severely if the sampler activates the pump while you are working on it or inside it. Disconnect power from the sampler before replacing the pump tube.

2. Loosen the liquid detector's cover by unscrewing the black knob on top of the detector. Unlatch the pump band. (The band is the rounded metal band that holds the tube in the pump.)
3. Pull the tube away from the bulkhead fitting. Pull it from the pump and detector.
4. Clean the pump rollers and the inside of the pump band.
5. Thread the new tubing through the pump so that the tube follows its natural curve around the pump rollers. You may need to move the pump rollers to make the installation easier.
6. The blue collars on the tube help align the tube in the detector and pump. Align the tube by placing the collars in the grooves inside the liquid detector.
7. Close the detector's cover and tighten the black knob. Close the pump strap and latch it.
8. Reset the pump-tube counter. (See example in table 8-2.)
9. Take a "dry" grab sample to test the tube installation.

☑ *Note*

To extend the pump tube life:

• Always use Teledyne Isco pump tubes.

• Install the tube properly, aligning the blue collars correctly in the liquid detector's grooves.

• Follow the natural curve of the tube when wrapping the tube around the pump rollers.

• Minimize the line rinses and sampling retries in the sampling programs

• Use the shortest possible suction line.

Conditions that shorten tube life:

• Improper installation.

• Abrasive materials suspended in sample liquid.

• Frequent line rinses.

• Long purge cycles, such as those used with long suction lines.

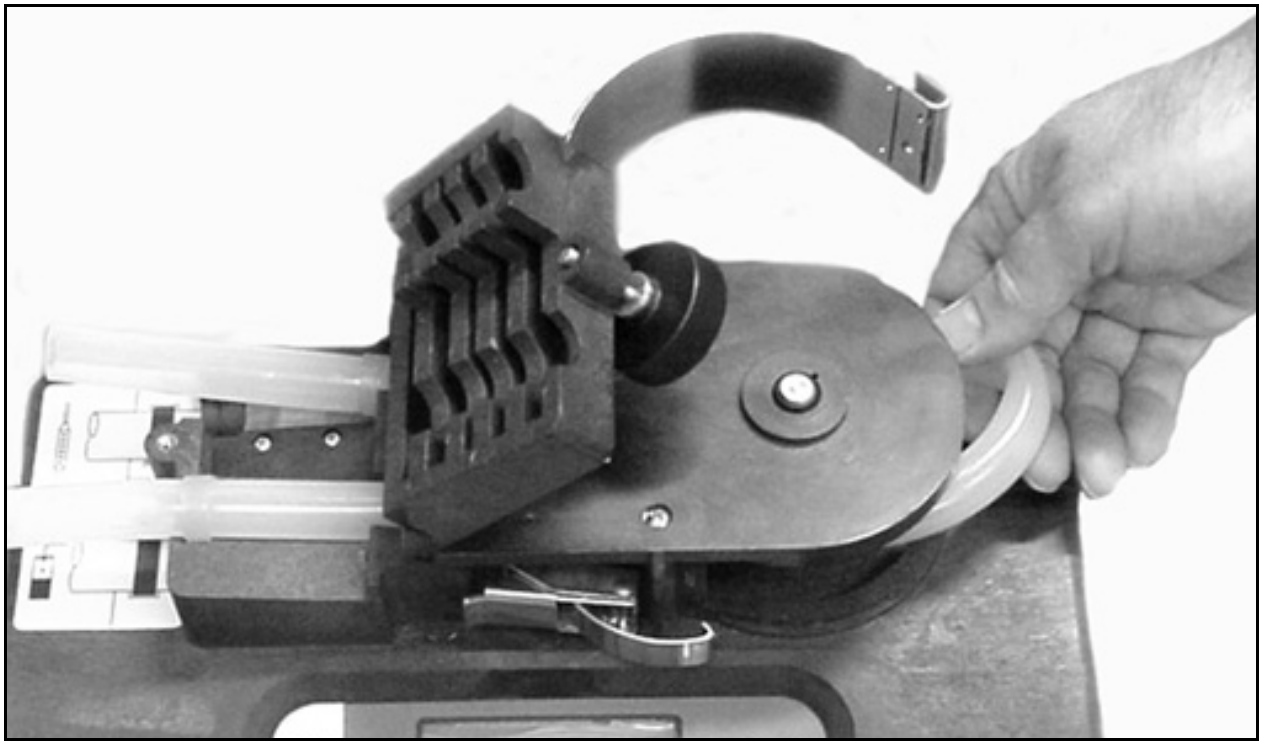


Figure 8-1 Removing and Replacing the Pump Tube

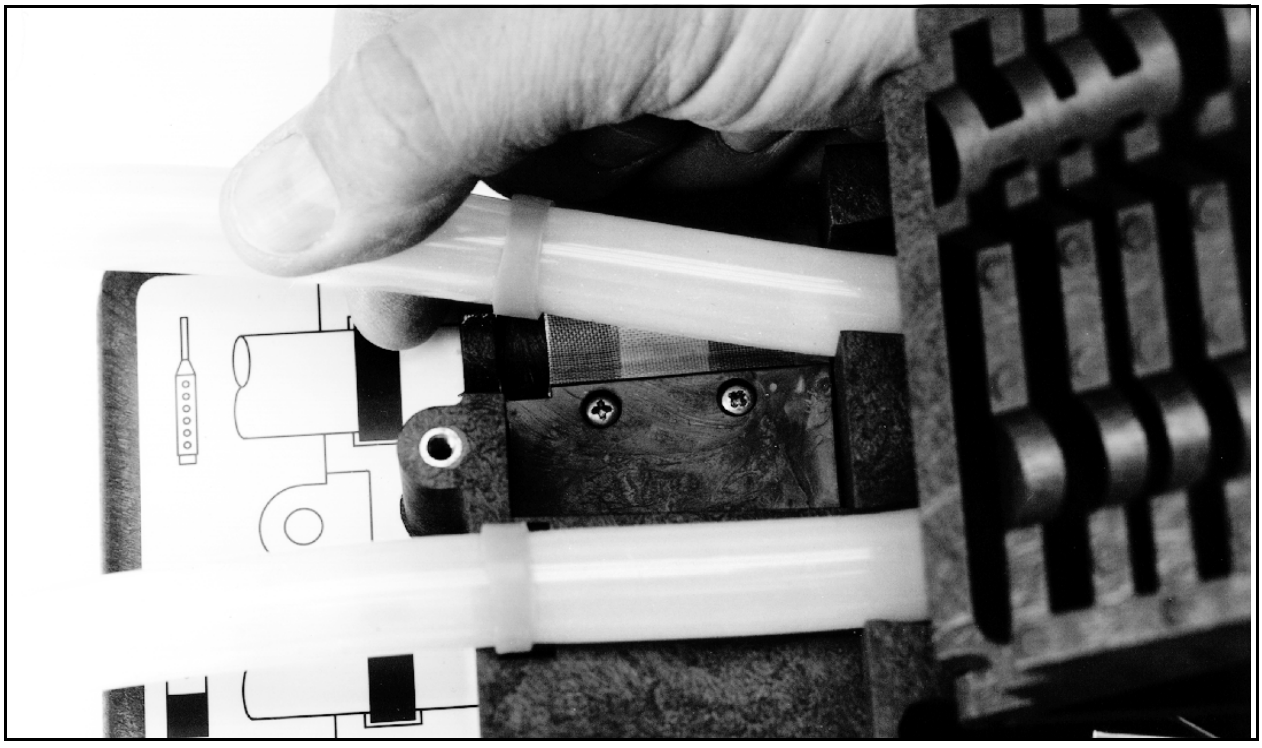


Figure 8-2 Placing the Pump Tube in the Liquid Detector

8.6 Opening the Controller Case

You will need to open the controller case to gain access to:

- The desiccant bag that dries the controller's interior
- The battery that provides backup power to the controller

⚠ CAUTION

The circuit boards can be damaged from a discharge of static electricity. Always use an antistatic mat when opening the controller to protect the circuit boards.

To open the case:

1. Pull the discharge tube and pump tube away from the bulkhead fitting.
2. Remove the distributor arm by unscrewing the nut that attaches the arm to the distributor shaft. DO NOT ROTATE THE DISTRIBUTOR ARM MANUALLY; THIS WILL SEVERELY DAMAGE THE DISTRIBUTOR DRIVE GEARS.
3. Remove the controller from the center section.
4. Open the case by removing the 11 screws that attach the case bottom to the case top.

☑ *Note*

The case top and bottom fit together with a sealed tongue-and-groove joint. Any damage — nicks or cuts — to the tongue, groove, or sealing gasket prevent the case from sealing completely when you close it. Use extreme care when opening the case to avoid damaging the joining surfaces.

Refer to Figure 8-3 for the location of the desiccant box. To gain access to the main circuit board and battery, remove the two distributor connectors and the EMI shield.

8.7 Replacing the Desiccant

A humidity indicator, labeled "INTERNAL CASE HUMIDITY," is located to the right of the keypad. It indicates the amount of moisture present inside the control box. The paper indicator is **blue** when the control box is dry.

The control box is a completely sealed unit. You do not need to open the control box during normal operation. The 6712 Samplers use a desiccant bag inside the controller case to prevent moisture damage to its electronic components. Thus, the humidity indicator should remain blue under normal conditions. If moisture does accumulate, the numbered areas on the indicator will turn light **pink** or **white**, starting with the area numbered "20." This indicates that the relative humidity inside the control box exceeds 20%. As more moisture accumulates, the areas numbered "30" and "40" will turn light pink or white, indicating relative humidities of 30% and 40% respectively.

If the 30% area of the humidity indicator turns light pink or white, open the control unit, inspect it for leaks, and replace the desiccant bag.

⚠ CAUTION

Do not attempt to reactivate the used desiccant. Reactivation may cause desiccant to leak out of the bag, causing mechanical damage inside the controller.

Follow the instructions in Opening the Controller Case in Section 8.6 to open the controller. Remove the bag from the cardboard box (part #69-9003-518) at the front of the case and replace it with a fresh bag of desiccant (part #099-0002-00).

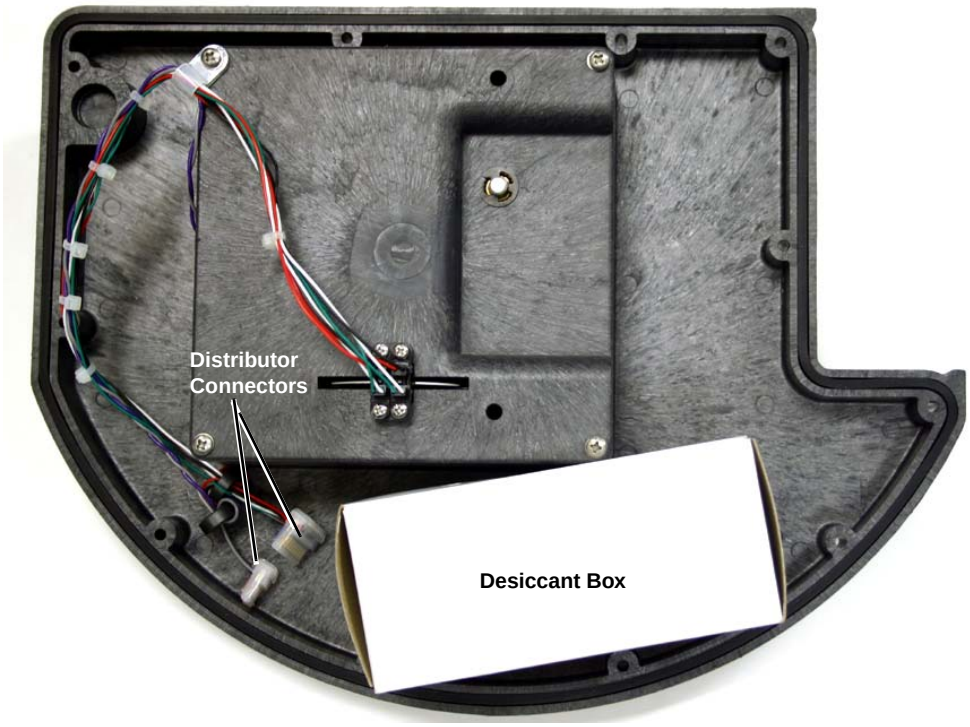


Figure 8-3 Opening the Controller

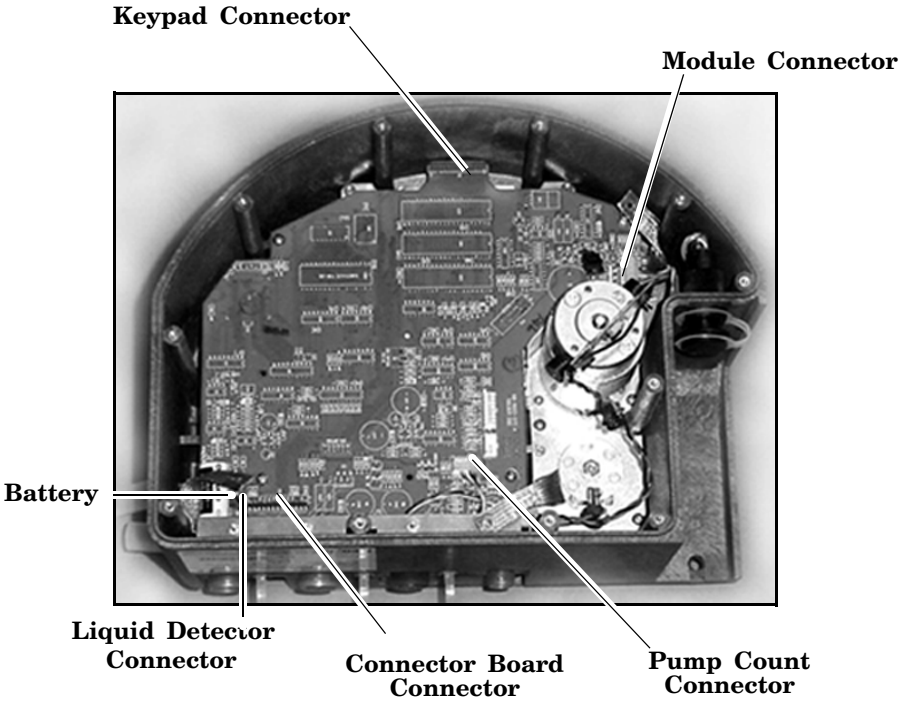


Figure 8-4 Main Circuit Board Connections

8.8 Replacing the Internal Battery

Battery Status Display

WARNING!
REPLACE INTERNAL
BATTERY BEFORE
17-OCT-06

A lithium battery housed inside the controller maintains power to the sampler's memory when the controller is disconnected from a power source. If it discharges completely, the sampler will lose all program settings and all data stored in memory when the external power source is disconnected. The battery requires replacement every five years. The sampler keeps track of the time that has passed since the battery was installed. To view this information, select INTERNAL BATTERY from the Maintenance screen (see example at left). After 5 seconds, the sampelr asks if you have replaced the internal battery (see exapmple at left).

DID YOU REPLACE THE
INTERNAL BATTERY?
YES NO

Select YES to reset the countdown to 59 months from the current date.

While replacing the battery, it is likely that the stored readings will be lost and your program will revert to the default program. Before proceeding, retrieve the stored data and record your program settings.

☑ *Note*

Teledyne Isco recommends you replace the battery every five years, as soon as the battery warning appears. To ensure that the replacement meets Teledyne Isco's specifications, use only Teledyne Isco replacement batteries. (See *Appendix D, Replacement Parts*.)

To replace the internal battery:

1. Open the controller case. Separate the case bottom and top by removing the two distributor connectors.
2. Lift the desiccant box from the case.
3. Remove the EMI shield and grounding straps by loosening the five $^{1}/_{4}$-inch stop nuts.
4. Disconnect the module, liquid detector, and pump count connectors from the main circuit board.
5. Remove the three screws and the $^{1}/_{4}$-inch stud attaching the main circuit board to the case.
6. Detach the main circuit board from the keypad connector by pulling gently upward on the edges of the board next to the connector. Pull the main board up until the keypad connector is almost even with the edge of the case. Next, detach the main circuit board from the connector board.
7. De-solder the lithium battery, using care to prevent damage to the circuit board. Insert the replacement battery and solder it in place.

☑ *Note*

Poor soldering techniques can easily damage a printed circuit board. The battery should be replaced by a skilled technician.

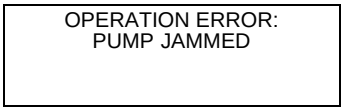
⚠ WARNING

Danger of explosion if lithium battery is incorrectly replaced. Replace with the same type, ensuring correct polarity. Do not dispose of used lithium battery in fire.

8. Reconnect the main circuit board to the connector board before reconnecting it to the keypad. Replace the $^{1}/_{4}$-inch stud and the three screws, and reconnect the module, liquid detector, and pump count connectors.
9. Replace the EMI shield and grounding straps. Reconnect the two distributor connectors.
10. Ensure that all connections and hardware are secure. Replace the desiccant and close the case.
11. Reset the battery alarm.

8.9 Error Messages

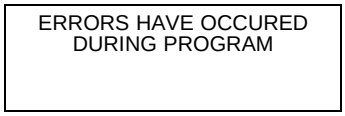
If the sampler detects an error that prevents it from taking a sample or continuing the program, it displays an error message.



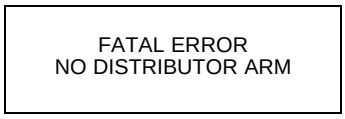
There are messages for the following conditions:

- PUMP JAMMED
- DISTRIBUTOR JAMMED
- PROBABLE OVERFLOW
- POWER FAILED
- LOW BATTERY
- USER STOPPED
- NO DISTRIBUTOR ARM
- NO LIQUID DETECTED
- NO MORE LIQUID
- PUMP LATCH OPEN
- SAMPLER SHUT OFF
- BOTTLE FULL
- SAMPLE IN PROGRESS

Error Messages



Since the sampler may encounter more than one error during a program, it does not display the messages continuously. Instead, it records each error and the time it occurred in the Sampling Results and Combined Results report. It alerts you to the recorded errors by displaying the message, "ERRORS HAVE OCCURRED DURING PROGRAM."

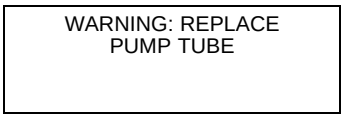


If the sampler detects a low battery condition, it stops the running program and displays the "LOW BATTERY" error message. A low battery condition exists when five consecutive sample events have resulted in a POWER FAILED error message.

Fatal Error – The Fatal Error message will only show up if you are using a multiple bottle configuration and the distributor system fails. Failing the test can indicate any of the following conditions:

- The distributor arm is not attached to the sampler.
- The distributor-arm stop inside the center section is missing or broken.
- The distributor drive mechanism inside the controller is malfunctioning.

8.10 Pump Tube Warning



Occasionally, the sampler displays a warning message to alert you to a potential problem. The warning, REPLACE PUMP TUBE, reminds you to check the condition of the pump tube. Instructions regarding the pump tube can be found elsewhere in this section.

6712 Portable Sampler

Appendix A Menu Flowcharts

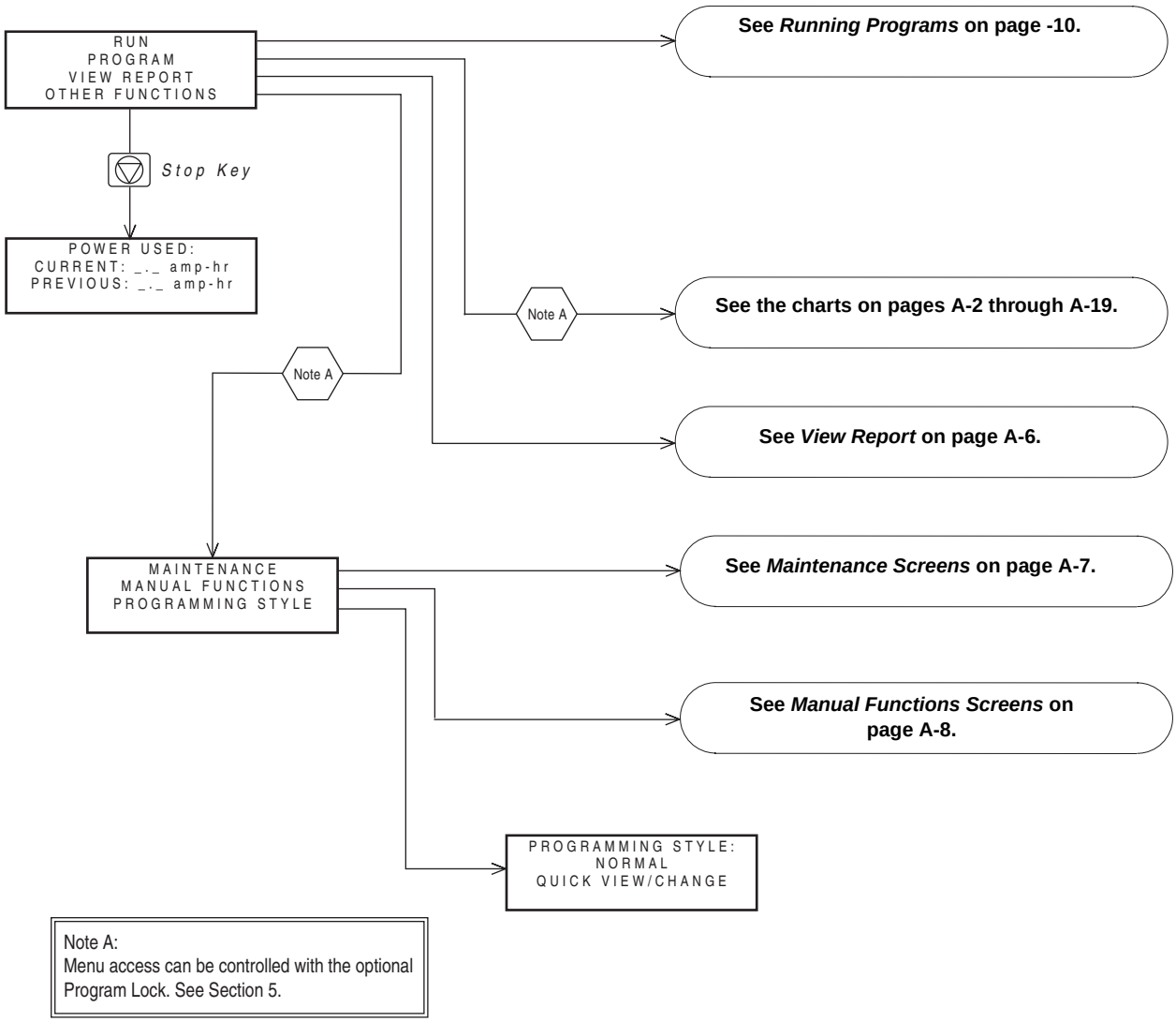


Figure A-1 6712 Menu Tree for Standard Programming

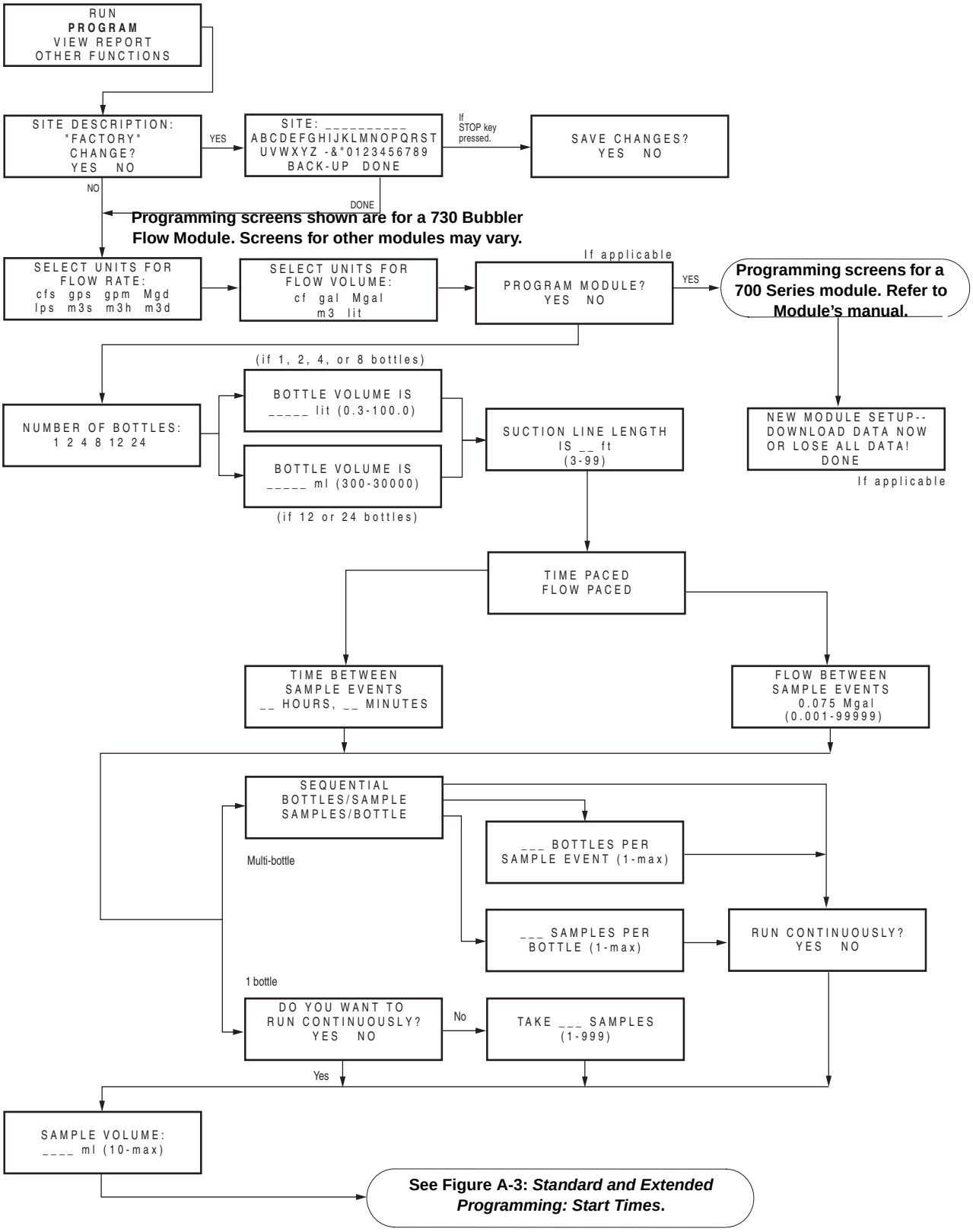


Figure A-2 Standard Programming: Programming Screens

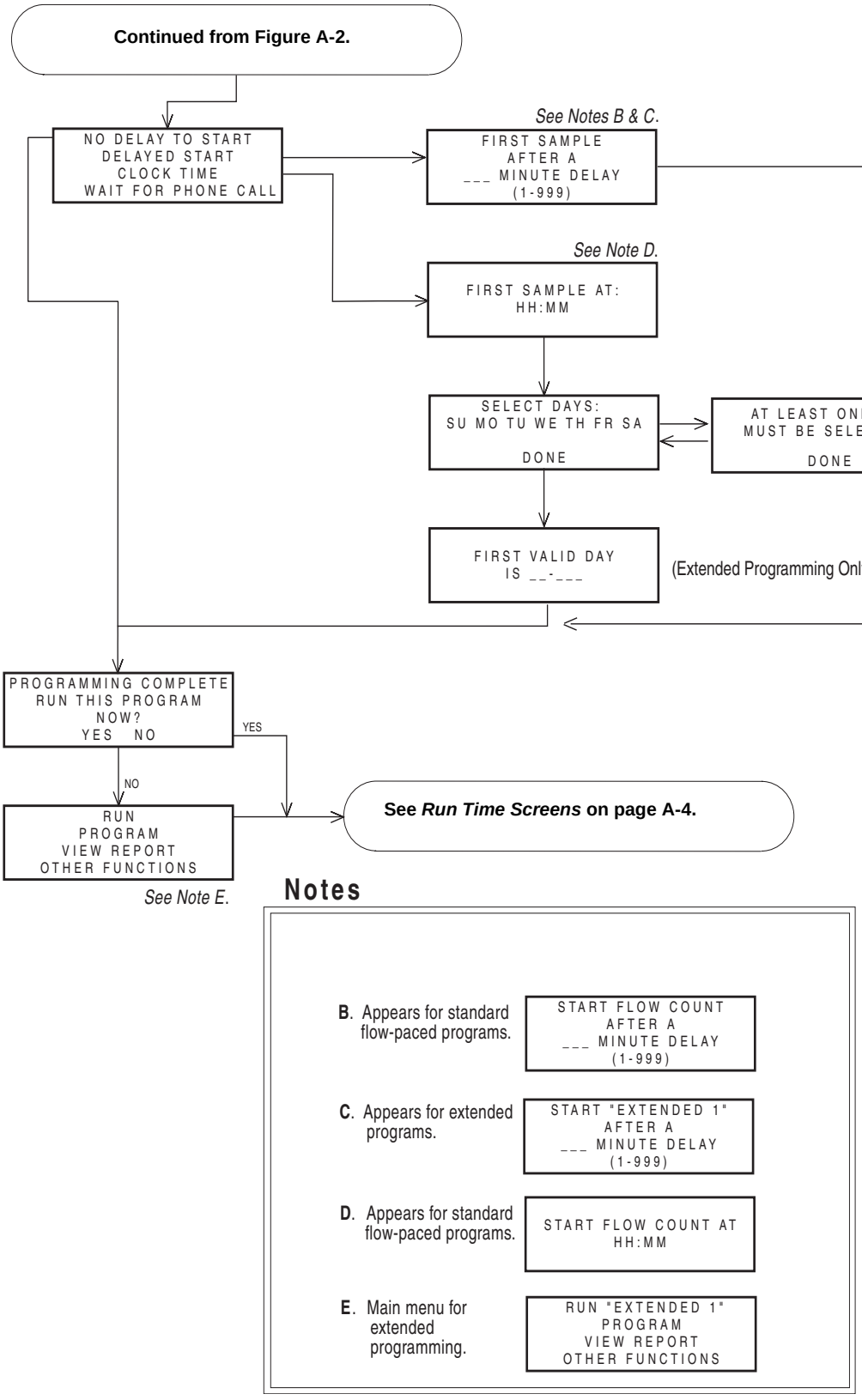


Figure A-3 Standard and Extended Programming: Start Times

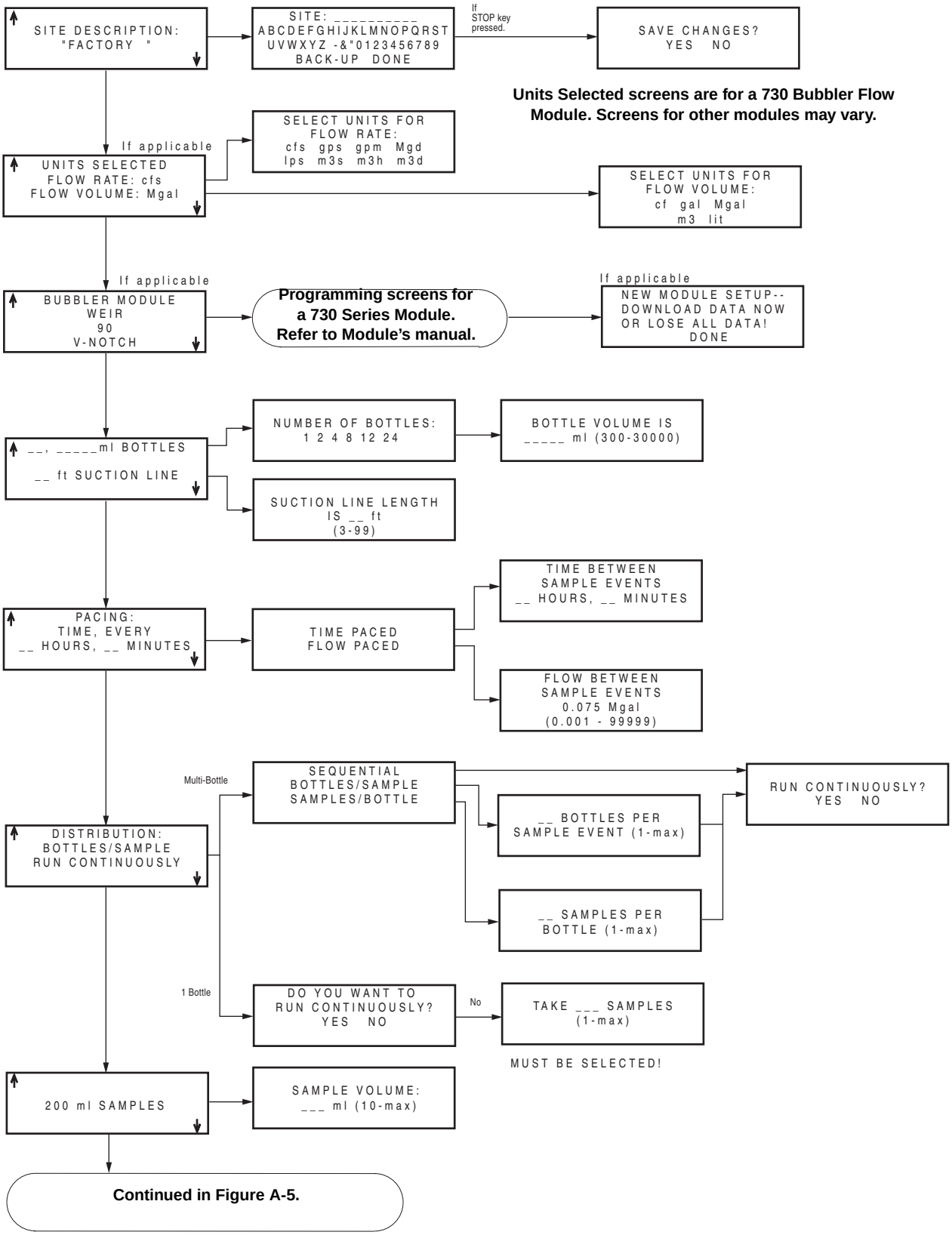


Figure A-4 Standard Programming: Quick View; Programming Screens

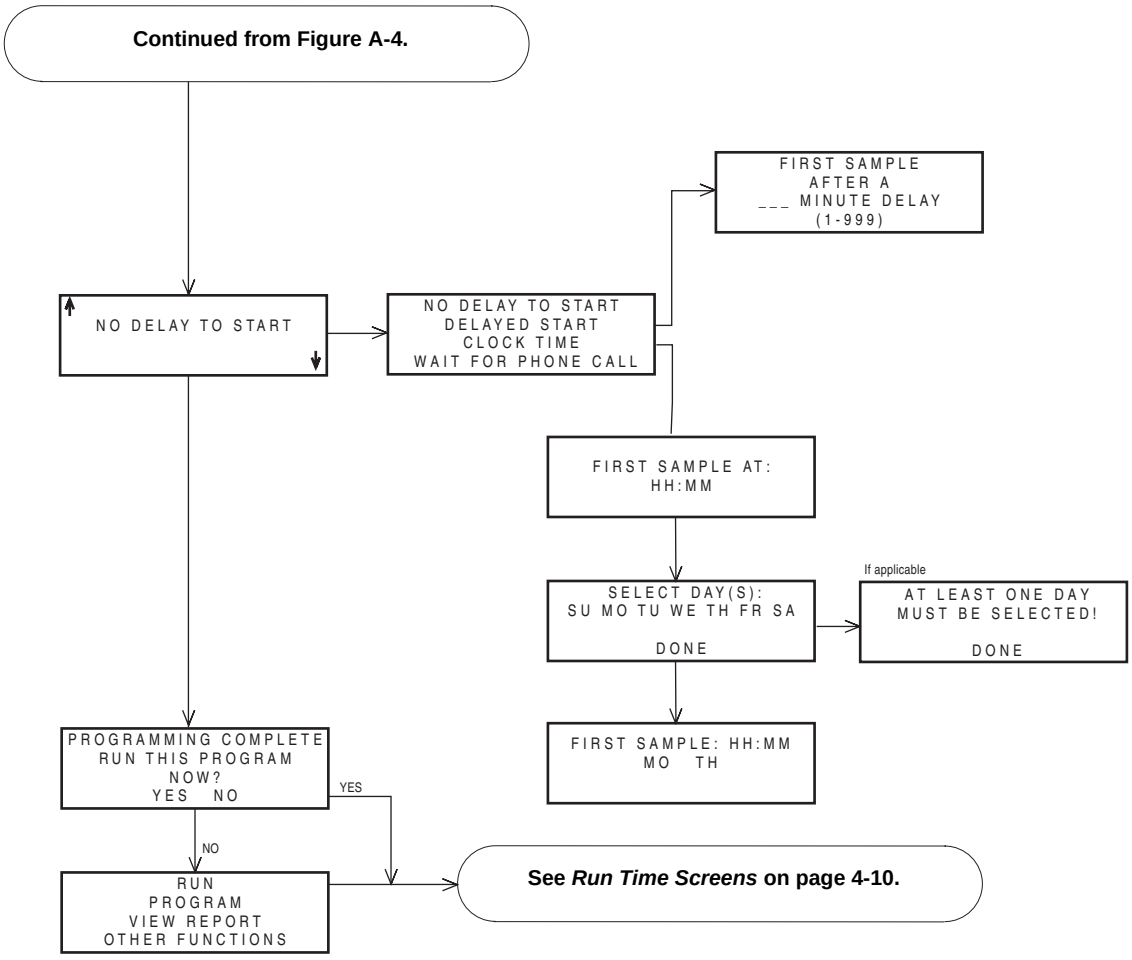


Figure A-5 Standard Programming: Quick View; Start Times

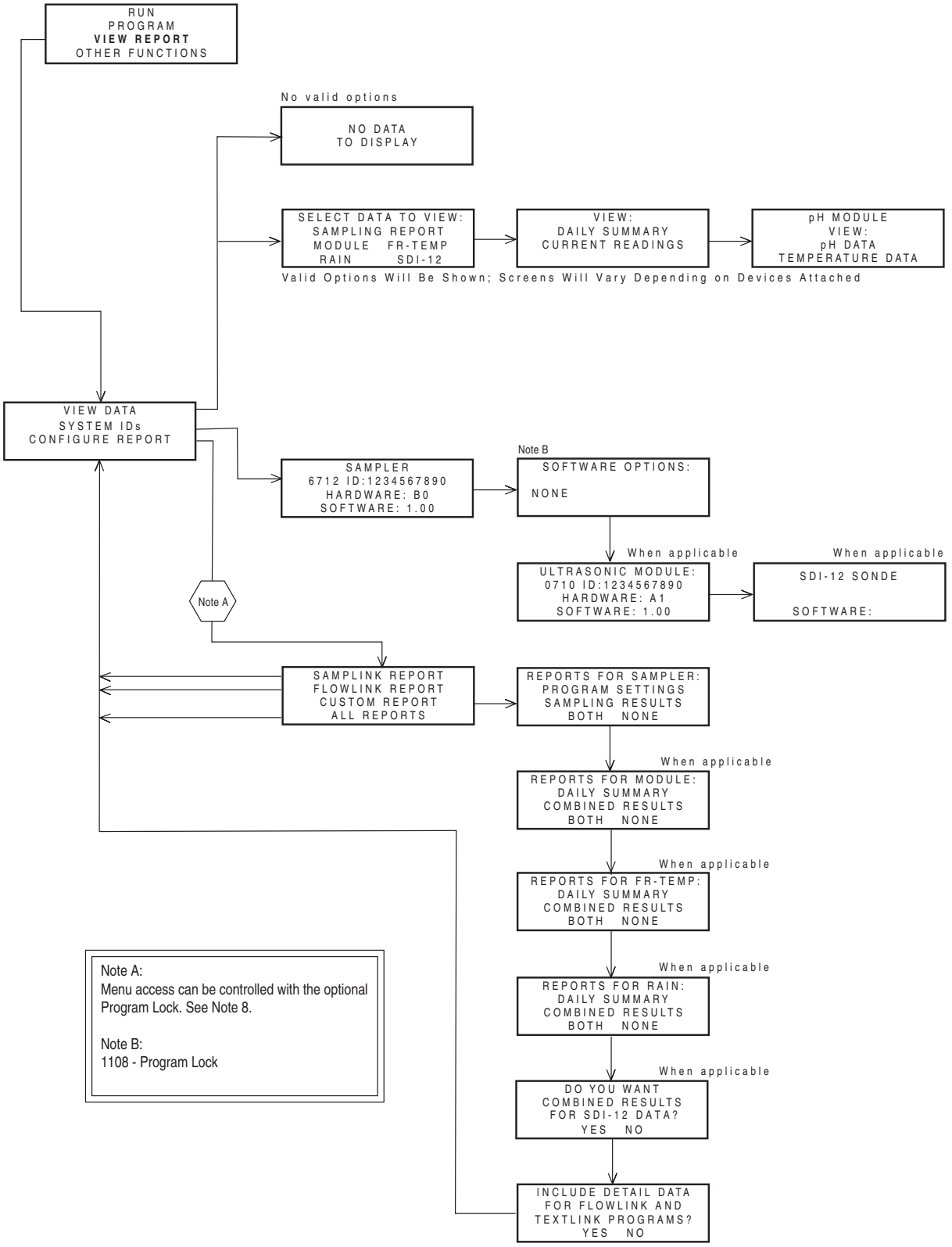
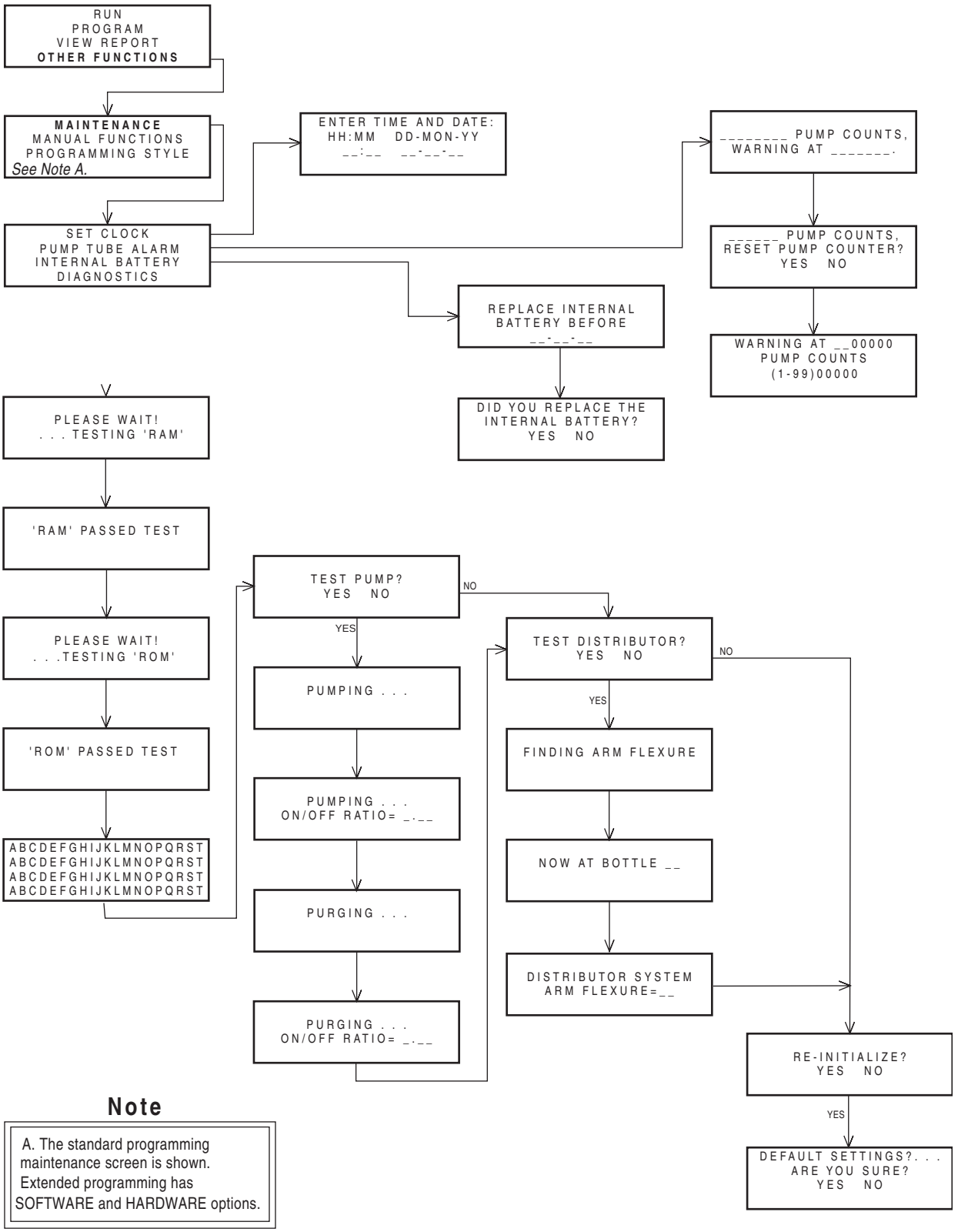


Figure A-6 View Report



Note

A. The standard programming maintenance screen is shown. Extended programming has SOFTWARE and HARDWARE options.

Figure A-7 Maintenance Screens

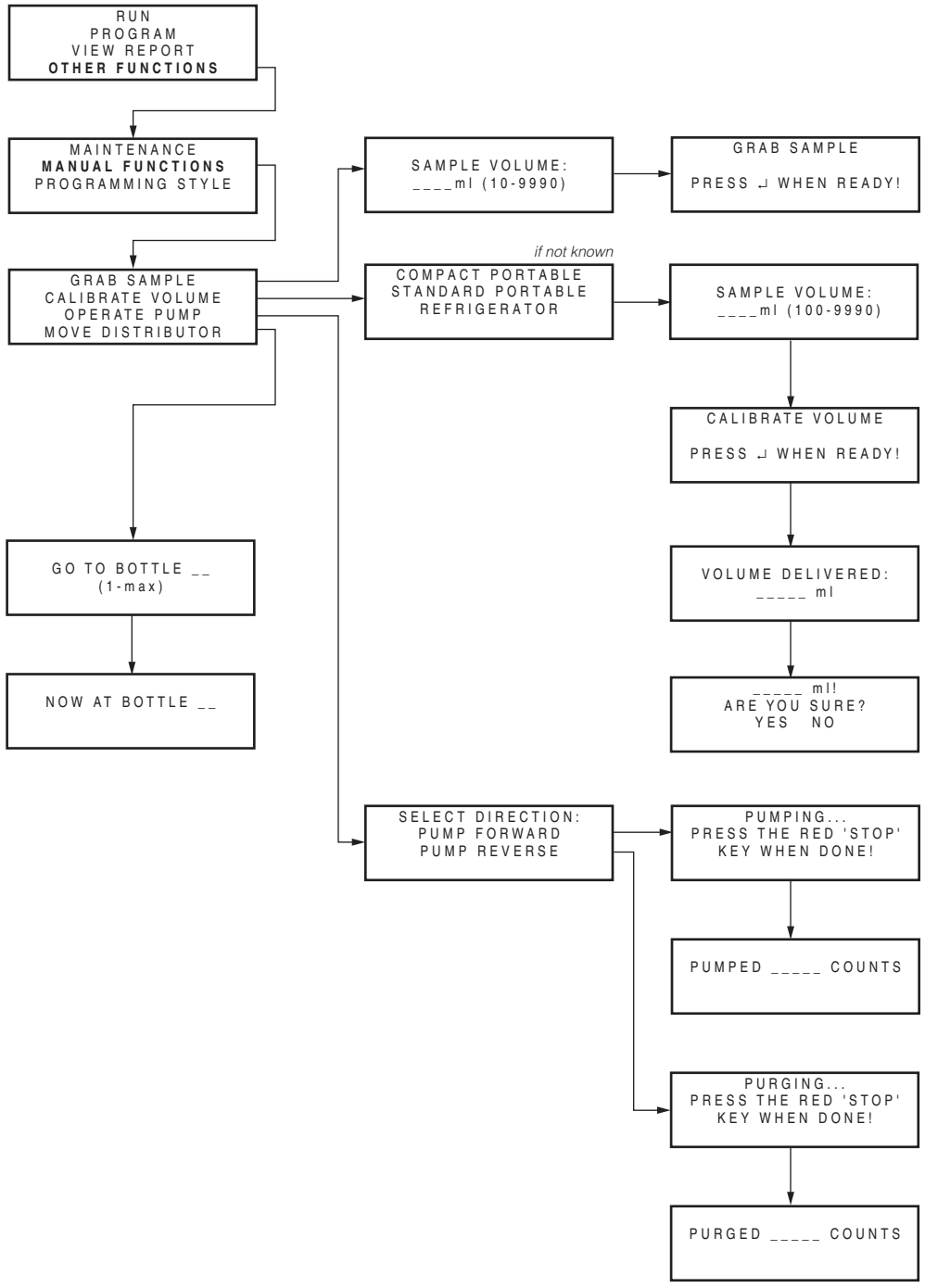


Figure A-8 Manual Functions Screens

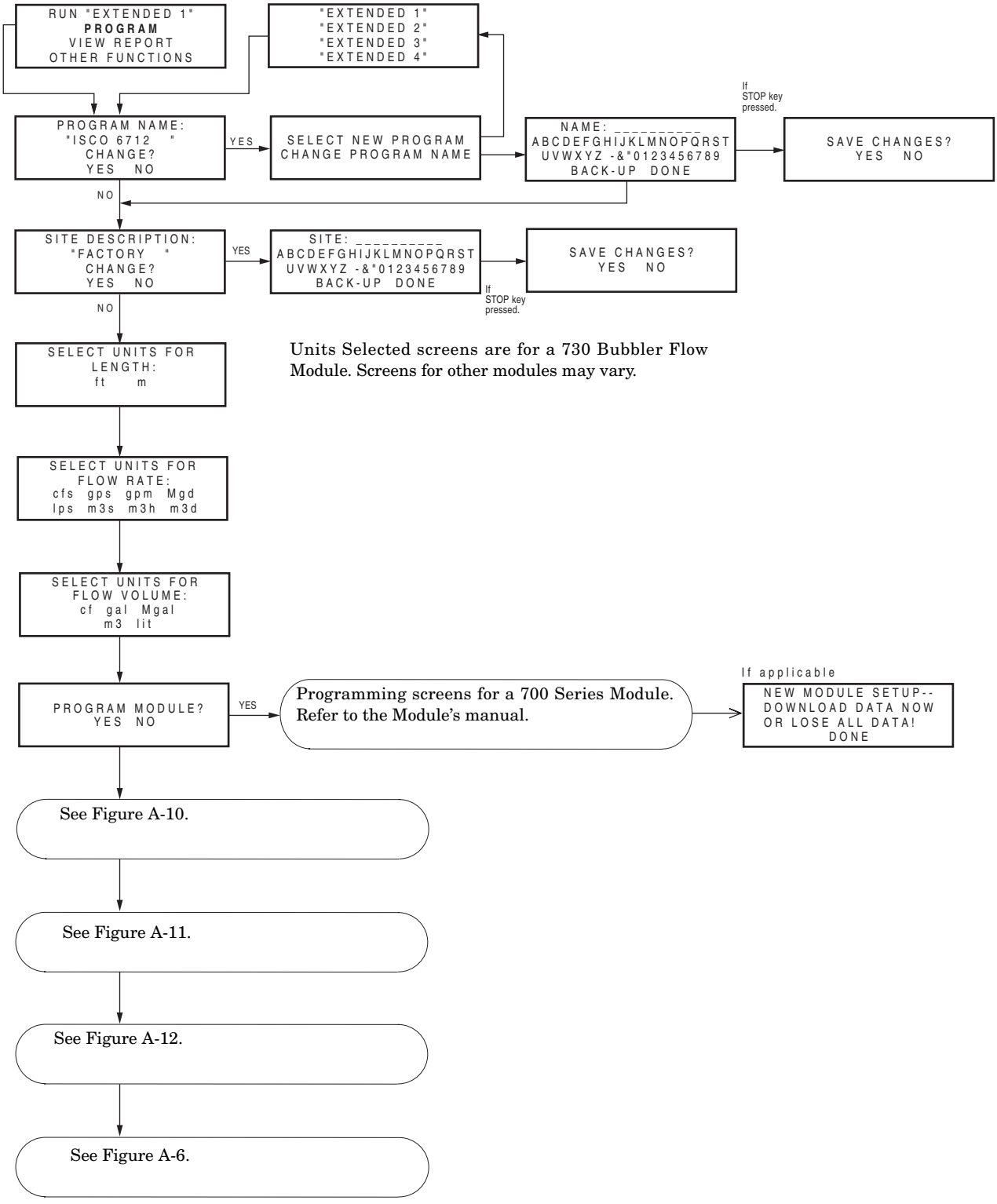


Figure A-9 Extended Programming: Programming Screens

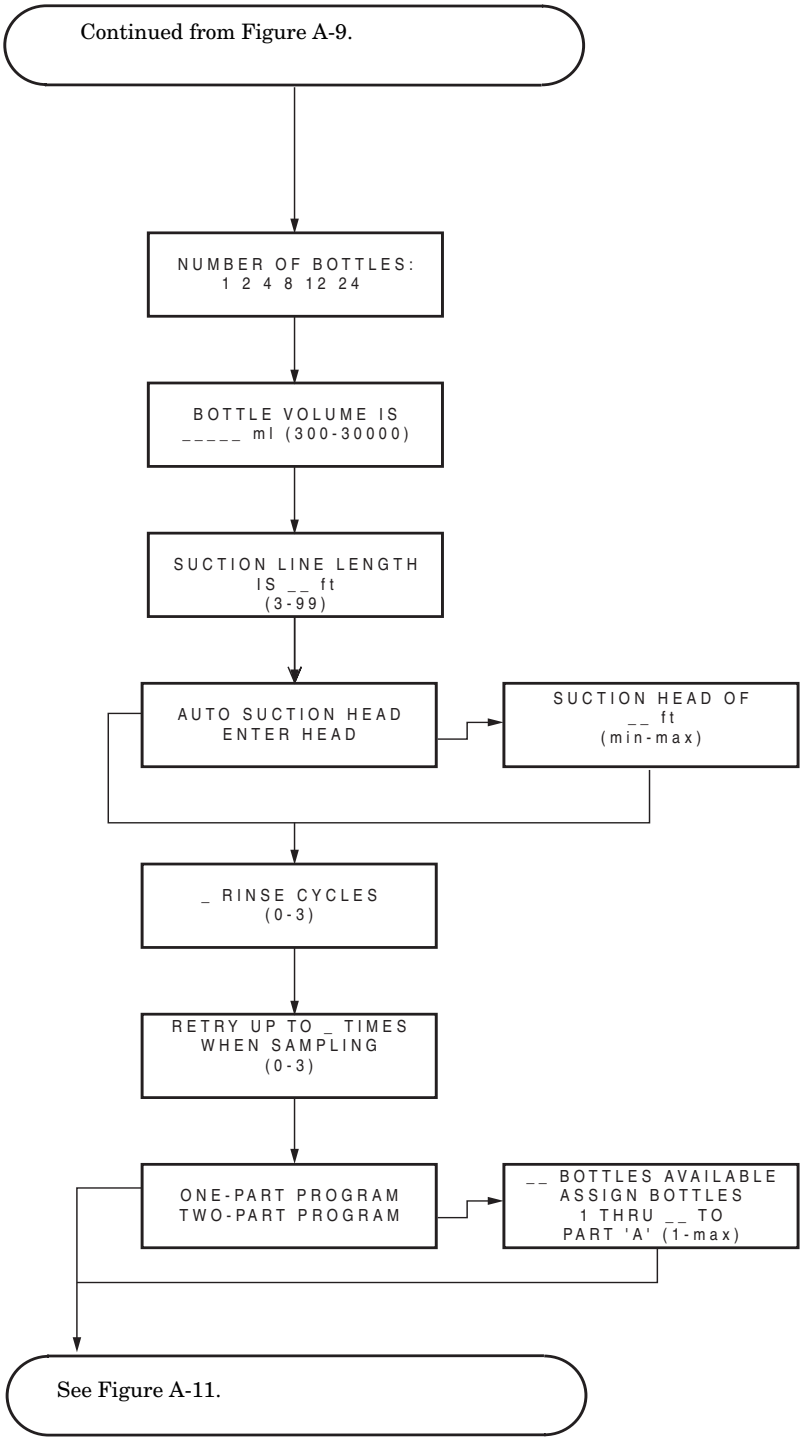


Figure A-10 Extended Programming: Equipment Setup

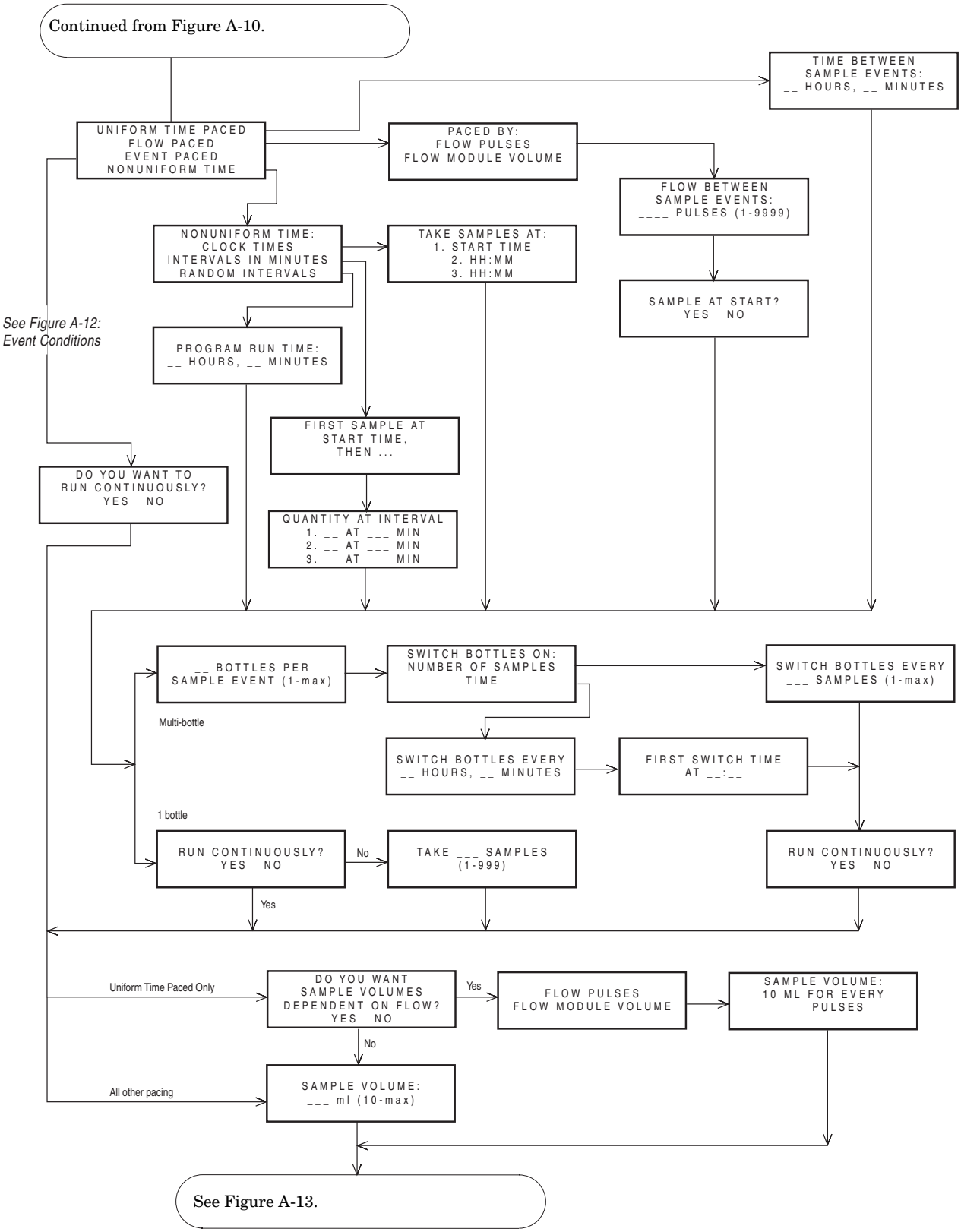


Figure A-11 Extended Programming: Pacing and Distribution

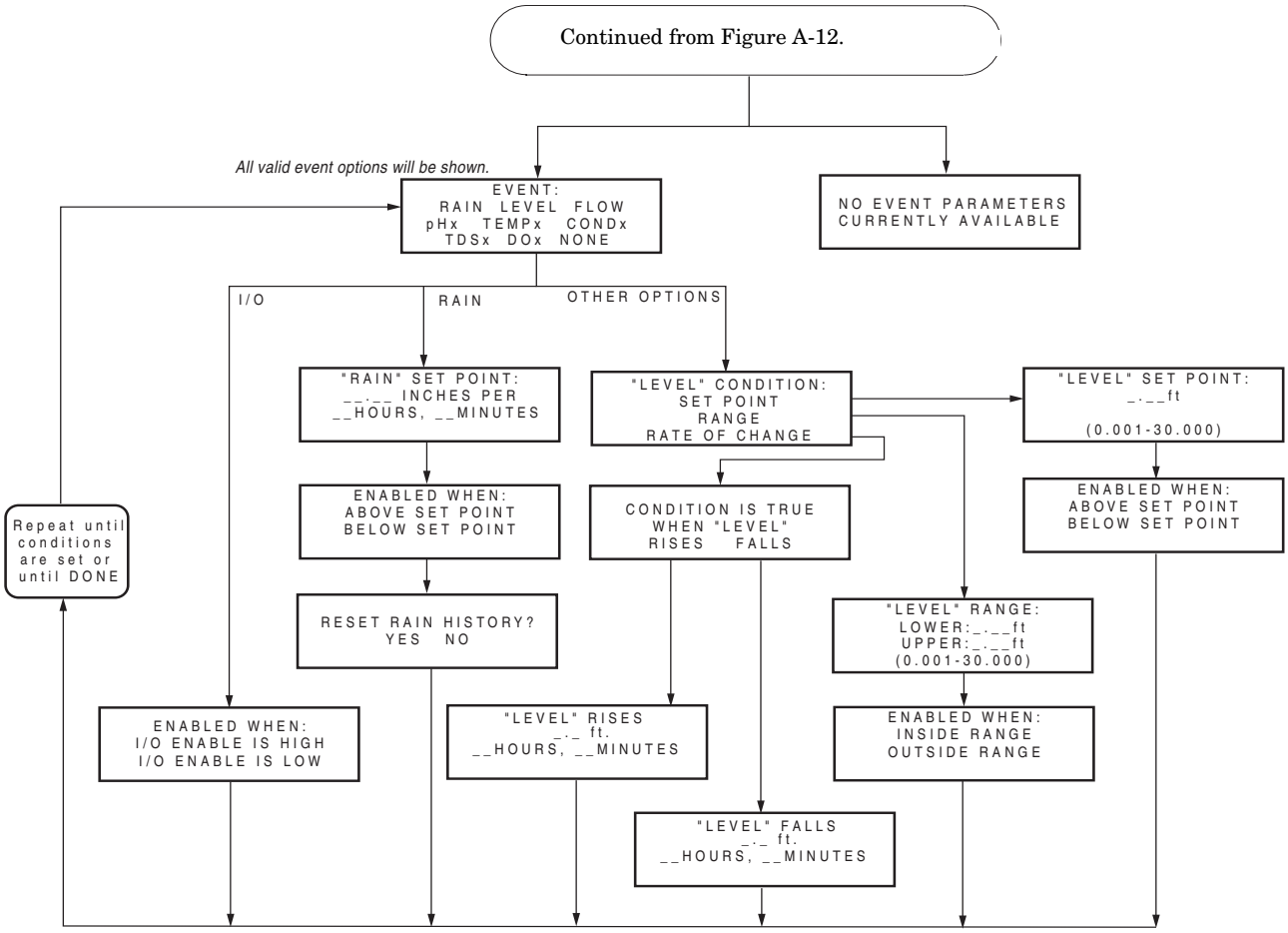


Figure A-12 Extended Programming: Event Conditions

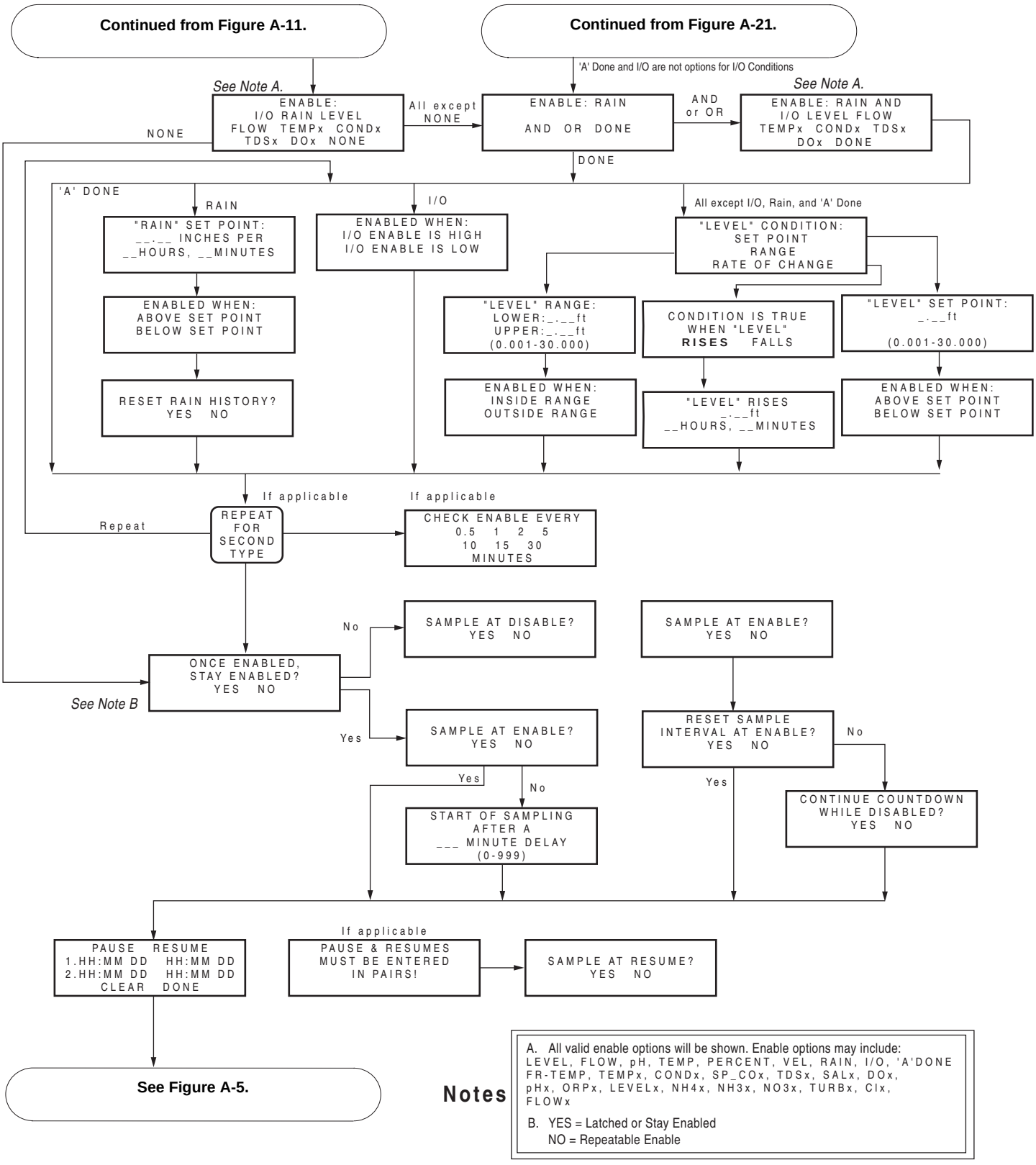


Figure A-13 Extended Programming: Programmed Sampler Enable

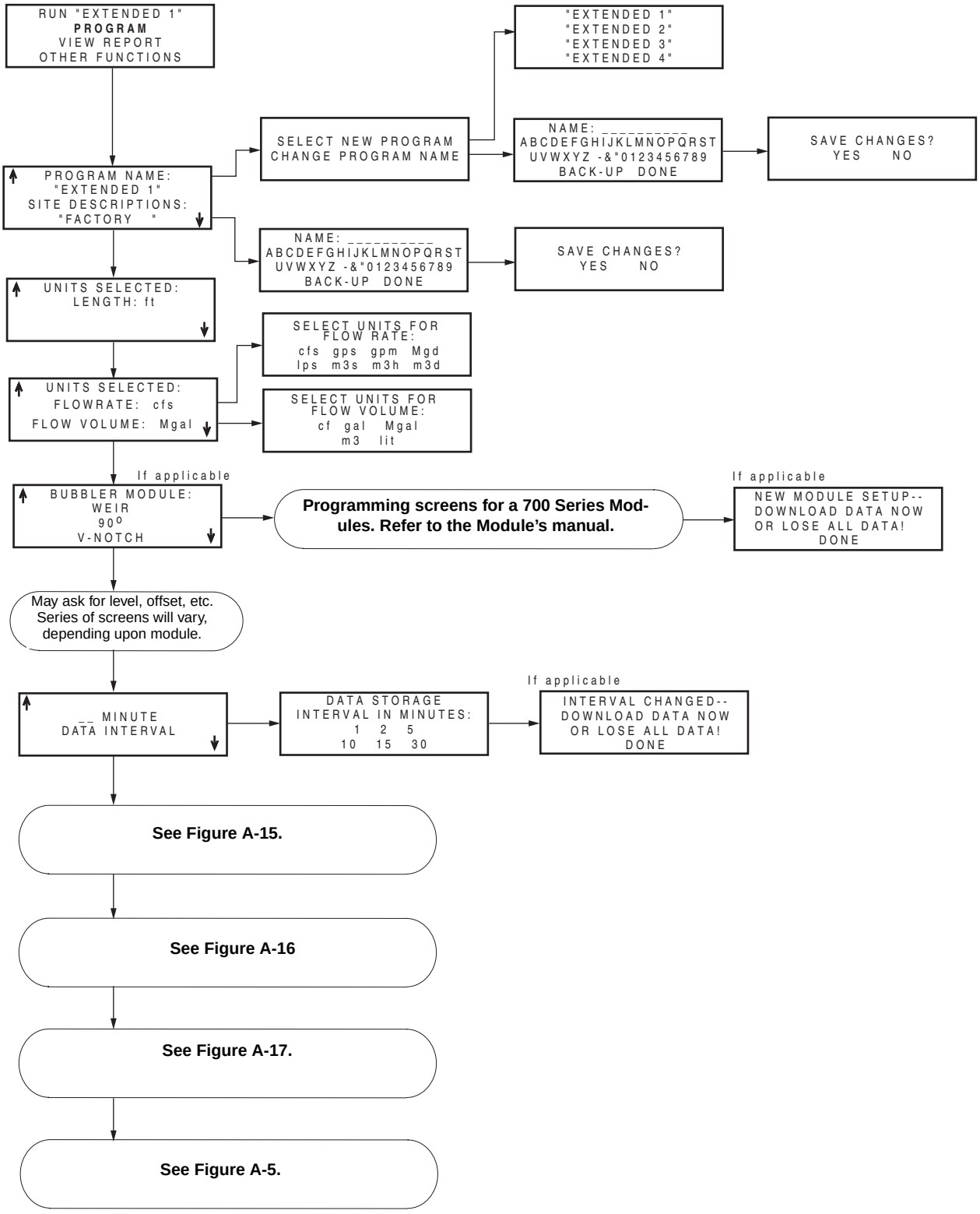


Figure A-14 Extended Programming: Quick View; Programming Screens

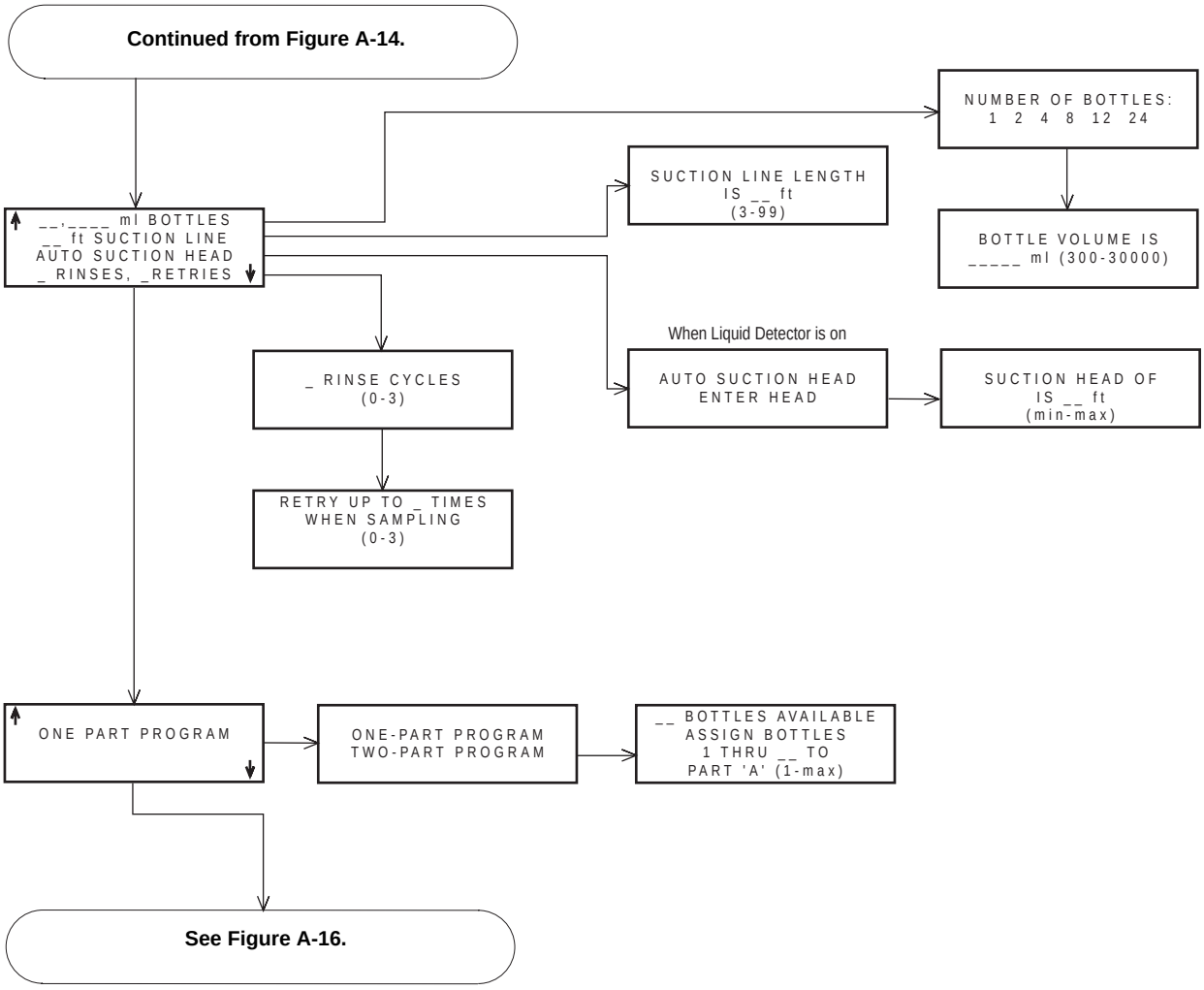


Figure A-15 Extended Programming: Quick View; Equipment Set-Up

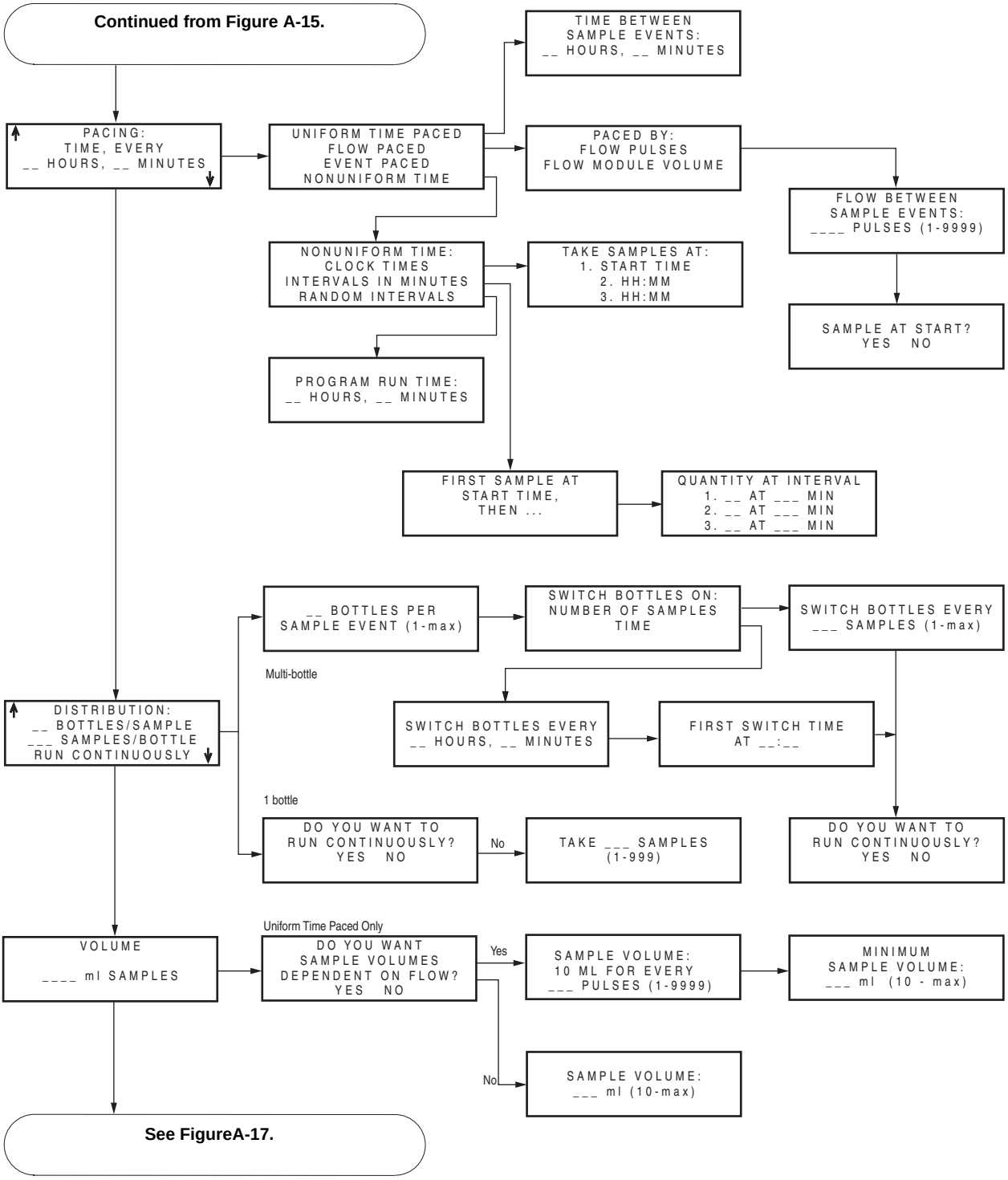


Figure A-16 Extended Programming: Quick View; Pacing and Distribution

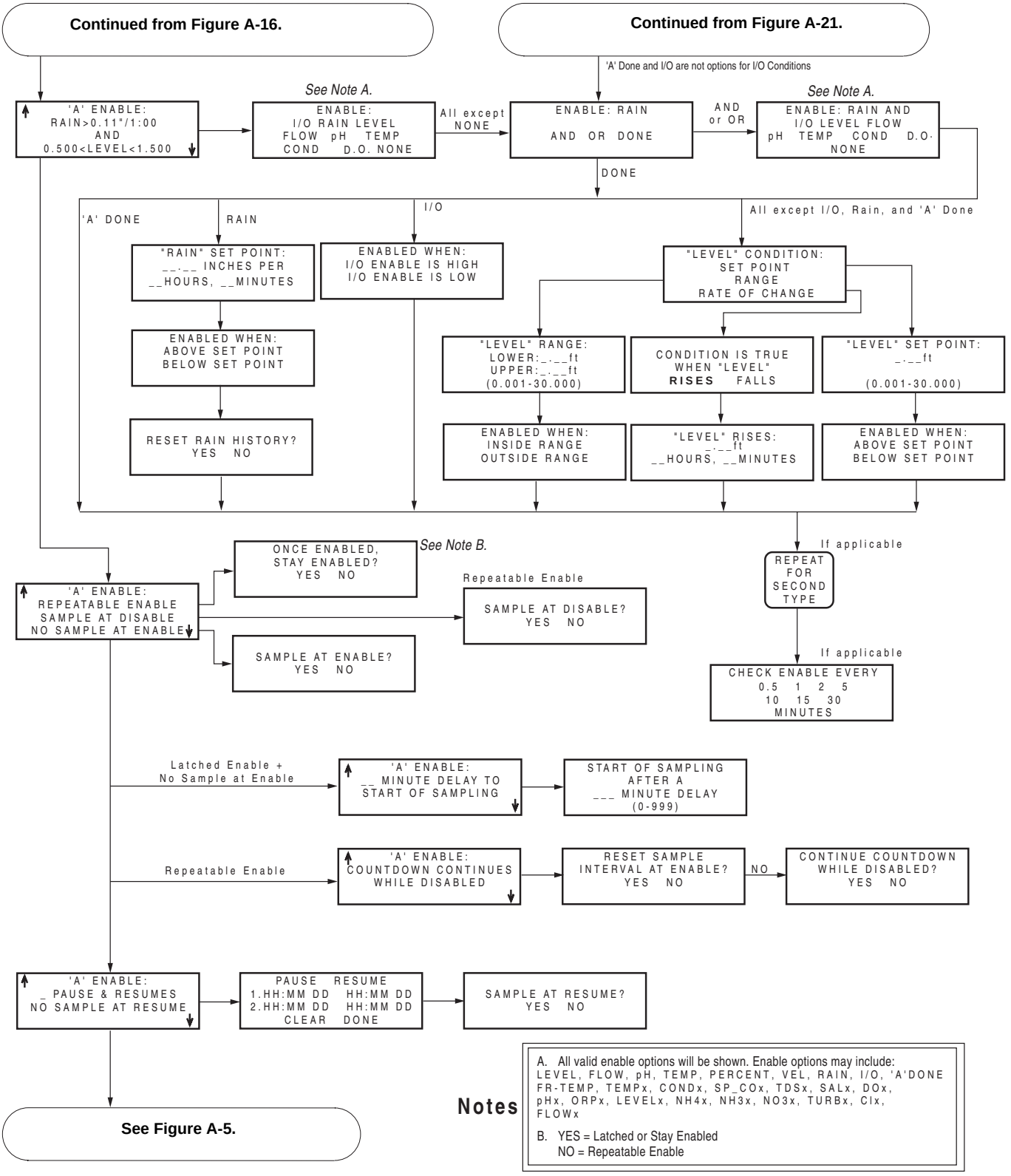


Figure A-17 Extended Programming: Quick View; Programmed Sampler Enable

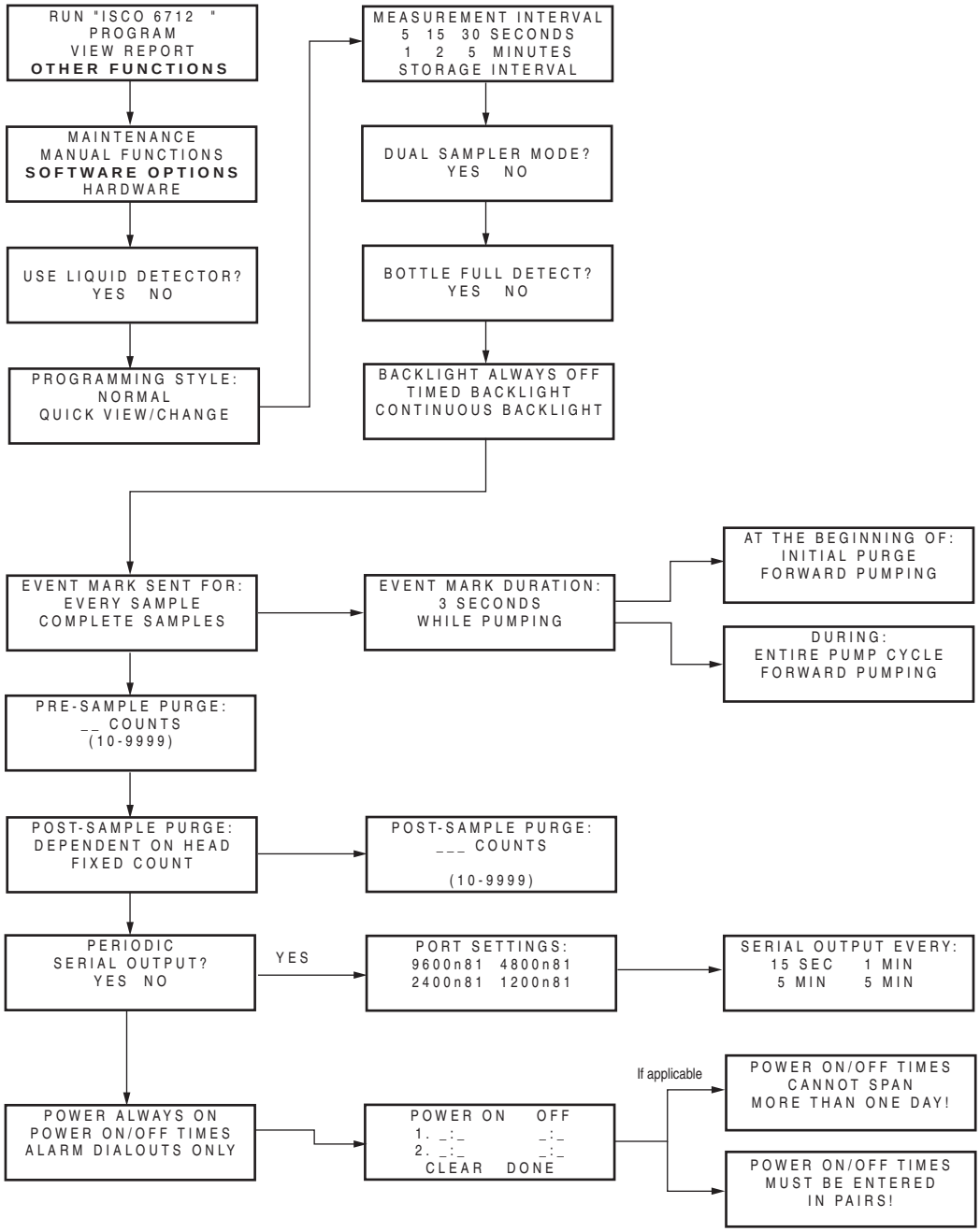


Figure A-18 Extended Programming: Normal View; Software Options

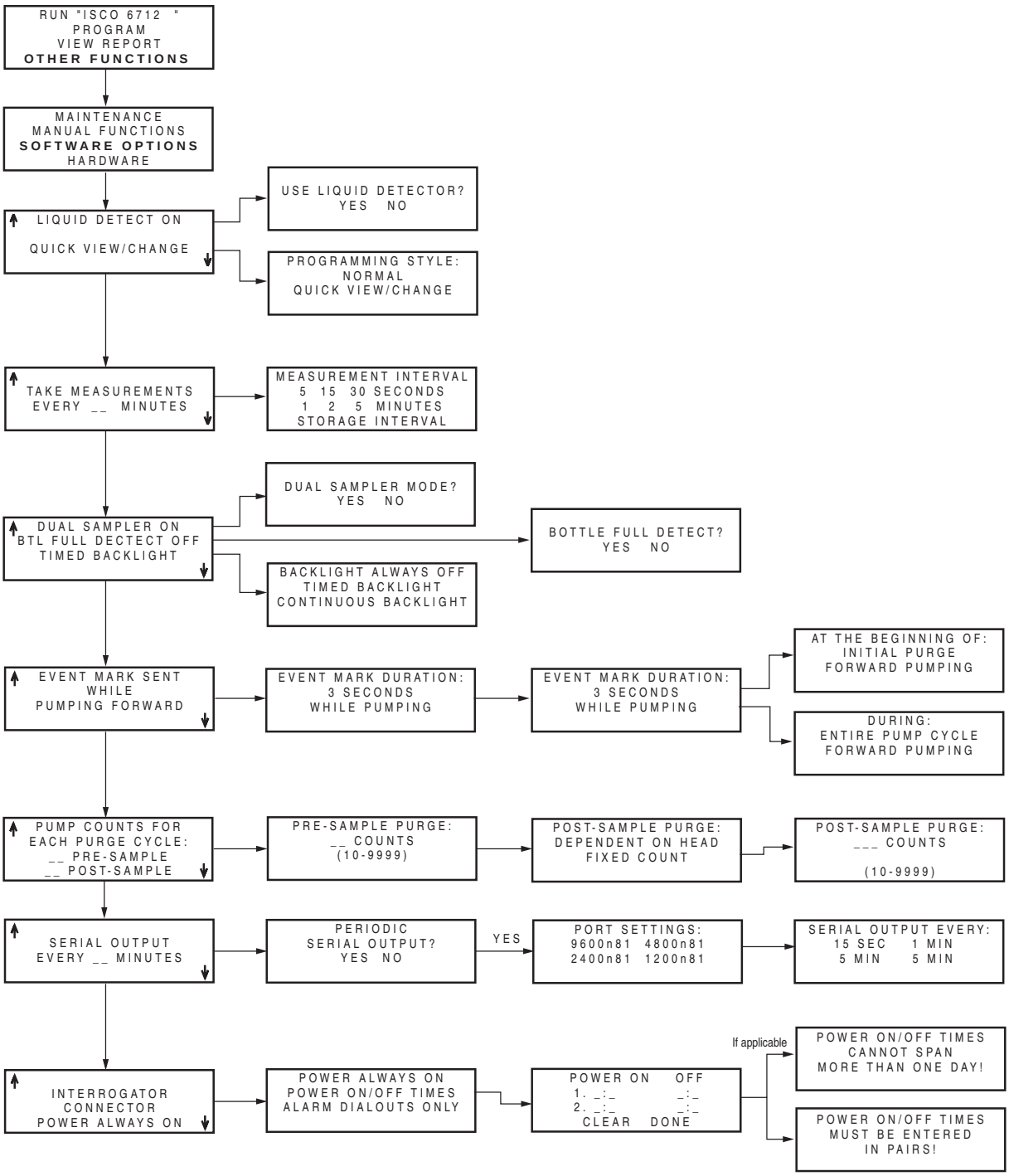


Figure A-19 Extended Programming: Quick View; Software Options

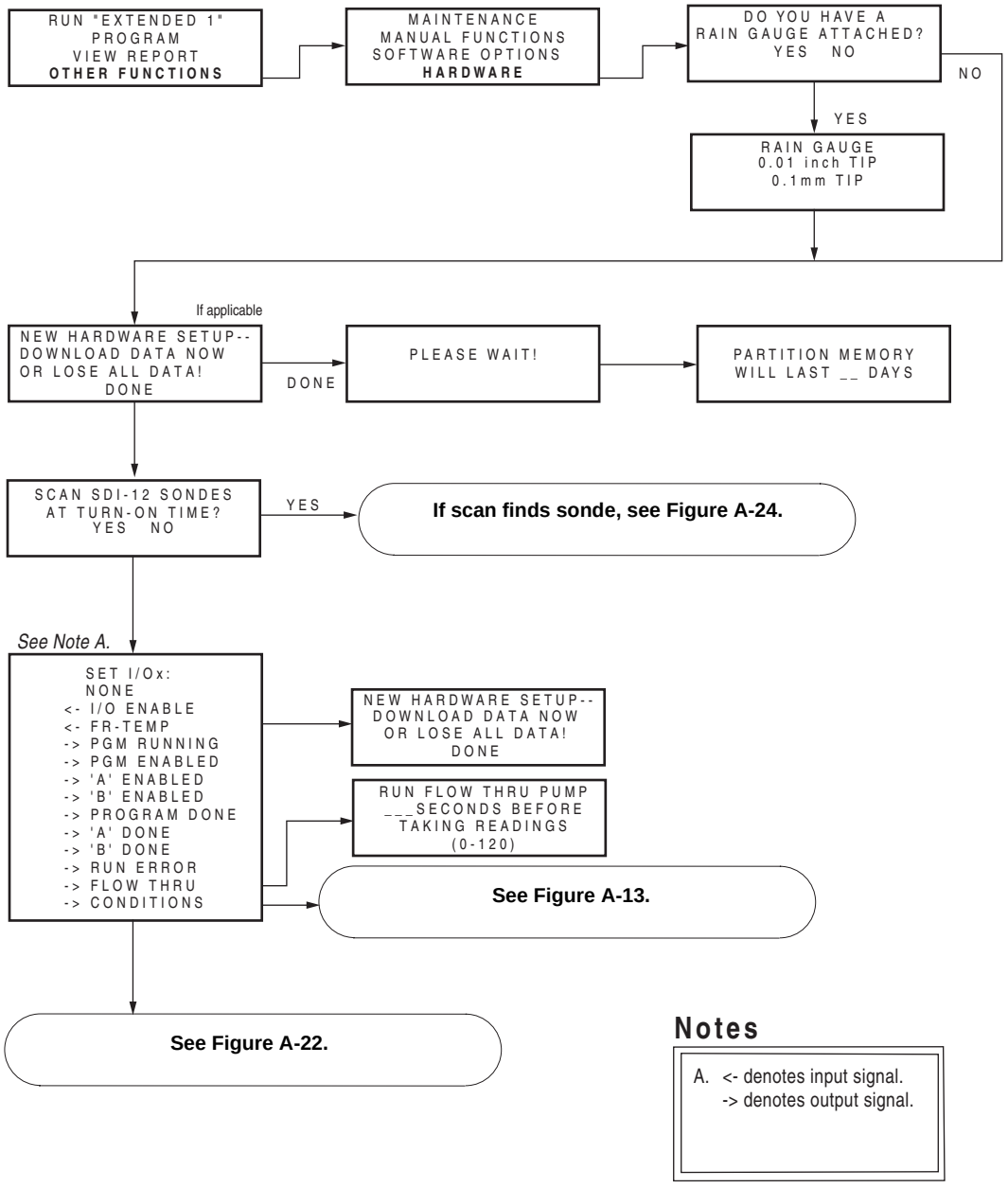


Figure A-20 Extended Programming: Normal View; Hardware

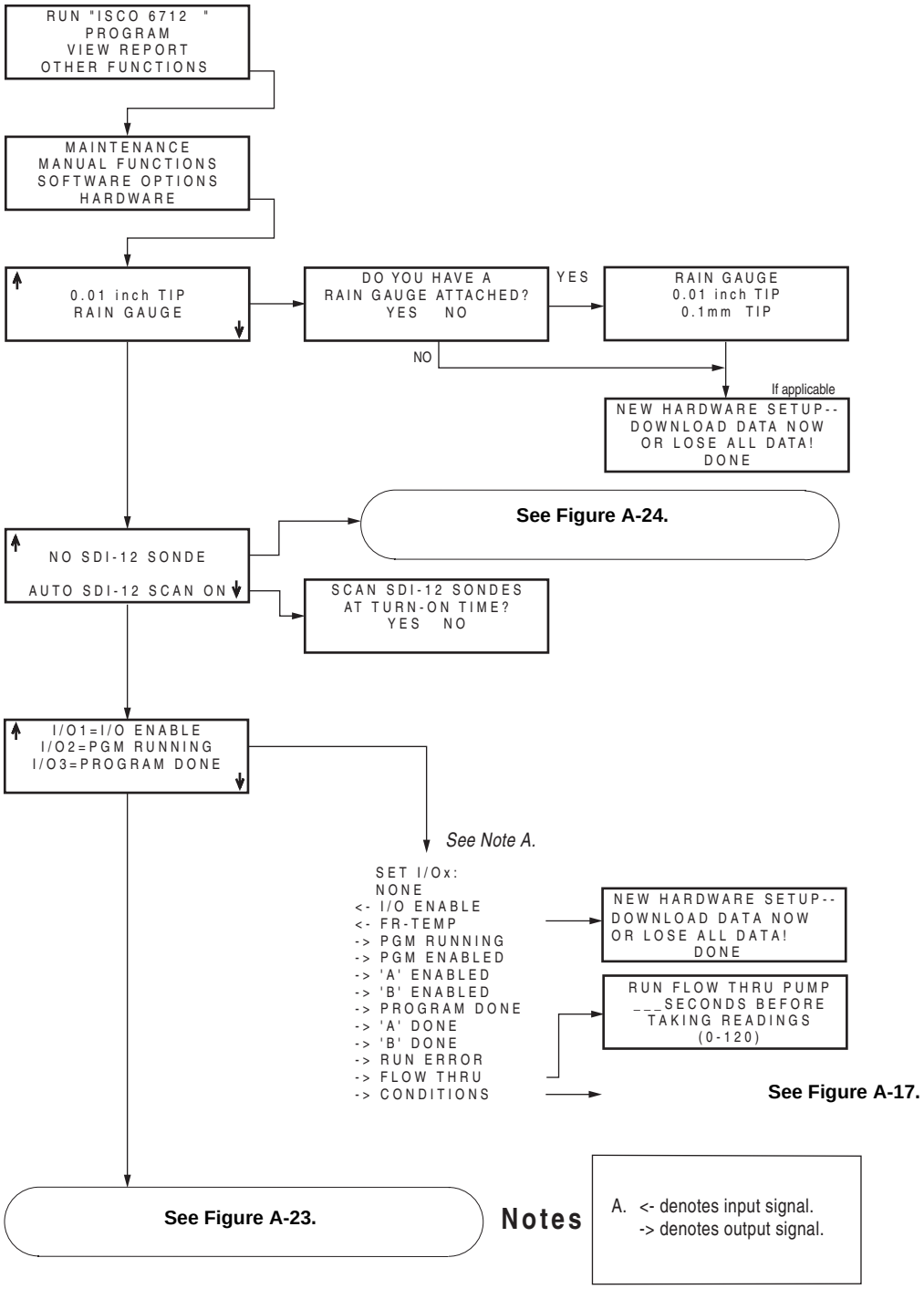


Figure A-21 Extended Programming: Quick View; Hardware

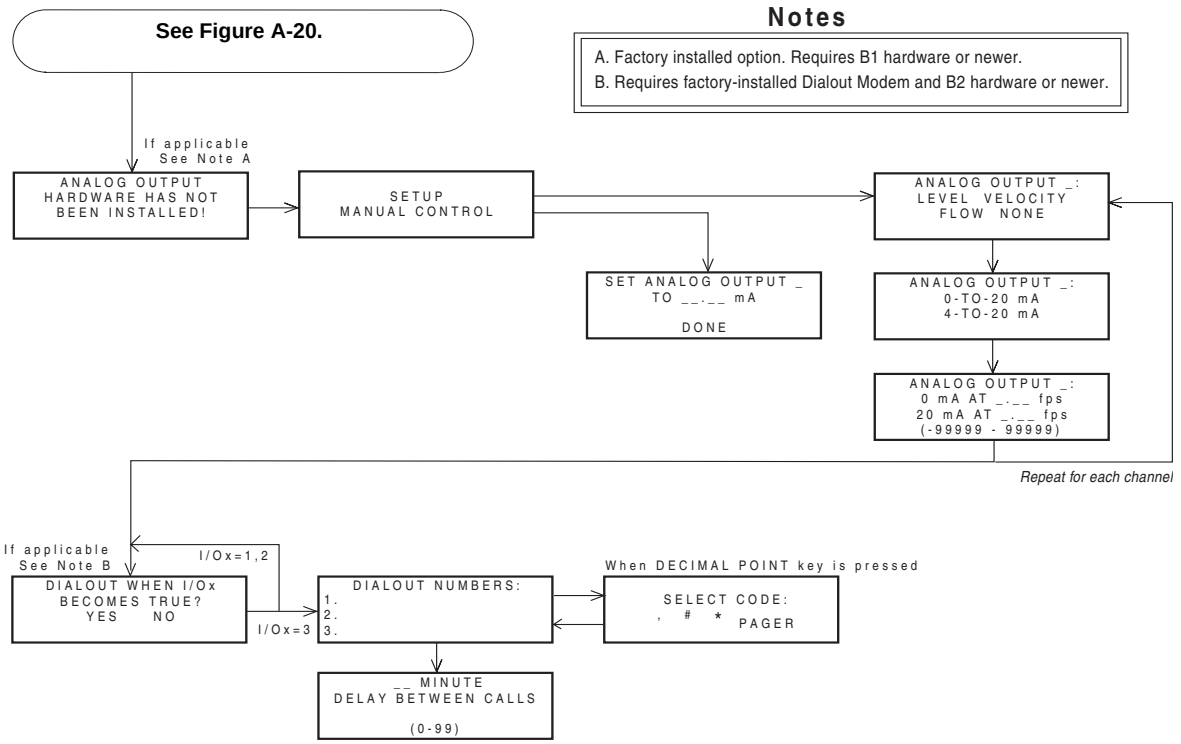


Figure A-22 Analog and Dialout Screens

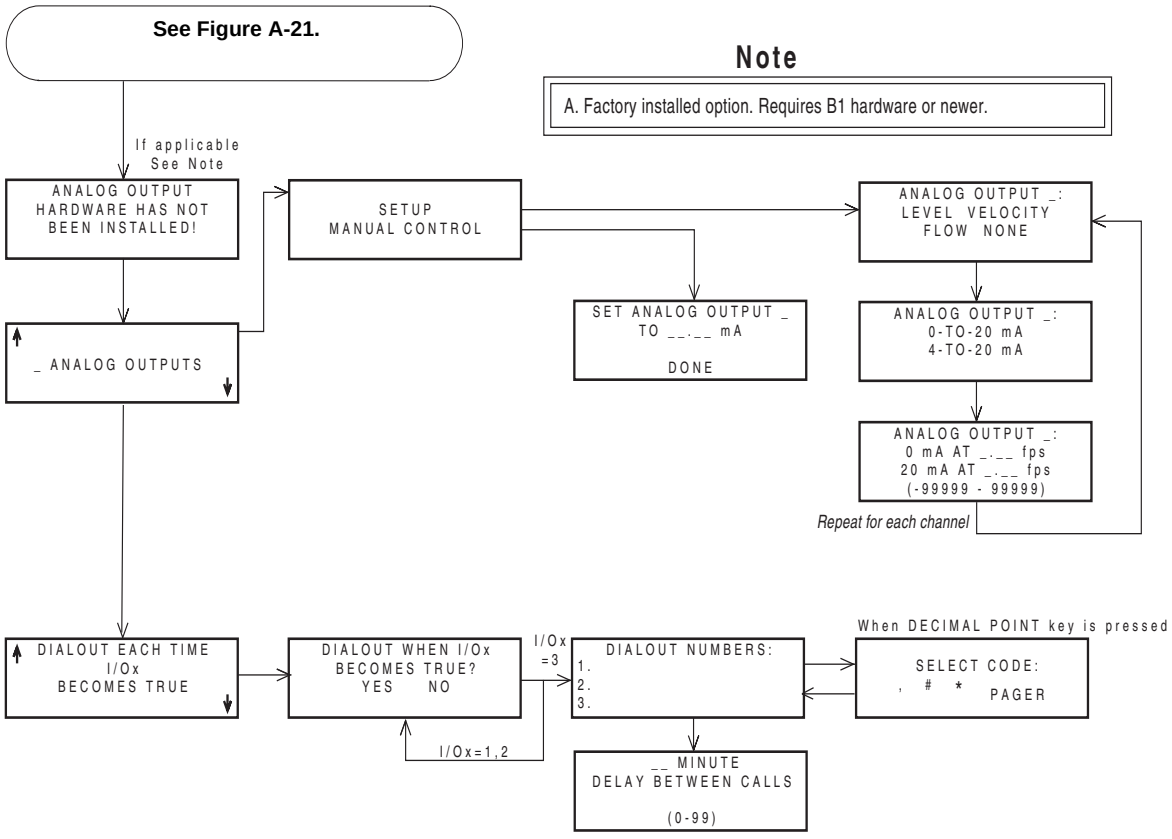


Figure A-23 Analog Output and Dialout Quick View Screens

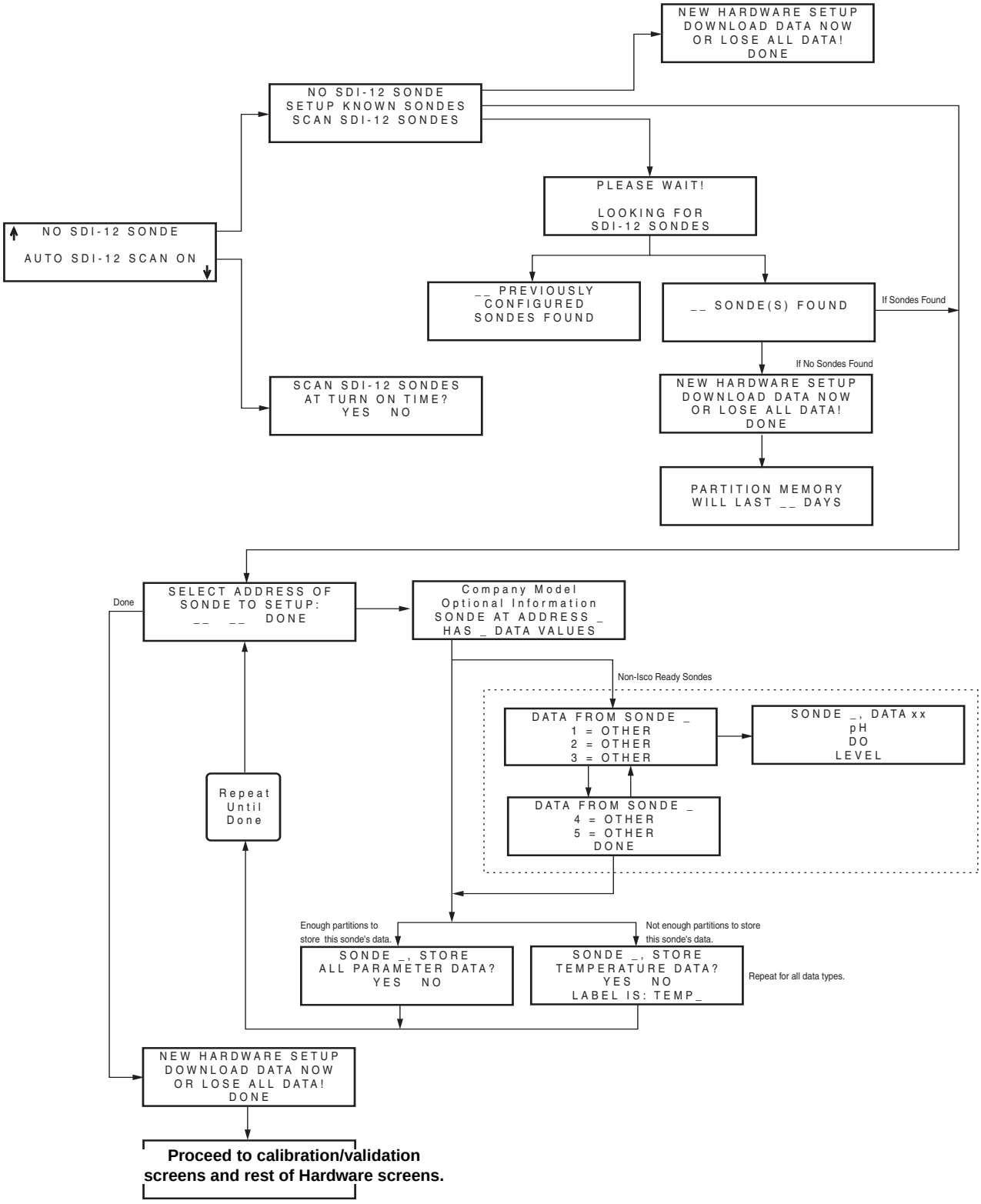


Figure A-24 SDI-12 Sonde Screens

6712 Portable Sampler

Appendix B Material Safety Data Sheets

This appendix provides Material Safety Data sheets for the internal desiccant used in the 6712 sampler.

Specific questions regarding the use and handling of these products should be directed to the manufacturer listed in the MSDS.

101 Christine Drive
Belen, New Mexico 87002
Phone: (505) 864-6691
Fax: (505) 861-2355

SÜD-CHEMIE
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MATERIAL SAFETY DATA SHEET -- September 28, 1998
SORB-IT®
Packaged Desiccant

SECTION I -- PRODUCT IDENTIFICATION

Trade Name and Synonyms:	Silica Gel, Synthetic Amorphous Silica, Silicon, Dioxide
Chemical Family:	Synthetic Amorphous Silica
Formula:	$SiO_2.x\ H_2O$

SECTION II -- HAZARDOUS INGREDIENTS

Components in the Solid Mixture

COMPONENT	CAS No	%	ACGIH/TLV (PPM)	OSHA-(PEL)
Amorphous Silica	63231-67-4	>99	PEL - 20 (RESPIRABLE), TLV – 5	LIMIT – NONE, HAZARD - IRRITANT ″

Synthetic amorphous silica is not to be confused with crystalline silica such as quartz, cristobalite or tridymite or with diatomaceous earth or other naturally occurring forms of amorphous silica that frequently contain crystalline forms.

This product is in granular form and packed in bags for use as a desiccant. Therefore, no exposure to the product is anticipated under normal use of this product. Avoid inhaling desiccant dust.

SECTION III -- PHYSICAL DATA

Appearance and Odor:	White granules; odorless.
Melting Point:	>1600 Deg C; >2900 Deg F
Solubility in Water:	Insoluble.
Bulk Density:	>40 lbs./cu. ft.
Percent Volatile by Weight @ 1750 Deg F:	<10%.

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SECTION IV -- FIRE EXPLOSION DATA

Fire and Explosion Hazard - Negligible fire and explosion hazard when exposed to heat or flame by reaction with incompatible substances.

Flash Point - Nonflammable.

Firefighting Media - Dry chemical, water spray, or foam. For larger fires, use water spray fog or foam.

Firefighting - Nonflammable solids, liquids, or gases: Cool containers that are exposed to flames with water from the side until well after fire is out. For massive fire in enclosed area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of the tank due to fire.

SECTION V -- HEALTH HAZARD DATA

Health hazards may arise from inhalation, ingestion, and/or contact with the skin and/or eyes. Ingestion may result in damage to throat and esophagus and/or gastrointestinal disorders. Inhalation may cause burning to the upper respiratory tract and/or temporary or permanent lung damage. Prolonged or repeated contact with the skin, in absence of proper hygiene, may cause dryness, irritation, and/or dermatitis. Contact with eye tissue may result in irritation, burns, or conjunctivitis.

First Aid (Inhalation) - Remove to fresh air immediately. If breathing has stopped, give artificial respiration. Keep affected person warm and at rest. Get medical attention immediately.

First Aid (Ingestion) - If large amounts have been ingested, give emetics to cause vomiting. Stomach siphon may be applied as well. Milk and fatty acids should be avoided. Get medical attention immediately.

First Aid (Eyes) - Wash eyes immediately and carefully for 30 minutes with running water.

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Packaged Desiccant

NOTE TO PHYSICIAN: This product is a desiccant and generates heat as it adsorbs water. The used product can contain material of hazardous nature. Identify that material and treat accordingly.

SECTION VI -- REACTIVITY DATA

Reactivity - Silica gel is stable under normal temperatures and pressures in sealed containers. Moisture can cause a rise in temperature which may result in a burn.

SECTION VII --SPILL OR LEAK PROCEDURES

Notify safety personnel of spills or leaks. Clean-up personnel need protection against inhalation of dusts or fumes. Eye protection is required. Vacuuming and/or wet methods of cleanup are preferred. Place in appropriate containers for disposal, keeping airborne particulates at a minimum.

SECTION VIII -- SPECIAL PROTECTION INFORMATION

Respiratory Protection - Provide a NIOSH/MSHA jointly approved respirator in the absence of proper environmental control. Contact your safety equipment supplier for proper mask type.

Ventilation - Provide general and/or local exhaust ventilation to keep exposures below the TLV. Ventilation used must be designed to prevent spots of dust accumulation or recycling of dusts.

Protective Clothing - Wear protective clothing, including long sleeves and gloves, to prevent repeated or prolonged skin contact.

Eye Protection - Chemical splash goggles designed in compliance with OSHA regulations are recommended. Consult your safety equipment supplier.

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Packaged Desiccant

SECTION IX -- SPECIAL PRECAUTIONS

Avoid breathing dust and prolonged contact with skin. Silica gel dust causes eye irritation and breathing dust may be harmful.

* No Information Available

HMIS (Hazardous Materials Identification System) for this product is as follows:

Health Hazard	0
Flammability	0
Reactivity	0
Personal Protection	HMIS assigns choice of personal protective equipment to the customer, as the raw material supplier is unfamiliar with the condition of use.

The information contained herein is based upon data considered true and accurate. However, United Desiccants makes no warranties expressed or implied, as to the accuracy or adequacy of the information contained herein or the results to be obtained from the use thereof. This information is offered solely for the user's consideration, investigation and verification. Since the use and conditions of use of this information and the material described herein are not within the control of United Desiccants, United Desiccants assumes no responsibility for injury to the user or third persons. The material described herein is sold only pursuant to United Desiccants' Terms and Conditions of Sale, including those limiting warranties and remedies contained therein. It is the responsibility of the user to determine whether any use of the data and information is in accordance with applicable federal, state or local laws and regulations.

Material Safety Data Sheet

Indicating Silica Gel

Identity (Trade Name as Used on Label)

Manufacturer :	MULTISORB TECHNOLOGIES, INC. (formerly Multiform Desiccants, Inc.)	MSDS Number* :	M75
Address:	325 Harlem Road Buffalo, NY 14224	CAS Number* :	
Phone Number (For Information):	716/824-8900	Date Prepared:	July 6, 2000
Emergency Phone Number:	716/824-8900	Prepared By* :	G.E. McKedy

Section 1 - Material Identification and Information

Components - Chemical Name & Common Names (Hazardous Components 1% or greater; Carcinogens 0.1% or greater)	%*	OSHA PEL	ACGIH TLV	OTHER LIMITS RECOMMENDED
Silica Gel SiO_2	98.0	6mg/m^3 (total dust)	10mg/m^3 (total dust)	
Cobalt Chloride	>2.0	0.05mg/m^3 (TWA cobalt metal dust & fume)	.05mg/m^3 (Cobalt, TWA)	
Non-Hazardous Ingredients				
TOTAL	100			

Section 2 - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_20 = 1)	2.1
Vapor Pressure (mm Hg and Temperature	N/A	Melting Point	N/A
Vapor Density (Air =1)	N/A	Evaporation Rate (_____=1)	N/A
Solubility in Water	Insoluble, but will adsorb moisture.	Water Reactive	Not reactive, but will adsorb moisture.
Appearance and Odor	Purple crystals, no odor.		

Section 3 - Fire and Explosion Hazard Data

Flash Point and Methods Used	N/A	Auto-Ignition Temperature	N/A	Flammability Limits in Air % by Volume	N/A	LEL	UEL
Extinguisher Media	Dry chemical, carbon dioxide and foam can be used.						
Special Fire Fighting Procedures	Water will generate heat due to the silica gel which will adsorb water and liberate heat.						
Unusual Fire and Explosion Hazards	When exposed to water, the silica gel can get hot enough to reach the boiling point of water. Flooding with water will reduce the temperature to safe limits.						

Section 4 - Reactivity Hazard Data

STABILITY ☐**Stable** ☐**Unstable**	Conditions To Avoid	Moisture and high humidity environments.
Incompatibility (Materials to Avoid)	Water.	
Hazardous Decomposition Products	Carbon dioxide, carbon monoxide, water	
HAZARDOUS POLYMERIZATION ☐May Occur	Conditions To Avoid	None.

*Optional

Section 5 - Health Hazard Data

PRIMARY ROUTES OF ENTRY	☐Inhalation ☐Skin Absorption	☐Ingestion ☐Not Hazardous	**CARCINOGEN LISTED IN**	☐NTP ☐IARC Monograph	☐OSHA ☐Not Listed
HEALTH HAZARDS	Acute	May cause eye, skin and mucous membrane irritation.			
	Chronic	Prolonged inhalation may cause lung damage.			
Signs and Symptoms of Exposure	Drying and irritation.				
Medical Conditions Generally Aggravated by Exposure	Asthma.				
EMERGENCY FIRST AID PROCEDURES - Seek medical assistance for further treatment, observation and support if necessary.					
Eye Contact	Flush with water for at least 15 minutes.				
Skin Contact	Wash affected area with soap and water.				
Inhalation	Remove affected person to fresh air.				
Ingestion	Drink at least 2 glasses of water.				

Section 6 - Control and Protective Measures

Respiratory Protection (Specify Type)	Use NIOSH approved dust mask or respirator.		
Protective Gloves	Light cotton gloves.	Eye Protection	Safety glasses.
VENTILATION TO BE USED	☐ Local Exhaust	☐Mechanical (General)	☐Special
	☐Other (Specify)		
Other Protective Clothing and Equipment	None.		
Hygienic Work Practices	Avoid raising dust. Avoid contact with skin, eyes and clothing.		

Section 7 - Precautions for Safe Handling and Use/Leak Procedures

Steps to be Taken if Material Is Spilled Or Released	Sweep or vacuum up and place the spilled material in a waste disposal container. Avoid raising dust.
Waste Disposal Methods	Dispose in an approved landfill according to federal, state and local regulations.
Precautions to be Taken In Handling and Storage	Cover promptly to avoid blowing dust. Wash after handling.
Other Precautions and/or Special Hazards	Keep in sealed containers away from moisture. The silica gel will readily adsorb moisture.

*Optional Indicating Silica Gel

6712 Portable Sampler

Appendix C General Safety Procedures

In field installations of Teledyne Isco wastewater samplers and associated equipment, the safety of the personnel involved should be the foremost consideration. The following sections provide safety procedures for working in and around manholes and sewers. the first section offers general safety advice. The second section deals with the special problem of hazardous gases found in sewers.

⚠ WARNING

The 6712 has not been approved for use in hazardous locations as defined by the National Electrical Code.

⚠ CAUTION

Before any sampler is installed, the proper safety precautions must be taken. The following discussions of safety procedures are only general guidelines. Each situation in which you install a flow meter varies. You must take into account the individual circumstances you are in. Additional safety considerations, other than those discussed here, may be required.

C.1 Practical Safety Precautions

The following procedures are those used by Black & Veatch, a respected consulting firm, and are published here by permission.

Field personnel must keep safety uppermost in their minds at all times. When working above ground, rules of common sense and safety prevail. However, when entering manholes, strict safety procedures must be observed. Failure to do so could jeopardize not only your own life, but also the lives of other crew members.

C.1.1 Hazards

There are many hazards connected with entering manholes. Some of the most common hazards are:

Adverse Atmosphere – The manhole may contain flammable or poisonous gases or the atmosphere may be deficient in oxygen. orced ventilation may be necessary.

Deteriorated Rungs – Manhole steps may be corroded and not strong enough to support a man. It may be difficult to inspect the rungs because of poor lighting.

Traffic – Whenever manholes are located in the traveled way, barricades and warning devices are essential to direct traffic away from an open manhole.

Falling Objects – Items placed near the manhole opening may fall and injure a worker in the manhole.

Sharp Edges – Sharp edges of items in or near a manhole may cause cuts or bruises.

Lifting Injuries – Unless proper tools are used to remove manhole covers, back injuries or injuries to hands or feet may result.

C.1.2 Planning

Advance planning should include arrangements for test equipment, tools, ventilating equipment, protective clothing, traffic warning devices, ladders, safety harness, and adequate number of personnel. Hasty actions may result in serious injuries. Time spent in the manhole should be kept to a minimum.

C.1.3 Adverse Atmospheres

[Refer to Table C-1, Hazardous Gases, at the end of this appendix.] Before workers enter a manhole, tests should be made for explosive atmosphere, presence of hydrogen sulfide, and oxygen deficiency. Combustible or toxic vapors may be heavier than air, so the tests on the atmosphere must be run at least 3/4 of the way down the manhole.

Whenever adverse atmosphere is encountered, forced ventilation must be used to create safe conditions. After the ventilating equipment has been operated for a few minutes, the atmosphere in the manhole should be retested before anyone enters the manhole.

When explosive conditions are encountered, the ventilating blower should be placed upwind to prevent igniting any gas that is emerging from the opening. When a gasoline engine blower is used, it must be located so that exhaust fumes cannot enter the manhole.

If testing equipment is not available, the manhole should be assumed to contain an unsafe atmosphere and forced ventilation must be provided. It should never be assumed that a manhole is safe just because there is no odor or the manhole has been entered previously.

C.1.4 Entering Manholes

Since the top of the manhole is usually flush with the surrounding surface, there may not be anything for the person who is entering the manhole to grab on to steady himself. Persons who are entering manholes should not be permitted to carry anything in their hands as they enter the manhole, to ensure that their hands will be free to hold on or grab if they slip. A good method for entering a manhole is to sit on the surface facing the manhole steps or ladder, with the feet in the hole and the arms straddling the opening for support. As the body slides forward and downward, the feet can engage a rung, and the back can rest against the opposite side of the opening. If there is any doubt about the soundness of the manhole steps, a portable ladder should be used.

A person should never enter a manhole unless he is wearing personal safety equipment, including a safety harness and a hard hat. Two persons should be stationed at the surface continuously while anyone is working inside a manhole, to lift him out if he is

overcome or injured. One man cannot lift an unconscious man out of a manhole. The persons stationed at the surface should also function as guards to keep people and vehicles away from the manhole opening. To avoid a serious injury, a person should not be lifted out of a manhole by his arm unless it is a dire emergency.

When more than one person must enter a manhole, the first person should reach the bottom and step off the ladder before the next one starts down. When two men climb at the same time, the upper one can cause the lower one to fall by slipping or stepping on his fingers.

C.1.5 Traffic Protection

In addition to traffic cones, markers, warning signs, and barricades, a vehicle or a heavy piece of equipment should be placed between the working area and oncoming traffic. Flashing warning signals should be used to alert drivers and pedestrians. Orange safety vests should be worn by personnel stationed at the surface when the manhole is located in a vehicular traffic area.

C.1.6 Falling Objects

All loose items should be kept away from the manhole opening. This applies to hand tools as well as stones, gravel and other objects.

C.1.7 Removing the Covers

Manhole covers should be removed with a properly designed hook. Use of a pick ax, screwdriver, or small pry bar may result in injury. A suitable tool can be made from $^{3}/_{4}$-inch round or hex stock. Two inches of one end should be bent at a right angle and the other end should be formed into a D-handle wide enough to accommodate both hands. Even with this tool, care must be exercised to prevent the cover from being dropped on the toes. The 2-inch projection should be inserted into one of the holes in the cover, the handle grasped with both hands, and the cover lifted by straightening the legs which have been slightly bent at the knees.

C.1.8 Other Precautions

Other precautions which should be taken when entering a manhole are:

- Wear a hard hat.
- Wear coveralls or removable outer garment that can be readily removed when the work is completed.
- Wear boots or nonsparking safety shoes.
- Wear rubberized or waterproof gloves.
- Wear a safety harness with a stout rope attached.
- Do not smoke.
- Avoid touching yourself above the collar until you have cleaned your hands.

C.1.9 Emergencies

Every member of the crew should be instructed on procedures to be followed in cases of an emergency. It is the duty of each crew chief to have a list of emergency phone numbers, including the nearest hospital and ambulance service, police precinct, fire station, and rescue or general emergency number.

C.1.10 Field Equipment

The following equipment will be available for use:

Blowers	Gloves	Traffic cones
Breathing apparatus	Hard Hats	Coveralls
Harnesses	First aid kits	Manhole irons
Emergency flashers	Pick axes	Flashlights
Rain slickers	Mirrors	Ropes
Gas detectors	Safety vests	Gas masks
Waders”		

C.2 Lethal Atmospheres in Sewers

The following is an article written by Dr. Richard D. Pomeroy, and published in the October 1980 issue of ***Deeds & Data*** of the WPCF. Dr. Pomeroy is particularly well known for his studies, over a period of nearly 50 years, in the field of the control of hydrogen sulfide and other odors in sewers and treatment plants. He has personally worked in a great many functioning sewers. In the earlier years he did so, he admits, with little knowledge of the grave hazards to which he exposed himself.

It is gratifying that the subject of hazards to people working in sewers is receiving much more attention than in past years, and good safety procedures are prescribed in various publications on this subject. It is essential that people know and use correct procedures.

It is less important to know just what the hazardous components of sewer atmospheres are, as safety precautions should in general be broadly applicable, but there should be a reasonable understanding of this subject. It is disturbing to see statements in print that do not reflect true conditions.

One of the most common errors is the assumption that people have died from a lack of oxygen. The human body is able to function very well with substantially reduced oxygen concentrations. No one worries about going to Santa Fe, New Mexico, (elev. 2,100 meters), where the partial pressure of oxygen is equal to 16.2% (a normal atmosphere is about 21%) oxygen. When first going there, a person may experience a little ‘shortness of breath’ following exercise. People in good health are not afraid to drive over the high passes in the Rocky Mountains. At Loveland Pass, oxygen pressure is 13.2% of a normal atmosphere. At the top of Mt. Whitney, oxygen is equal to 12.2%t. Many hikers go there, and to higher peaks as well. After adequate acclimation, they may climb to the top of Mt. Everest, where oxygen is equal to only 6.7%.

The lowest oxygen concentrations that I have observed in a sewer atmosphere was 13 percent. It was in a sealed chamber, near sea level, upstream from an inverted siphon on a metropolitan trunk. A man would be foolish to enter the chamber. Without ventilation, he might die, but not from lack of oxygen.

It seems unlikely that anyone has ever died in a sewer from suffocation, that is, a lack of oxygen. Deaths have often been attributed to 'asphyxiation.' This is a word which, according to the dictionary, is used to mean death from an atmosphere that does not support life. The word has sometimes been misinterpreted as meaning suffocation, which is only one kind of asphyxiation.

In nearly all cases of death in sewers, the real killer is hydrogen sulfide. It is important that this fact be recognized. Many cities diligently test for explosive gases, which is very important, and they may measure the oxygen concentration which usually is unimportant, but they rarely measure H_2S. Death has occurred where it is unlikely that there was any measurable reduction in the oxygen concentration. Waste water containing 2 mg per liter of dissolved sulfide, and at a pH of 7.0, can produce, in a chamber with high turbulence, a concentration of 300 PPM H_2S, in the air. This is considered to be a lethal concentration. Many people have died from H_2S, not only in sewers and industries, but also from swamps and from hot springs. In one resort area, at least five persons died from H_2S poisoning before the people were ready to admit that H_2S is not a therapeutic agent. Hardly a year passes in the U.S. without a sewer fatality from H_2S as well as deaths elsewhere in the world.

The presence of H_2S in a sewer atmosphere is easily determined. A bellows-and-ampoule type of tester is very satisfactory for the purpose, even though it is only crudely quantitative. When using a tester of this type, do not bring the air to the ampoule by way of a tube, as this may change the H_2S concentration. Hang the ampoule in the air to be tested, with a suction tube to the bulb or bellows.

Lead acetate paper is very useful as a qualitative indicator. It cannot be used to estimate the amount of sulfide, but it will quickly turn black in an atmosphere containing only a tenth of a lethal concentration.

Electrodes or other similar electrical indicating devices for H_2S in air have been marketed. Some of them are known to be unreliable, and we know of none that have proved dependable. Do not use one unless you check it at frequent intervals against air containing known H_2S concentrations. A supposed safety device that is unreliable is worse than none at all.

Remember that the nose fails, too, when it comes to sensing dangerous concentrations of H_2S.

Various other toxic gases have been mentioned in some publications. It is unlikely that any person has been asphyxiated in a sewer by any of those other gases, except possibly chlorine. The vapor of gasoline and other hydrocarbons is sometimes present in

amounts that could cause discomfort and illness, but under that condition, the explosion hazard would be far more serious. The explosimeter tests, as well as the sense of smell, would warn of the danger. Pipelines in chemical plants might contain any number of harmful vapors. They, too, are sensed by smell and explosimeter tests if they get into the public sewer. Such occurrences are rare.

The attempt to instill a sense of urgency about real hazards is diluted if a man is told to give attention to a long list of things that in fact are irrelevant.

Be very careful to avoid high H_2S concentrations, flammable atmospheres, and hazards of physical injuries. Remember that much H_2S may be released by the stirring up of sludge in the bottom of a structure. Obey your senses in respect to irritating gases, such as chlorine (unconsciousness comes suddenly from breathing too much). Be cautious about strange odors. Do not determine percent oxygen in the air. There is a danger that the result will influence a man's thinking about the seriousness of the real hazards. Most important, use ample ventilation, and do not enter a potentially hazardous structure except in a good safety harness with two men at the top who can lift you out."

C.3 Hazardous Gases

The following table contains information on the properties of hazardous gases.

Table C-1 Hazardous Gases

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air =1	Physiological Effect	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Ammonia	NH_3	Irritant and poisonous. Colorless with characteristic odor.	0.60	Causes throat and eye irritation at 0.05%, coughing at 0.17%. Short exposure at 0.5% to 1% fatal.	300 to 500	85	16 25	Near top. Concentrates in closed upper spaces	Sewers, chemical feed rooms.	Detectable odor at low concentrations
Benzene	C_6H_6	Irritant, colorless anesthetic	2.77	Slight symptoms after several hours exposure at 0.16% to 0.32%. 2% rapidly fatal.	3,000 to 5,000	25	1.3 7.1	At bottom.	Industrial wastes, varnish, solvents.	Combustible gas indicator
Carbon Bisulfide	CS_2	Nearly odorless when pure, colorless, anesthetic. Poisonous.	2.64	Very poisonous, irritating, vomiting, convulsions, psychic disturbance.	—	15	1.3 44.0	At bottom	An insecticide	Combustible gas indicator

Table C-1 Hazardous Gases (Continued)

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air =1	Physiological Effect	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Carbon Dioxide	CO_2	Asphyxiant, Colorless, odorless. When breathed in large quantities, may cause acid taste. Non-flammable. Not generally present in dangerous amounts unless an oxygen deficiency exists.	1.53	Cannot be endured at 10% more than a few minutes, even if subject is at rest and oxygen content is normal. Acts on respiratory nerves.	40,000 to 60,000	5,000	— —	At bottom; when heated may stratify at points above bottom.	Products of combustion, sewer gas, sludge. Also issues from carbonaceous strata.	Oxygen deficiency indicator
Carbon Monoxide	CO	Chemical asphyxiant. Colorless, odorless, tasteless. Flammable. Poisonous.	0.97	Combines with hemoglobin of blood. Unconsciousness in 30 min. at 0.2% to 0.25%. Fatal in 4 hours at 0.1%. Headache in few hours at 0.02%.	400	50	12.5 74.0	Near top, especially if present with illuminating gas.	Manufactured gas, flue gas, products of combustion, motor exhausts. Fires of almost any kind.	CO ampoules.
Carbon Tetra-Chloride	CCl_4	Heavy, ethereal odor.	5.3	Intestinal upset, loss of consciousness, possible renal damage, respiratory failure.	1,000 to 1,500	100	— —	At bottom.	Industrial wastes, solvent, cleaning	Detectable odor at low concentrations.
Chlorine	Cl_2	Irritant. Yellow-green color. Choking odor detectable in very low concentrations. Non-flammable.	2.49	Irritates respiratory tract. Kills most animals in a very short time at 0.1%.	4	1	— —	At bottom.	Chlorine cylinder and feed line leaks.	Detectable odor at low concentrations.
Formaldehyde	CH_2O	Colorless, pungent suffocating odor.	1.07	Irritating to the nose.	—	10	7.0 73.0	Near bottom.	Incomplete combustion of organics. Common air pollutant, fungicide.	Detectable odor.
Gasoline	C_5H_{12} to C_9H_{20}	Volatile solvent. Colorless. Odor noticeable at 0.03%. Flammable.	3.0 to 4.0	Anesthetic effects when inhaled. Rapidly fatal at 2.4%. Dangerous for short exposure at 1.1 to 2.2%.	4,000 to 7,000	1,000	1.3 6.0	At bottom.	Service stations, garages, storage tanks, houses.	1. Combustible gas indicator. 2. Oxygen deficiency indicator.**
Hydrogen	H_2	Simple asphyxiant. Colorless, odorless, tasteless. Flammable	0.07	Acts mechanically to deprive tissues of oxygen. Does not support life.	—	—	4.0 74.0	At top.	Manufactured gas, sludge digestion tank gas, electrolysis of water. Rarely from rock strata.	Combustible gas indicator.
Hydrogen Cyanide	HCN	Faint odor of bitter almonds. Colorless gas	0.93	Slight symptoms appear upon exposure to 0.002% to 0.004%. 0.3% rapidly fatal.	—	10	6.0 40.0	Near top.	Insecticide and rodenticide.	Detector tube

Table C-1 Hazardous Gases (Continued)

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air =1	Physiological Effect	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air = 1	Physiological Effect*	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air.) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Hydrogen Sulfide	H_2S	Irritant and poisonous volatile compound. Rotten egg odor in small concentrations. Exposure for 2 to 15 min. at 0.01% impairs sense of smell. Odor not evident at high concentrations. Colorless. Flammable.	1.19	Impairs sense of smell, rapidly as concentration increases. Death in few minutes at 0.2%. Exposure to 0.07 to 0.1% rapidly causes acute poisoning. Paralyzes respiratory center.	200 to 300	20	4.3 45.0	Near bottom, but may be above bottom if air is heated and highly humid.	Coal gas, petroleum, sewer gas. Fumes from blasting under some conditions. Sludge gas.	1. H_2S Ampoule. 2. 5% by weight lead acetate solution.
Methane	CH_4	Simple asphyxiant. Colorless, odorless, tasteless, flammable.	0.55	Acts mechanically to deprive tissues of oxygen. Does not support life.	Probably no limit, provided oxygen percentage is sufficient for life.	—	5.0 15.0	At top, increasing to certain depth.	Natural gas, sludge gas, manufactured gas, sewer gas. Strata of sedimentary origin. In swamps or marshes.	1. Combustible gas indicator 2. Oxygen deficiency indicator.
Nitrogen	N_2	Simple asphyxiant. Colorless, tasteless. Non-flammable. Principal constituent of air. (about 79%).	0.97	Physiologically inert.	—	—	— —	Near top, but may be found near bottom.	Sewer gas. sludge gas. Also issues from some rock strata.	Oxygen deficiency indicator.
Nitrogen Oxides	NO N_2O NO_2	Colorless Colorless, sweet odor. Reddish-brown. Irritating odor. Deadly poison	1.04 1.53 1.58	60 to 150 ppm cause irritation and coughing. Asphyxiant. 100 ppm dangerous. 200 ppm fatal.	50	10	— —	Near bottom.	Industrial wastes. Common air pollutant.	NO_2 detector tube.
Oxygen	O_2	Colorless, odorless, tasteless. Supports combustion.	1.11	Normal air contains 20.8% of O_2. Man can tolerate down to 12%. Minimum safe 8 hour exposure, 14 to 16%. Below 10%, dangerous to life. Below 5 to 7% probably fatal.	—	—	— —	Variable at different levels.	Oxygen depletion from poor ventilation and absorption, or chemical consumption of oxygen.	Oxygen deficiency indicator.
Ozone	O_3	Irritant and poisonous. Strong electrical odor. Strong oxidizer. Colorless. At 1 ppm, strong sulfur-like odor.	1.66	Max. naturally occurring level is 0.04 ppm. 0.05 ppm causes irritation of eyes and nose. 1 to 10 ppm causes headache, nausea; can cause coma. Symptoms similar to radiation damage.	0.08	0.04	— —	Near bottom.	Where ozone is used for disinfection.	Detectable odor at 0.015 ppm.

Table C-1 Hazardous Gases (Continued)

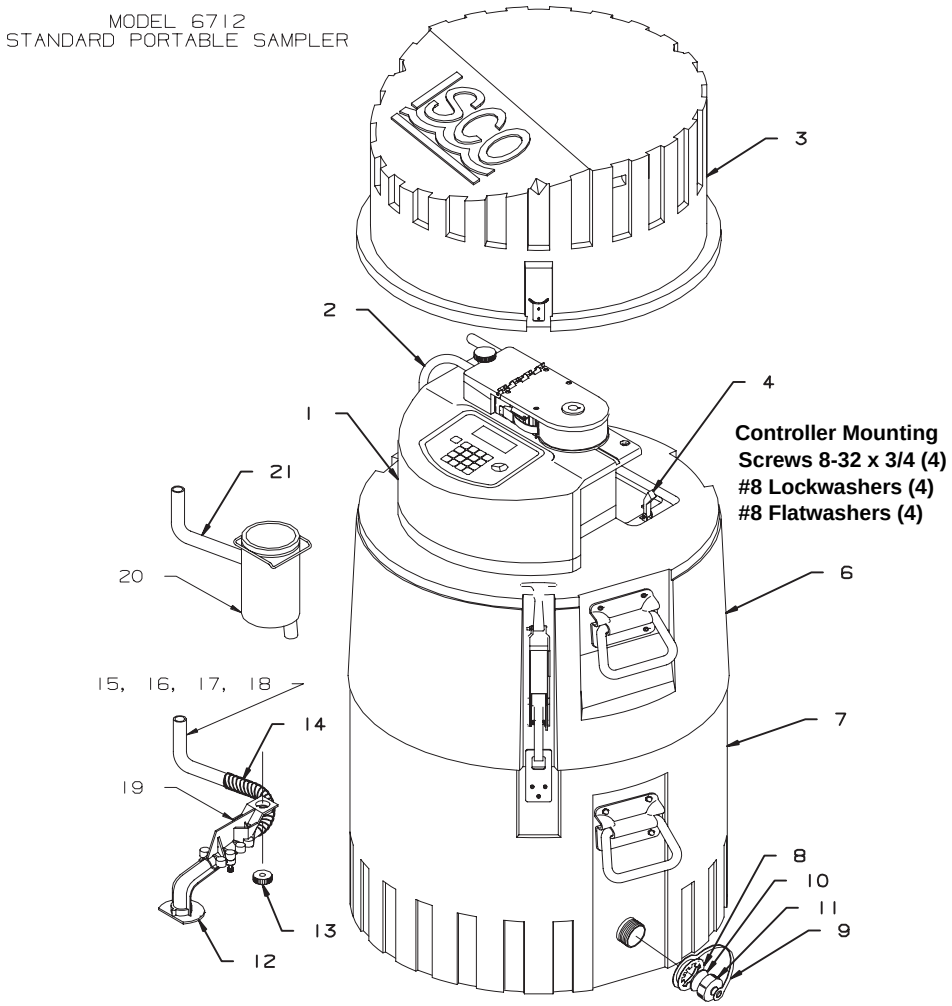
Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air =1	Physiological Effect	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Sludge Gas	—***	Mostly a simple asphyxiant. May be practically odorless, tasteless.	Variable	Will not support life.	No data. Would vary widely with composition.		5.3 19.3	Near top of structure.	From digestion of sludge.	See components.
Sulfur Dioxide	SO_2	Colorless, pungent odor. Suffocating, corrosive, poisonous, non-flammable.	2.26	Inflammation of the eyes. 400 to 500 ppm immediately fatal.	50 to 100	10	— —	At bottom, can combine with water to form sulfurous acid.	Industrial waste, combustion, common air pollutant.	Detectable taste and odor at low concentration.
Toluene	C_5H_{12} to C_9H_{20}	Colorless, benzene-like odor.	3.14	At 200-500 ppm, headache, nausea, bad taste, lassitude.	200	100	1.27 7.0	At bottom.	Solvent.	Combustible gas indicator.
Turpentine	$C_{10}H_{16}$	Colorless, Characteristic odor.	4.84	Eye irritation. Headache, dizziness, nausea, irritation of the kidneys.	—	100		At bottom.	Solvent, used in paint.	1. Detectable odor at low concentrations. 2.Combustible gas indicator.
Xylene	C_8H_{10}	Colorless, flammable	3.66	Narcotic in high concentrations. less toxic than benzene.	—	100	1.1 7.0	At bottom.	Solvent	Combustible gas indicator.

* Percentages shown represent volume of gas in air.
** For concentration over 0.3%.
***Mostly methane and carbon dioxide with small amounts of hydrogen, nitrogen, hydrogen sulfide, and oxygen; occasionally traces of carbon monoxide.

6712 Portable Sampler

Appendix D Replacement Parts List

The following appendix contains illustrated replacement parts listings, including part descriptions and order numbers.

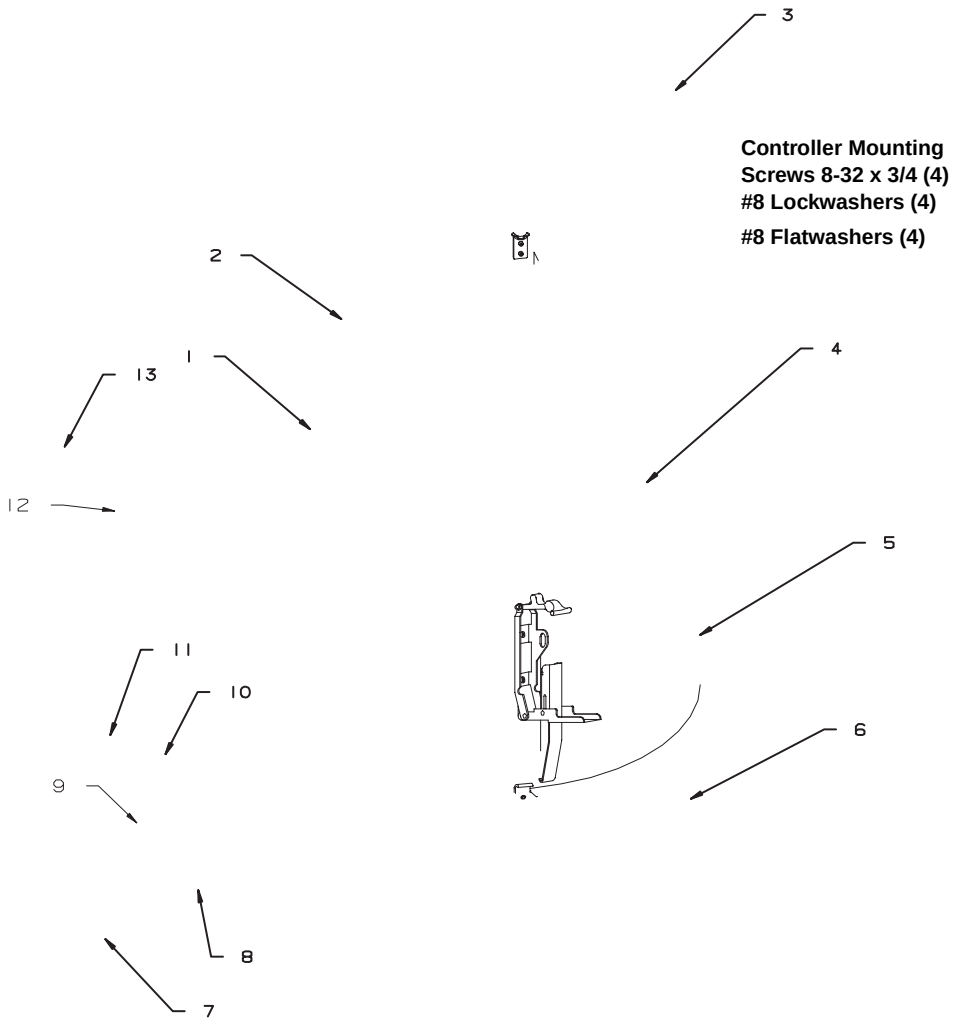


ITEM	INVENTORY NO.	DESCRIPTION
1	609004330	MO E 12 CONTROL E \
2	609004157	PUMP TUBE QUICK DISCONNECT
3	609004247	TOP COVER ASSY STD
4	109060503	DRAW LATCH ASSY SMALL
5*	609003088	BULKHEAD FITTING
6	609004246	CENTER SECTION ASSY STD (INCLUDES ITEM 4)
7	609004052	SAMPLE TUB ASSY STD (INCLUDES ITEMS 8-11)
8	209001828	RTNG RING SST .875SFT 1.20D
9	609003250	DRAIN CAP STRAP
10	603113032	GASKET CONNECTOR CAP
11	609003294	DRAIN CAP
12	609004020	DIST ARM ASSY BOTTOM
13	602923007	DISTRIBUTOR ARM NUT
14	609003317	SPRING DISTRIBUTOR ARM
15	609003260	DISCHARGE TUBE FOR STANDARD 24 BOTTLE KIT
16	609003262	DISCHARGE TUBE FOR STANDARD 12 BOTTLE KIT
17	609003264	DISCHARGE TUBE FOR STANDARD 8 BOTTLE KIT
18	609003266	DISCHARGE TUBE FOR STANDARD 4 BOTTLE KIT
19	609004019	DIST ARM TOP ASSY
20	609004051	COMPOSITE TUBE GUIDE (FOR STANDARD AND COMPACT)
21	609003271	DISCHARGE TUBE FOR STANDARD 1 BOTTLE KITS
22*	609004194	5 GALLON BOTTLE BASE

*-NOT SHOWN

DWG 60-9002-065

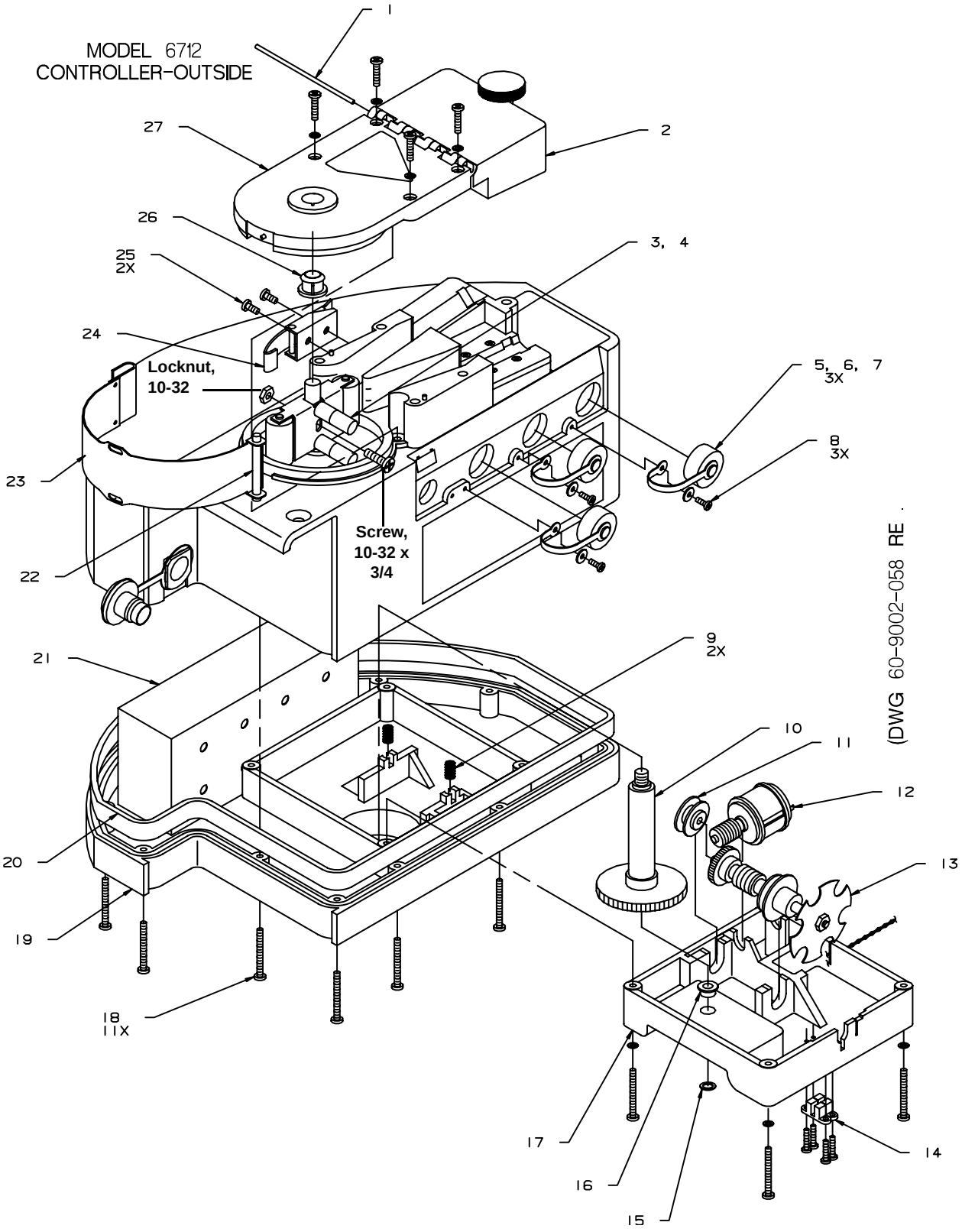
EL 6712
COMPACT PORTAB E SAMP ER



ITC	1 E TOR	E I TI
1	609004330	MODEL 6712 CONTROLLER
2	609004157	PUMP TUBE QUICK DISCONNECT
3	609004248	TOP COVER ASSY CMPT
4	109060503	DRAW LATCH ASSY SMALL
5	609004245	CENTER SECTION ASSY CMPT (INCLUDES ITEM 4)
6	603704129	SAMPLE TUB ASSY CMPCT
7	609004020	DIST ARM ASSY BOTTOM
8	602923007	DISTRIBUTOR ARM NUT
9	609004019	DIST ARM ASSY TOP
10	609003317	SPRING DISTRIBUTOR ARM
11	609003257	DISCHARGE TUBE FOR COMPACT 24 & 12 BOTTLE KITS
12	609004051	COMPOSITE TUBE GUIDE (FOR STANDARD AND COMPACT)
13	609003258	DISCHARGE TUBE FOR COMPACT 1 BOTTLE KITS
14*	609003088	BULKHEAD FITTING
15*	603704181	1 1 C C

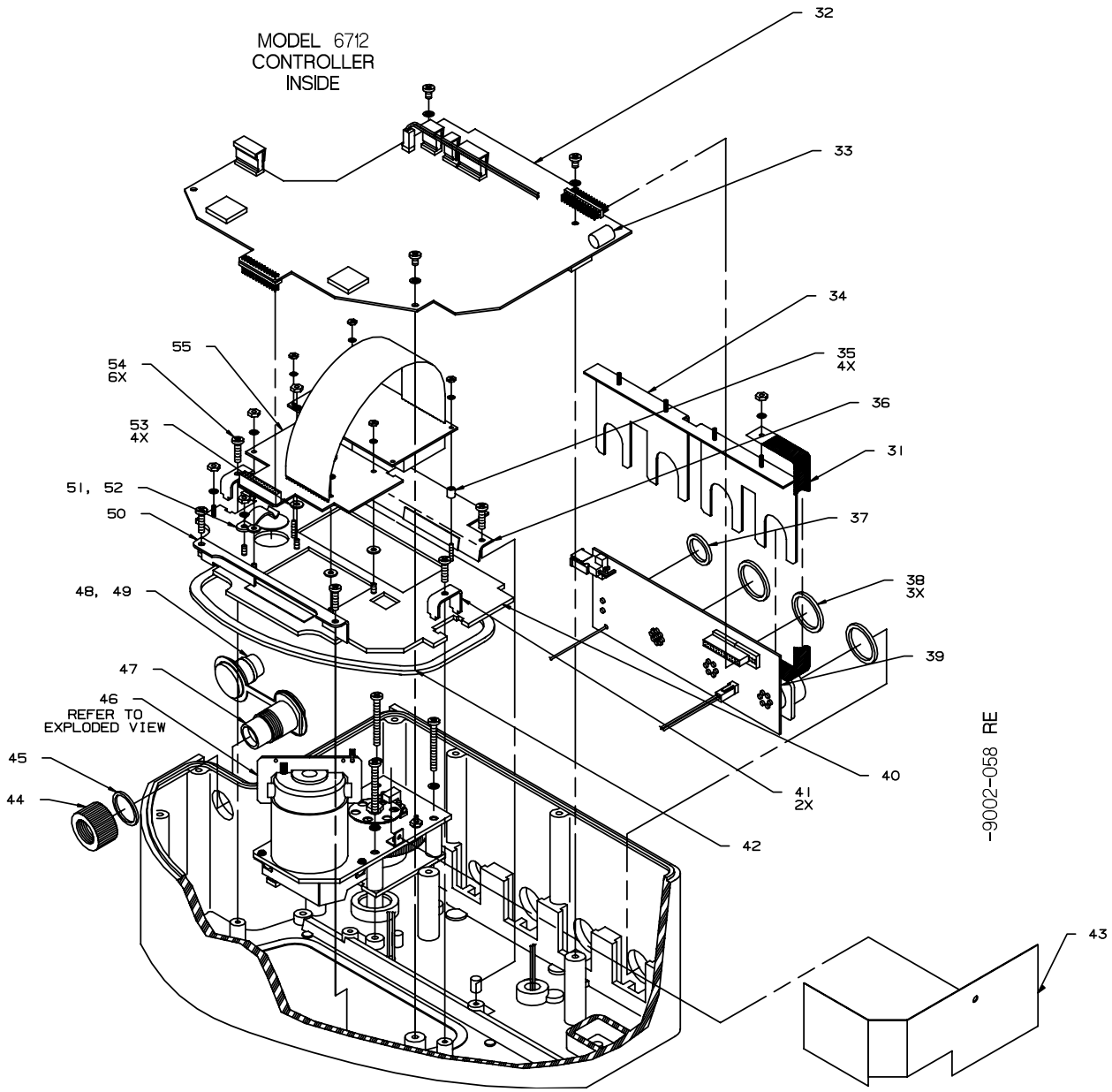
*-NOT SHOWN

DWG 60-9002-066


MODEL 6712
CONTROLLER-OUTSIDE
1
2
3, 4
5, 6, 7
3X
8
3X
9
2X
10
11
12
13
14
15
16
17
18
11X
19
20
21
22
23
24
25
2X
26
27
Locknut,
10-32
Screw,
10-32 x
3/4
(DWG 60-9002-058 RE

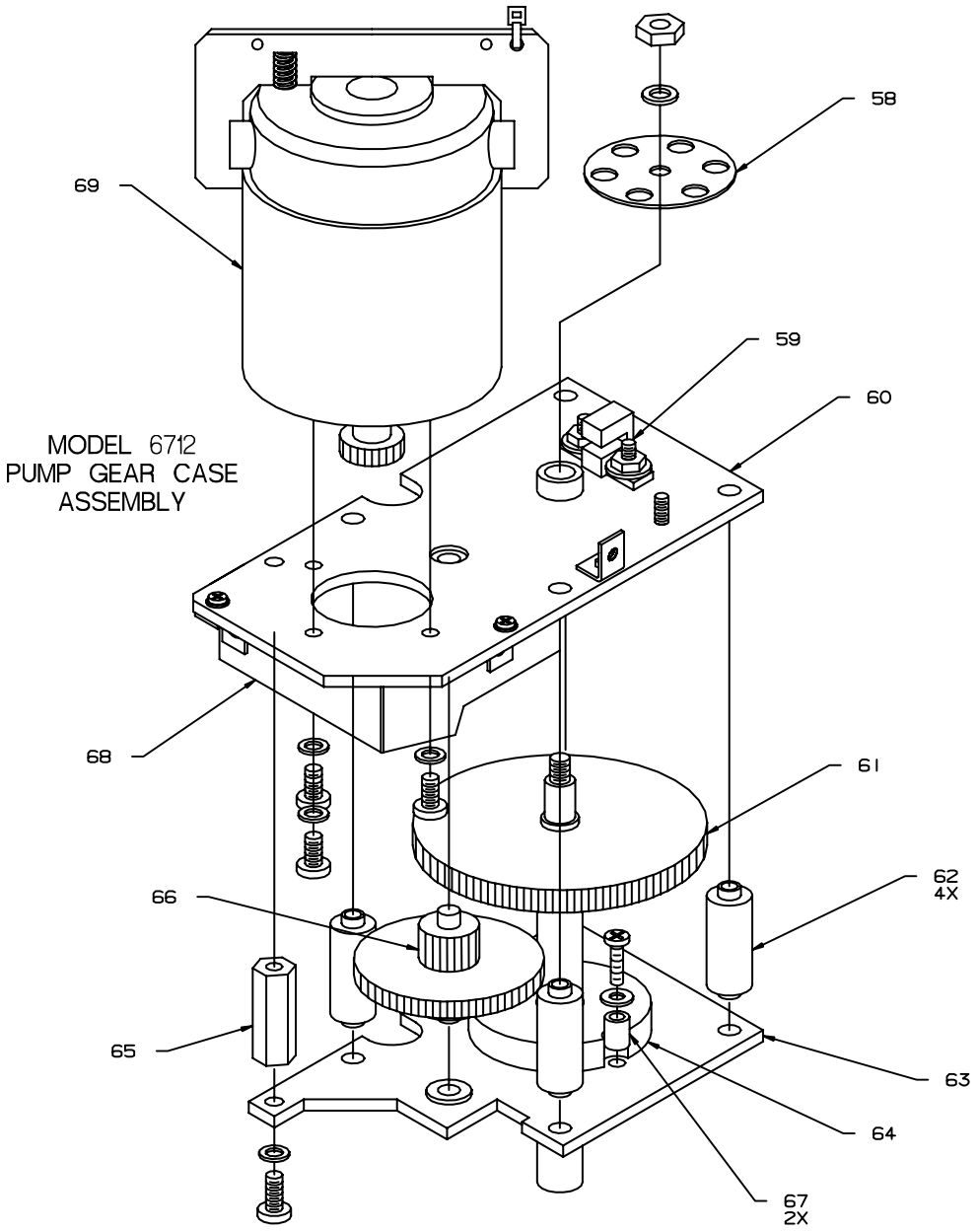
ITEM	INVENTORY NO.	DESCRIPTION
1	609003035	PIN HNG .09X3.635
2	609004013	LID ASSY LIQ DET
3	609004009	PMP PADDLE ASSY
4	232916101	NUT S 10-32
5	603113024	CAP CONN PTCTR MDM
6	603113032	GSKT CONN CAP MDM
7	609003291	STRAP CONN CAP
8	231310106	SCR SLFTPG #4X3/8
9	203012203	SPR CPRSN .042WIRE
10	609004016	SFT ASSY DISTR
11	609003040	BSHG .184 ID
12	609004014	DISTR MOT ASSY
13	609004015	SFT ASSY WORM
14	609004114	OPT SNSR ASSY
15	209000900	RTNG RING EXT.211D
16	201312300	BRG CYL.250ID.380D
17	609003007	PL TOP DISTR (ENV)
18	231014436	SCR PNH 6-32X1 1/8
19	609004011	CONT BOX S/A BOT
20	609003054	GSKT CONT BOX
21	699003518	BOX 2.88X2.33X5.13
22	609003052	PIN HNG .18X2.000
23	609004300	PMP HSG BND ASSY
24	109080300	LCH DRAW SST
25	231311206	SCR SLFTPG #6X3/8
26	603703278	BSHG PMP (ENV)
27	609004295	PMP COV ASSY
*28	202999100	SEAL .625IDX1.000D

NOTE: * ITE T T SHOWN T T TR-TI


MODEL 6712
CONTROLLER
INSIDE
32
33
34
35
4X
36
31
37
38
3X
39
40
41
2X
42
43
54
6X
55
53
4X
51, 52
50
48, 49
47
46
REFER TO
EXPLODED VIEW
45
44
-9002-058 RE

ITEM	INVENTORY NO.	DESCRIPTION
31	609003407	STRAP INTCON 3.5"
32	609004324	CBA CPU YSI CE
33	340500000	BAT 2/3A LITHIUM
34	609004201	RTNG CLIP ASSY CE
35	609003077	SPCR .188 X 0.25 L
36	609003132	HLDN CONT PNL TOP
37	202400114	O RING .612ID .103
38	202400118	O-RING .862ID .103
39	609004346	CBA 6712 CONN 2001
40	609004328	CONT PNL ASSY CE
41	609003029	HLDN CONT PNL
42	609003066	GSKT CONT PNL
43	699003554	SHLD MN PCB
44	609003020	NUT CONN
45	202100018	O-RING .739ID .070
46	609004301	PMP GR CS ASSY CE (INCLUDES ITEMS 59 THRU 69)
47	609004206	CONN ASSY 8 PIN CE
48	609003074	STRAP P
49	609003075	P FL MDL CONN
50	609003133	HLDN CONT PNL BOT
51	209902138	CLIP TNSN .375 DIA
52	490001300	HMD INDCTR CARD
53	233040405	WSHR FL .125 NYL
54	231514920	SCR SLFTPG6-19X5/8
55	609004006	DSPL KYPD ASSY
57	232910100	NUT S 4-40

NOTE: * ITC I T SHOW 1 I TR-TI



(DWG 60-9002-058 RE)

ITEM	INVENTORY NO.	DESCRIPTION
58	609003112	DISK OPT
59	609004203	WGR ASSY PMP SNSR
60	609004296	MOT MTG PL ASSY CE
61	609004304	PMP SFT ASSY
62	602703129	STDF DISTR GR CS
63	609004298	MTG PL ASSY PMP
64	609004305	SPCR 1.38 X 0.31 L
65	237263210	STDF 6-32 X 1.00 L
66	609004303	GR ASSY
67	237012000	SPACER, .140 ID X .313 OD X .312 LONG
68	699003555	SHLD DSPL
69	609004046	MOT ASSY

6712 Portable Sampler

Appendix E Accessories List

E.1 Order Information

Prices available on request. Additional items appear in *Appendix D, Replacement Parts List*. Many other items are available. To order any item, contact your sales representative or the factory. Note that the part name listed on your order acknowledgment and invoice may be different from the item name listed here. When examining these documents, use the part number for reference.

Teledyne Isco, Inc.
P.O. Box 82531
Lincoln, NE 68501
Telephone Within U.S.A.
Toll free: (800) 228-4373
Outside U.S.A.:(402) 464-0231
Fax: (402) 465-3022
IscoCSR@teledyne.com

E.2 Controller, Center Sections, Top Covers, and Tubs

6712 Sampler Controller 68-6710-074
(Includes 2 Pump Tubes)
6712 Portable Sampler Instruction Manual 60-9004-334
6712 Portable Sampler Pocket Guide 60-9003-589
Compact Center Section 60-9004-245
Compact Tub 60-3704-129
Mini-Tub (for use with Compact Tub and multiple bottle carrier only) 60-3704-181
Compact Top Cover 60-9004-248
Standard Center Section 60-9004-246
Standard Top Cover 60-9004-247
Standard Tub 60-9004-052

E.3 Compact and Mini Sampler Bottle Kits

24-Bottle Kit (500-milliliter Polyethylene Bottles) 68-6700-022
(Includes Bottle Carrier, Bottles, Retaining Ring and 2 Discharge Tubes.)
12-Bottle Kit (500-milliliter Polyethylene Bottles) 68-6700-023
(Includes Bottle Carrier, Retaining Ring, Bottles, and 2 Discharge Tubes.)
12-Bottle Kit (375-milliliter Glass Bottles) 68-6700-024
(Includes Bottle Carrier, Retaining Ring, Bottles, and 2 Discharge Tubes.)

E.4 Compact Sampler Bottle Kits

1-Bottle Kit (9.4-liter Polyethylene) 68-6700-025
(Includes Bottle and 2 Discharge Tubes.)

1-Bottle Kit (9.4-liter Glass Bottle) 68-6700-026
(Includes Bottle and 2 Discharge Tubes.)

E.5 Standard Sampler Bottle Kits

24-Bottle Kit (1,000-milliliter Polypropylene Bottles) 68-6700-006
(Includes Retaining Ring, Bottles, and 2 Discharge Tubes.)

24-Bottle Kit (350-milliliter Glass Bottles) 68-6700-007
(Includes Retaining Ring, Bottles, and 2 Discharge Tubes.)

12-Bottle Kit (1,000-milliliter Polypropylene Bottles) 68-6700-008
(Includes Insert, Bottles, Retaining Ring, and 2 Discharge Tubes.)

12-Bottle Kit (950-milliliter Glass Bottles) 68-6700-009
(Includes Insert, Retaining Ring Bottles, and 2 Discharge Tubes.)

8-Bottle Kit (2.0-liter Polyethylene Bottles) 68-6700-010
(Includes Insert, Bottles, Retaining Ring, and 2 Discharge Tubes.)

8-Bottle Kit (1.8-liter Glass Bottles) 68-6700-011
(Includes Insert, Bottles, Retaining Ring, and 2 Discharge Tubes.)

4-Bottle Kit (3.7-liter Polyethylene Bottles) 68-6700-012
(Includes Bottles, Rack, and 2 Discharge Tubes.)

4-Bottle Kit (3.7-liter Glass Bottles) 68-6700-013
(Includes Bottles, Rack, and 2 Discharge Tubes.)

1-Bottle Kit (9.4-liter Polyethylene Bottle) 68-6700-014
(Includes Bottle and 2 Discharge Tubes.)

1-Bottle Kit (9.4-liter Glass Bottle) 68-6700-015
(Includes Bottle and 2 Discharge Tubes.)

4 (15 Liter) Gallon Bottle Configuration 68-6700-080
(Includes Jumbo Base, Polyethylene Bottle, Cap, Two Discharge Tubes, and Composite Tube Guide.)

5 Gallon (19 Liter) Bottle Configuration 68-6700-078
(Includes Jumbo Base, Glass Bottle, Cap, Teflon Cap Liner, Two Discharge Tubes, and Composite Tube Guide.)

5.5 Gallon (20.8 Liter) Bottle Configuration
(Includes Jumbo Base, Polyethelene Bottle, Cap, Two Discharge Tubes, and Composite Tube Guide.)

ProPak Starter Kit 68-6700-112
(Includes 24 holders with caps, 100 liners, retaining ring, instruction video, instruction sheet.)

ProPak Configuration Kit for 6700 Full-size Samplers 68-6700-105
(Includes 25 holders, 1,000 liners, retaining ring, instruction video, instruction sheet.)

ProPak holders with caps, and standard liners (24) 68-6700-087

ProPak disposable liners, 1-liter polyethylene (100) 68-6700-113

ProPak disposable liners, 1-liter polyethylene (500) 68-6700-114

ProPak disposable liners, 1-liter polyethylene (1000) 68-6700-096

ProPak labels (1000) 68-6700-100

ProPak retaining ring for 24 holders 60-9003-475

E.6 Bottle Carriers, Retaining Rings and Racks, Bottle Inserts, Discharge Tubes

Bottle Carrier for Compact 12-Bottle Kits 60-9004-131
Bottle Carrier for Compact 24-Bottle Kits 60-9004-132
Retaining Ring for Compact 12-Bottle Kits 60-2904-062
Retaining Ring for Compact 24-Bottle Kits 60-9003-235
Retaining Ring for Standard 24-Bottle Kit (1000-milliliter Polypropylene Bottles) 60-9003-242
Retaining Ring for Standard 24-Bottle Kit (350 milliliter Glass Bottles) 60-2703-011
Retaining Ring for Standard 12-Bottle Kits 60-3704-112
Bottle Insert for Standard 12-Bottle Kits 60-9004-147
Retaining Ring for Standard 8-Bottle Kits 60-9004-149
Bottle Insert for Standard 8-Bottle Kits 60-9004-146
Retaining Rack for Standard 4-Bottle Kits 60-9004-351
Discharge Tube for Compact 12- Bottle Kit and 24-Bottle Kit 60-9003-257
Discharge Tube for Compact 1 Bottle Kit 60-9003-258
Discharge Tube for Standard 24-Bottle Kit 60-9003-260
Discharge Tube for Standard 12-Bottle Kit 60-9003-262
Discharge Tube for Standard 8-Bottle Kit 60-9003-264
Discharge Tube for Standard 4-Bottle Kit 60-9003-266
Discharge Tube for Standard 1-Bottle Kits 60-9003-271
Bulk Discharge Tube (10 foot Length) 60-6700-046
Bulk Discharge Tube (50 foot Length) 60-6700-047

E.7 Bulk Sets of Bottles with Lids

Set of 24, 500-milliliter Polyethylene Bottles with Polyethylene Foam Lined Lids 68-2900-002
Set of 100, 500-milliliter Polyethylene Bottles with Polyethylene Foam Lined Lids 68-6700-027
Set of 500, 500-milliliter Polyethylene Bottles with Polyethylene Foam Lined Lids 68-6700-028
Set of 12, 500-milliliter Polyethylene Bottles with Unlined Lids 68-2900-014
Set of 100, 500-milliliter Polyethylene Bottles with Unlined Lids 68-6700-029
Set of 500, 500-milliliter Polyethylene Bottles with Unlined Lids 68-6700-030
Set of 12, 375-milliliter Glass Bottles 68-2900-015
Set of 100, 375-milliliter Glass Bottles 68-6700-031
Set of 24, 1,000-milliliter Polypropylene Bottles with Polyethylene Foam Lined Lids 68-2100-007
Set of 100, 1,000-milliliter Polypropylene Bottles with Polyethylene Foam Lined Lids 68-3700-046
Set of 500, 1,000-milliliter Polypropylene Bottles with Polyethylene Foam Lined Lids 68-3700-047
Set of 24, 350-milliliter Glass Bottles with Teflon Lined Lids 68-2100-001
Set of 100, 350-milliliter Glass Bottles with Teflon Lined Lids 68-3700-048
Set of 12, 1,000-milliliter Polypropylene Bottles with Lids 68-3700-035
Set of 100, 1,000-milliliter Polypropylene Bottles with Lids 68-6700-016
Set of 500, 1,000-milliliter Polypropylene Bottles with Lids 68-6700-017
Set of 12, 950-milliliter Bottles 68-3700-023
Set of 100, 950-milliliter Bottles with Teflon Lined Lids 68-6700-018
Set of 8, 2.0-liter Polyethylene Bottles with Unlined Lids 68-2740-026
Set of 100, 2.0-liter Polyethylene Bottles with Unlined Lids 68-3720-028

Set of 8, 1.8-liter Glass Bottles with Teflon Lined Lids 68-2740-027
Set of 100, 1.8-liter Glass Bottles with Teflon Lined Lids 68-3720-030
3.7-liter Glass Bottles with Teflon Lined Lids 68-6700-147
3.7-liter Polyethylene Bottles with Unlined Lids 68-2910-003
Set of 4, 3.7-liter Glass Bottles with Teflon Lined Lids 68-6700-146
Set of 4, 3.7-liter Polyethylene Bottles with Unlined Lids 68-6700-020
9.4-liter (2 1/2-gallon) Glass Bottle with Teflon Lined Lid 68-2700-005
9.4-liter (2 1/2-gallon) Polyethylene Bottle with Lid 299-0013-04
18.9-liter (5-gallon) Glass Bottle with Cap and
Teflon Liner (for the 5 Gallon Bottle Base) 68-6700-079

E.8 General Accessories: Compact and Standard Samplers

Composite Tube Guide (Recommended for all 1-Bottle Kits) 60-9004-051
Distributor Arm 60-9004-050
Equipment Suspension Platform (For Suspending Samplers In Manhole or
Other Locations). 60-3004-151
Locking Assy, compact samplers (includes locking cables and padlock). 68-6700-111
Locking Assy, standard samplers (includes locking cables and padlock) 68-6700-134
Suspension Harness for Compact and Standard Samplers. 60-1394-014
1000-milliliter Plastic Graduated Cylinder 299-0020-00

E.9 Pump Tubes, Suction Line, Strainers

Pump Tube (Qty 5). 68-6700-062
Pump Tube (Qty 10). 68-6700-044
Pump Tube (Qty 25). 68-6700-045
3/8-inch Standard weighted polypropylene strainer with 10 foot Suction Line 60-9004-378
3/8-inch Standard weighted polypropylene strainer with 25 foot Suction Line 60-9004-379
Teflon Suction Line (10 foot length) 60-1683-146
Teflon Suction Line (25 foot length) 60-2703-114
Bulk Vinyl Suction Line (100 foot length) 68-1680-058
Bulk Vinyl Suction Line (500 foot length) 68-1680-059
3/8-inch Vinyl Suction Line Accessory Kit (includes tube coupling,
clamp, and instructions) 68-3700-007
3/8-inch Standard weighted polypropylene strainer. 60-9004-367
CPVC Plastic-coated Weighted Strainer. 60-3704-066
3/8-inch Stainless Steel Low Flow Strainer 69-2903-138

E.10 Data Collection Devices and Cables

581 Rapid Transfer Device (RTD). 60-9004-027
Power Cable 581 Rapid Transfer Device (RTD) 60-9004-077
Flowlink® for Windows Software – New License. . . . . call factory
Flowlink® for Windows Software – Upgrade . . . . . call factory

SAMPLINK Software (Includes Instruction Manual) 60-3774-013
Computer Connect Cable (25-pin) 60-2544-040
Computer Connect Cable (9-pin) 60-2544-044
Connector to Attach Non-Teledyne Isco Flow Meter to Customer Supplied Cable 68-1680-060
Serial Output Connect Cable (for use with the periodic serial output feature) 60-9004-263
External 12-volt DC Power Cable 60-1394-023
Flow-Meter to Two-Samplers Cable 60-3004-018
Dual Sampler Mode Interconnect Cable 60-3704-065
Dual Sampler Mode to Flow-Meter Cable 60-3704-080
Non-Teledyne Isco Flow-Meter to Sampler Cable 60-1394-077
Sampler to Flow Meter /1640 Liquid Level Actuator "Y" Cable 60-3004-019
Sampler to Flow Meter Cable 60-3004-107
2100 Series Sampler Interface Cable 60-2004-260
Solar Panel "Y" Cable 60-3004-098
Solar Panel/Interrogator Extension Cable 60-2544-028
Solar Panel Cable (25 foot length) 60-3004-097
Rain Gauge/Refrigerator Temperature Sensor "Y" cable 60-9004-294
4200T Modem . . . . . factory installed
(Contact your sales representative or Teledyne Isco Customer Service.)

> **☑ Note**
>
> The modem is disabled when an interrogator cable is connected to the sampler's Interrogator port. It cannot receive incoming calls, and the alarm dialout is rendered inoperative, while this cable is connected. **Disconnect the interrogator cable in order to use the 4200T modem.**

E.11 Power Sources and Chargers

913 High Capacity Power Pack (120-volt) 60-1684-088
914 Battery-Backed Power Pack (120-volt) 60-3004-130
921 Nickel-Cadmium Battery 60-1684-040
923 High Capacity Power Pack (240-volt) 60-1684-093
924 Battery-Backed Power Pack (240-volt) 60-3004-160
947 Lead-Acid Battery 60-3004-106
948 45-Amp-Hour Battery 68-3000-948
Portable 12-volt DC, 6-Amp Battery Charger for 948 Battery 341-0118-12
961 Battery Charger (120-volt) 60-3004-059
965 Five-Station Battery Charger, 120/240 V, with 120 V cord 68-3000-965
965 Five-Station Battery Charger, 120/240 V, with 240 V cord 68-3000-966
Solar Panel Battery Charger, 5-watt 60-5314-478
Solar Panel Battery Charger, 40-watt 60-5314-347
Solar Panel Battery Charger, 90-watt 60-5314-399
Power Products Guide 60-9003-092

E.12 Modules, Rain Gauges, & Interfacing Instruments

(Note: Additional accessories for modules and interfacing instruments appear in the accessories list at the back of the manual for each module or instrument.)

701 pH Module with Double Junction pH Sensor with Temperature Sensor. 68-6700-052
710 Ultrasonic Flow Module 68-6700-049
720 Submerged Probe Module, 10 ft range. 68-6700-068
730 Bubbler Flow Module 68-6700-050
780 Analog Interface Module 68-6700-048
675 Rain Gauge 60-3284-013
1640 Liquid Level Actuator 60-1644-000
4-20 mA Sampler Input Interface 60-3704-075
Refrigerator Temperature Sensor with 5 ft (1.55 m) cable 68-6700-136
Internal three channel 4-20 mA programmable output. 60-9004-266
(Includes multi-analog output cable, 10 ft.)

E.13 SDI-12 Data Acquisition Connect Cables

Note: Y-connect cables can be combined with other Y-connect cables or SDI-12 adapter cables if multiple SDI-12 devices are to be connected.

Rain Gauge Y-Connect Cable 60-9004-294
(This cable allows connection of 2 of the following: rain gauge, SDI-12 adapter cable, SDI-12 Y-connect cable, I/O adapter, temperature sensor.)

YSI SDI-12 Adapter Cable. 60-9004-337

YSI SDI-12 Y-Connect Cable 60-9004-338
(This cable allows connection of a YSI SDI-12 sonde and a Teledyne Isco Rain Gauge.)

Hydrolab Quanta SDI-12 Adapter Cable 60-9004-339

Hydrolab Quanta SDI-12 Y-Connect Cable 60-9004-340
(This cable allows connection of a Hydrolab Quanta SDI-12 sonde and a Teledyne Isco Rain Gauge.)

SDI-12 Adapter Cable (6 foot length, no connector). 60-9004-341
(This is for use with a customer supplied connector to an SDI-12 device.)

SDI-12 Y-Connect Cable (6 foot length, no connector) 60-9004-342
(This is for use with a customer supplied connector to an SDI-12 device and a Teledyne Isco Rain Gauge.)

6712 Portable Sampler

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产品中有毒有害物质或元素的名称及含量

Name and amount of Hazardous Substances or Elements in the product

部件名称 Component Name	有毒有害物质或元素 Hazardous Substances or Elements					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二联苯 (PBDE)
线路板 Circuit Boards	X	O	O	O	O	O
显示 Display	X	O	O	O	O	O
接线 Wiring	O	O	O	O	X	O
内部电缆 Internal Cables	O	O	O	O	X	O
主电源线 Line Cord	O	O	O	O	X	O
直流电机 DC Motor	X	O	O	O	X	O
小键盘 Keypad	O	O	O	O	X	O
接头 Connectors	O	O	X	O	O	O

产品中有毒有害物质或元素的名称及含量：Name and amount of Hazardous Substances or Elements in the product

O: 表示该有毒有害物质在该部件所有均质材料中的含量均在ST/ 标准规定的限量要求以下。

O: Represent the concentration of the hazardous substance in this component's any homogeneous pieces is lower than the ST/ standard limitation.

X：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出ST/ 标准规定的限量要求。

(企业可在此处，根据实际情况对上表中打"X" 的技术原因进行进一步说明。)

X: Represent the concentration of the hazardous substance in this component's at least one homogeneous piece is higher than the ST/ standard limitation.

(Manufacturer may give technical reasons to the "X"marks)

环保使用期由经验确定。

The Environmentally Friendly Use Period (EFUP) was determined through experience.

生产日期被编码在系列号码中。前三位数字为生产年(207 代表 2007 年) 。随后的一个字母代表月份：A 为一月，B 为二月，等等。

The date of Manufacture is in code within the serial number. The first three numbers are the year of manufacture (207 is year 2007) followed by a letter for the month. "A" is January, "B" is February and so on.

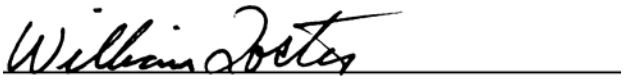
DECLARATION OF CONFORMITY

CE
ISM1-A

Application of Council Directive:	89/336/EEC – The EMC Directive 73/23/EEC – The Low Voltage Directive
Manufacturer's Name:	Teledyne Isco, Inc.
Manufacturer's Address:	4700 Superior, Lincoln, Nebraska 68504 USA Mailing Address: P.O. Box 82531, Lincoln, NE 68501
Equipment Type/Environment:	Laboratory Equipment for Light Industrial/Commercial Environments
Trade Name/Model No:	6712 Sampler
Year of Issue:	2001
Standards to which Conformity is Declared:	EN 61326-1998 EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use EN 61010-1 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

Standard	Description	Severity Applied	Performance Criteria
EN61000-4-2	Electrostatic Discharge	Level 2 - 4kV contact discharge Level 3 - 8kV air discharge	B B
EN61000-4-3	Radiated RF Immunity	80 MHz to 1000MHz 80% AM at 1kHz Level 1 – 10V/m	A
EN61000-4-4	Electrical Fast Transient	Level 2 - 2kV on ac lines	B
EN61000-4-5	Surge on AC Lines	2kV common mode, 1kV differential mode	B
EN61000-4-6	Conducted RF on AC lines	150 kHz to 80 MHz, 3V rms, 80% modulated	B
EN61000-4-11	Voltage Dips/Short Interruptions	0.5 cycle, each polarity/100%	B
CISPR11/ EN 55011	RF Emissions	Group 1, Class A Industrial, Scientific, and Medical Equipment	
EN61000-3-2, 3-3	Harmonic, Flicker		

We, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of March 6, 2001.



William Foster
USA Representative

TELEDYNE ISCO
A Teledyne Technologies Company

Williaml Foster
Director of Engineering
Teledyne Isco, Inc.
4700 Superior Street
Lincoln, Nebraska 68504

Phone: (402) 464-0231
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60-9002-068
Rev. A

DECLARATION OF CONFORMITY

CE

ISM1-A

Application of Council Directive:	89/336/EEC – The EMC Directive 73/23/EEC – The Low Voltage Directive
Manufacturer's Name:	Teledyne Isco, Inc.
Manufacturer's Address:	4700 Superior, Lincoln, Nebraska 68504 USA Mailing Address: P.O. Box 82531, Lincoln, NE 68501
Equipment Type/Environment:	Laboratory Equipment for Light Industrial/Commercial Environments
Trade Name/Model No:	4200T Modem
Year of Issue:	2001
Standards to which Conformity is Declared:	EN 55024-1998 EMC Requirements for Information Technology Equipment EN 60950 Safety Requirements for Information Technology Equipment FCC Part 68

Standard	Description	Severity Applied	Performance Criteria
EN61000-4-2	Electrostatic Discharge	Level 2 - 4kV contact discharge Level 3 - 8kV air discharge	B B
EN61000-4-3	Radiated RF Immunity	80 MHz to 1000MHz 80% AM at 1kHz Level 1 – 10V/m	A
EN61000-4-4	Electrical Fast Transient	Level 2 - 2kV on ac lines	B
EN61000-4-5	Surge on AC Lines	2kV common mode, 1kV differential mode	B
EN61000-4-6	Conducted RF on AC lines	150 kHz to 80 MHz, 3V rms, 80% modulated	B
EN61000-4-11	Voltage Dips/Short Interruptions	0.5 cycle, each polarity/100%	B
EN 55022	RF Emissions	Group 1, Class A, Information Technology Equipment	
EN61000-3-2, 3-3	Harmonic, Flicker		

We, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of July 5, 2001.

William Foster

William Foster
USA Representative

TELEDYNE ISCO
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60-3212-049
Rev. A

*Teledyne Isco One Year Limited Factory Service Warranty **

Teledyne Isco warrants covered products against failure due to faulty parts or workmanship for a period of one year (365 days) from their shipping date, or from the date of installation by an authorized Teledyne Isco Service Engineer, as may be appropriate.

During the warranty period, repairs, replacements, and labor shall be provided at no charge. Teledyne Isco's liability is strictly limited to repair and/or replacement, at Teledyne Isco's sole discretion.

Failure of expendable items (e.g., charts, ribbon, tubing, lamps, glassware, seals, filters, fittings, and wetted parts of valves), or from normal wear, accident, misuse, corrosion, or lack of proper maintenance, is not covered. Teledyne Isco assumes no liability for any consequential damages.

This warranty does not cover loss, damage, or defects resulting from transportation between the customer's facility and the repair facility.

Teledyne Isco specifically disclaims any warranty of merchantability or fitness for a particular purpose.

This warranty applies only to products sold under the Teledyne Isco trademark and is made in lieu of any other warranty, written or expressed.

No items may be returned for warranty service without a return authorization number issued from Teledyne Isco.

The warrantor is Teledyne Isco, Inc.
4700 Superior, Lincoln, NE 68504, U.S.A.

*** This warranty applies to the USA and countries where Teledyne Isco Inc. does not have an authorized dealer. Customers in countries outside the USA, where Teledyne Isco has an authorized dealer, should contact their Teledyne Isco dealer for warranty service.**

In the event of instrument problems, always contact the Teledyne Isco Service Department, as problems can often be diagnosed and corrected without requiring an on-site visit. In the U.S.A., contact Teledyne Isco Service at the numbers listed below. International customers should contact their local Teledyne Isco agent or Teledyne Isco International Customer Service.

Return Authorization

A return authorization number must be issued prior to shipping. Following authorization, Teledyne Isco will pay for surface transportation (excluding packing/crating) both ways for 30 days from the beginning of the warranty period. After 30 days, expense for warranty shipments will be the responsibility of the customer.

Shipping Address: Teledyne Isco, Inc. - Attention Repair Service
4700 Superior Street
Lincoln NE 68504 USA

Mailing address: Teledyne Isco, Inc.
PO Box 82531
Lincoln NE 68501 USA

Phone: Repair service: (800)775-2965 (lab instruments)
(800)228-4373 (samplers & flow meters)
Sales & General Information (800)228-4373 (USA & Canada)

Fax: (402) 465-3001

Email: iscoservice@teledyne.com **Web site:** www.isco.com

February 1, 2006 P/N 60-1002-040 Rev C

TELEDYNE ISCO
A Teledyne Technologies Company

674 Rain Gauge

Installation and Operation Guide

Part #60-3283-011
Copyright © 1992, 2004. All rights reserved, Isco, Inc.
Revision H, March 2004

Isco, Inc.

Foreword

This instruction manual is designed to help you gain a thorough understanding of the operation of the equipment. Isco recommends that you read this manual completely before placing the equipment in service.

Although Isco designs reliability into all equipment, there is always the possibility of a malfunction. This manual may help in diagnosing and repairing the malfunction.

If the problem persists, call or email the Isco Customer Service Department for assistance. Contact information is provided below. Simple difficulties can often be diagnosed over the phone. If it is necessary to return the equipment to the factory for service, please follow the shipping instructions provided by the Customer Service Department, including the use of the **Return Authorization Number** specified. **Be sure to include a note describing the malfunction.** This will aid in the prompt repair and return of the equipment.

Isco welcomes suggestions that would improve the information presented in this manual or enhance the operation of the equipment itself.

Isco is continually improving its products and reserves the right to change product specifications, replacement parts, schematics, and instructions without notice.

Contact Information

Phone:	(800) 228-4373	(USA, Canada, Mexico)
	(402) 464-0231	(Outside North America)
Repair Service:	(800) 775-2965	(Analytical and Process Monitoring Instruments)
	(800) 228-4373	(Samplers and Flow Meters)
Fax:	(402) 465-3022	
Email address:	info@isco.com	
Website:	www.isco.com	

Return equipment to: 4700 Superior Street, Lincoln, NE 68504-1398

Other correspondence: P.O. Box 82531, Lincoln, NE 68501-2531

674 Rain Gauge

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674 Rain Gauge

Operation Instructions

1.1 Description and Operation

The Isco 674 Rain Gauge is a precision instrument for accurately measuring rainfall. The rain gauge is mounted inside a steel cylinder and has an eight-inch opening on top to collect rain. Rain falls through a screen into a funnel. From the funnel, rain collects in one side of a two-chambered plastic bucket mounted on jewelled pivots. When rain fills the chamber, the bucket tips, draining the water and exposing the other chamber to fill. When that chamber fills, the bucket tips back and the process begins again.

Each time the bucket tips from one side to the other, a magnet passes over a reed switch, momentarily closing the normally open contacts. This contact closure provides a short-duration output pulse from the rain gauge for each 0.01 inch of rain.

1.2 Applications

When connected to a flow meter, the rain gauge enables the flow meter to print rainfall data on its chart or store rainfall data in memory. It also lets the flow meter actuate an associated Isco Automatic Wastewater Sampler.

Typical applications include monitoring of storm water runoff, inflow and infiltration studies (I&I), and combined sewer overflow monitoring. You can also use the rain gauge for any other general purpose rainfall measurement as long as the associated equipment is electrically compatible.

1.3 Materials and Construction

The rain gauge is constructed of steel, stainless steel, aluminum, and plastic. All metal parts are coated, plated, or painted to ensure a durable, ruggedly tough instrument capable of resisting deterioration from exposure to the elements. Screens cover all openings, preventing clogging by leaves, insects, or other debris. The powder-coated steel sleeve protects the internal parts. The jewelled-pivot mounting for the tipping bucket provides long life. A built-in bubble level makes leveling the rain gauge after installation easy. A 50-foot cable terminated in an M/S connector attaches the rain gauge to the flow meter or to other equipment.

⚠ CAUTION

The rain gauge is factory-calibrated and adjusted. Do **not** attempt to make any adjustments to the jewelled-pivot screws. You may damage the jewel bearings.

1.4 Location of the Rain Gauge

Location affects the accuracy of the rainfall catch because the prevailing winds may tend to carry the rain away from the gauge. There are advantages and disadvantages to most sites. Sites may be either open or protected. Totally open sites affect the accuracy of the catch if the rain is carried on strong winds, but are satisfactory if rainstorms are generally calm. With no nearby vegetation the characteristics of the site will not tend to change over time, which is an advantage. Where strong winds are characteristic of storms, protected sites are generally preferable. This is because the effect of the wind on the rainfall catch is reduced. The presence of small groups of objects or objects of varying heights around the gauge can also affect accuracy by producing eddy currents in the wind which will interfere with the catch.

1.4.1 Suggested Siting

Groups of objects of uniform height (such as trees) in the vicinity of the gauge are beneficial for an accurate catch by acting as a windbreak while not interfering with the catch. Mounting the rain gauge in the clearing of an orchard or a grove of trees would be a recommendation for a good site.

The **height** of the surrounding objects should not exceed **twice their distance** from the rain gauge. If vegetation serves as a windbreak, understand that growth will greatly change the conditions of the site with the passage of time. What may originally have been a good site may not always remain one.

Vegetation grows dramatically over time. Any construction nearby that takes place after the installation may also make a site undesirable by altering the wind currents and rainfall patterns around the gauge. Under no circumstances should any nearby object be allowed to grow above or hang directly over the gauge.

The rain gauge is solidly built to withstand years of outside use; however, vandals could ruin it. Always try to install the rain gauge where it will be protected from vandalism.

Avoid installation in low places where runoff from heavy storms could flood the gauge or wash it away. The rain gauge would not be hurt by submersion, but it would be unable to measure.

Do not drop the rain gauge or expose it to shock; that could damage the jeweled bearings.

1.5 Installation

To install the rain gauge, follow the procedure below. Step 7 is optional, depending on the requirements of your particular installation.

1. Unpack the rain gauge from the shipping box. Save the box and packing to return the rain gauge to Isco if that becomes necessary. Remove the outer tube (white cover with funnel) from the rain gauge by loosening the two thumb screws on either side.
2. Locate the bottom (mounting) plate of the rain gauge. This is circular and made of black metal. Mount this plate securely to a stable horizontal surface that is relatively

level. Isco suggests using corrosion-resistant hardware for mounting. The mounting holes will accommodate hardware as large as ¼ inch in diameter.

3. This is **very important**: Level the rain gauge by adjusting the three thumb screws on the base until the bubble in the bubble level is exactly centered.
4. Carefully remove the rubber band used to secure the tipping bucket assembly. Do not apply pressure to the bucket or the pivot arm. Do not attempt any adjustments.
5. Reinstall the protective outer tube on the rain gauge.
6. Route the cable from the rain gauge to the flow meter. Coil any extra wire by the flow meter.
7. If necessary, you can increase the distance between the flow meter and the rain gauge to **1,000 feet** (maximum) by splicing a **two-wire #18 AWG** cable (user- supplied) between the Isco-provided cable and the rain gauge, as described below.

   Disconnect the Isco cable from the terminal block inside the rain gauge and splice the user-supplied cable to that end of the Isco cable. If the wiring and the splice will be exposed to the weather, use wire appropriate for outdoor use and insulate the splice properly. A weatherproof box may be necessary. Do **not** cut the M/S connector from the Isco cable unless you are connecting the rain gauge to equipment that does not have a compatible connector. You will not be able to reconnect it easily.

1.6 Maintenance

The Isco Rain Gauge is built of quality materials to withstand years of exposure to the elements. Normally, no maintenance is required.

Once a year (or more often if conditions warrant) you may want to remove the cover and check the gauge to see that it has not been affected by the buildup of dust, debris, or insect infestation.

The rain gauge is factory-calibrated and needs no further adjustment. If your installation is temporary and you intend to move the rain gauge from site to site, use care in transporting the unit. Again, you could damage the jewelled pivots for the tipping bucket if you expose the rain gauge to a severe shock - for example, by dropping it. If you move the rain gauge frequently, always secure the tipping bucket with a rubber band and use the original packing box to protect the unit during transport.

Repack the rain gauge as it was originally shipped to you if you need to return it to Isco.

1.7 Electrical Considerations

The electrical output from the Isco Rain Gauge is the rapid contact closure of a normally open reed switch. The rain gauge is **not** itself a powered device. It contains neither batteries nor transformer and does not connect to the AC line. Electrically, it is a "dry contact" switch, with power supplied from whatever device it controls.

When you connect the rain gauge to an Isco Flow Meter, the current through the switch contacts is very low and there is no problem with line losses or damage to the switch contacts. However, if you plan to use the rain gauge for general-purpose rain measurement with other types of equipment not specified by Isco, please note the following:

⚠ CAUTION

The reed switch is rated for pilot duty only! The sealed contacts are limited to 10 watts (or 10 VA), 200 VDC maximum. Exceeding these limits may cause welding or rupturing of the reed switch, ruining it. For safety considerations, Isco recommends connection only to equipment supplying 30 volts or less, AC or DC.

Be particularly careful using the rain gauge with equipment supplying DC voltages at higher current loads or equipment presenting an inductive load to the reed switch. **Never** connect the rain gauge directly to any equipment where enough current passes to strike an arc when the contacts switch. You should always buffer such equipment with a solid-state switch (transistor, IC, SCR, etc.) or a sensitive relay.

1.8 Technical Specifications

The technical specifications for the 674 rain gauge are presented in Table 1-1.

Table 1-1 Technical Specifications for the 674 Rain Gauge

Type:	Tipping bucket
Orifice:	8 inches (20 cm) diameter
Sensitivity:	*English:* 0.01 inches *Metric:* 0.1 mm
Accuracy:	*English:* ± 1% at 2 inches/hr; +3, -4% up to 5 inches/hr *Metric:* ± 1½% at 5 cm/hr; +3.5, -9% up to 13 cm/hr
Maximum Capacity:	*English:* 22 inches/hr *Metric:* 38 cm/hr
Connector Pinout:	Pin A - Red, +12V DC from Flow Meter; Pin D - Black, Output from Rain Gauge
Output Signal:	Contact closure, 50 milliseconds minimum duration
Switch Type:	Hermetically sealed magnetic reed switch. Normally open. 200V DC, 0.5 A maximum
Height and Diameter:	13 inches (33 cm); 9½ inches (24 cm) at base
Weight:	10 pounds (4.5 kg)
Operating Temperature:	32° to 140° F (0° to 60° C)
Storage Temperature:	-40° to 140° F (-40° to 60° C)

1.9 Replacement Parts List

The following pages contain a list of replacement parts for the Isco 674 rain gauge. The illustration shows the location of the numbered parts, which are described in the accompanying table.

Replacement parts can be purchased by contacting Isco's Customer Service Department.

Isco, Inc.
Customer Service Department
P.O. Box 82531
Lincoln, NE 68501 USA

Phone: (800) 228-4373
(402) 464-0231
FAX: (402) 465-3022

E-mail: info@isco.com

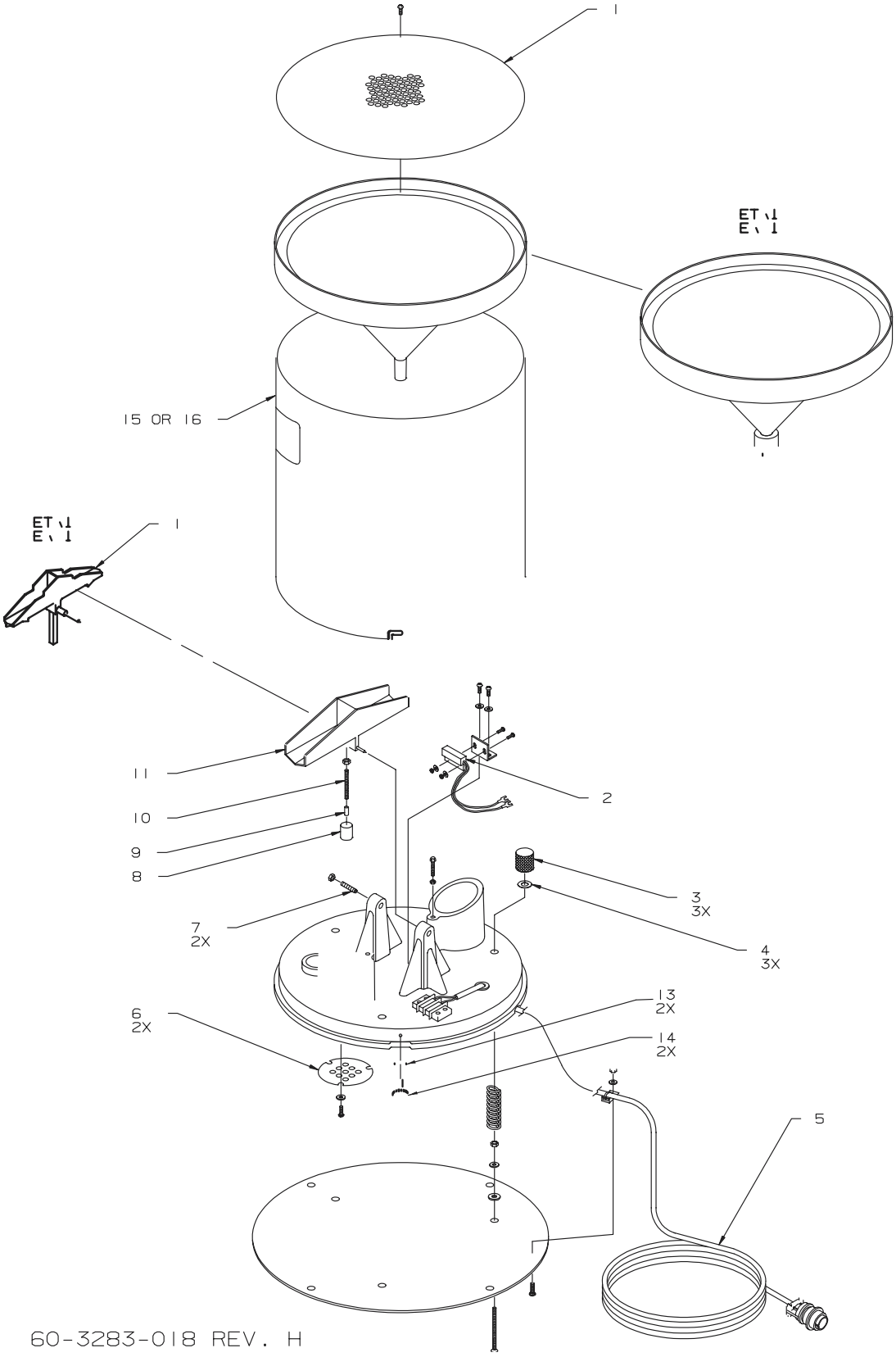

Figure 1-1 Replacement Parts List Illustration

ITC	⊥ E T \	E \I TI
1		⊥ ET \EC E H
2	410991001	E \ M- \X1 ı .175/. 1
3	603283004	C C - TI KNOB
4	233042800	N - HE \ . X . X . 1
5	603004149	CBL ı \-⊥ C
6	603283006	DR-I \EE
	201900000	\⊥ C EC C C C- \⊥
	12	ET T
9	209020400	M ET .12 ⊥- X 3/8 LONG
10	603283016	TI \OD
11		T⊥ I KE1
12	603284010	T⊥ I KE1 ET \I
13	603283044	WSHR .17 I
14	603283045	\ THM - T
15	1	ı 1 E \C ⊥ C E \EE
16		BOD ı 1 E \C ET \⊥ ⊥ C E \EC

60-3283-018 RE . H

Figure 1-2 Replacement Parts List

*Isco One Year Limited Factory Service Warranty **

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Isco specifically disclaims any warranty of merchantability or fitness for a particular purpose.

This warranty applies only to products sold under the Isco trademark and is made in lieu of any other warranty, written or expressed.

No items may be returned for warranty service without a return authorization number issued from Isco.

This warranty does not apply to the following products: Process Analyzers, SFX 3560 SFE Extractor, 6100 VOC Sampler.

The warrantor is Isco, Inc. 4700 Superior, Lincoln, NE 68504, U.S.A.

*** This warranty applies to USA customers. Customers in other countries should contact their Isco dealer for warranty service.**

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4700 Superior Street
Lincoln NE 68504 USA

Mailing address: Isco, Inc.
PO Box 82531
Lincoln NE 68501 USA

Phone: Repair service: (800)775-2965 (lab instruments)
(800)228-4373 (samplers & flow meters)
Sales & General Information (800)228-4373 (USA & Canada)

Fax: (402) 465-3001

Email: service@isco.com

August 2002 P/N 60-1002-040

Isco, Inc.
www.isco.com

750 Area Velocity Module

Installation and Operation Guide

TELEDYNE ISCO
A Teledyne Technologies Company

Part #60-9003-465
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Revision J, May 8, 2007

Foreword

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Teledyne Isco is continually improving its products and reserves the right to change product specifications, replacement parts, schematics, and instructions without notice.

Contact Information

Customer Service

Phone:	(800) 228-4373	(USA, Canada, Mexico)
	(402) 464-0231	(Outside North America)
Fax:	(402) 465-3022	
Email:	IscoCSR@teledyne.com	

Technical Service

Phone:	(800) 775-2965	(Analytical)
	(800) 228-4373	(Samplers and Flow Meters)
Email:	IscoService@teledyne.com	
Return equipment to:	4700 Superior Street, Lincoln, NE 68504-1398	

Other Correspondence

Mail to:	P.O. Box 82531, Lincoln, NE 68501-2531
Email:	IscoInfo@teledyne.com
Web site:	www.isco.com

Revised September 15, 2005

General Warnings

This product is often installed in confined spaces. Some examples of confined spaces are manholes, pipelines, digesters, and storage tanks. These spaces may become hazardous environments that can prove fatal for those unprepared. These spaces are governed by OSHA 1910.146 and require a permit before entering.

Hazard Severity Levels

This manual applies *Hazard Severity Levels* to the safety alerts, These three levels are described in the sample alerts below.

⚠ CAUTION

Cautions identify a potential hazard, which if not avoided, may result in minor or moderate injury. This category can also warn you of unsafe practices, or conditions that may cause property damage.

⚠ WARNING

Warnings identify a potentially hazardous condition, which if not avoided, could result in death or serious injury.

⚠ DANGER

DANGER – limited to the most extreme situations to identify an imminent hazard, which if not avoided, will result in death or serious injury.

Hazard Symbols

The equipment and this manual use symbols used to warn of hazards. The symbols are explained below.

Hazard Symbols	
Warnings and Cautions	
	The exclamation point within the triangle is a warning sign alerting you of important instructions in the instrument's technical reference manual.
	The lightning flash and arrowhead within the triangle is a warning sign alerting you of "dangerous voltage" inside the product.
	Pinch point. These symbols warn you that your fingers or hands will be seriously injured if you place them between the moving parts of the mechanism near these symbols.
Symboles de sécurité	
	Ce symbole signale l'existence d'instructions importantes relatives au produit dans ce manuel.
	Ce symbole signale la présence d'un danger d'électocution.
	Risque de pincement. Ces symboles vous avertit que les mains ou les doigts seront blessés sérieusement si vous les mettez entre les éléments en mouvement du mécanisme près de ces symboles
Warnungen und Vorsichtshinweise	
	Das Ausrufezeichen in Dreieck ist ein Warnzeichen, das Sie darauf aufmerksam macht, daß wichtige Anleitungen zu diesem Handbuch gehören.
	Der gepfeilte Blitz im Dreieck ist ein Warnzeichen, das Sei vor "gefährlichen Spannungen" im Inneren des Produkts warnt.
	Vorsicht Quetschgefahr! Dieses Symbol warnt vor einer unmittelbar drohenden Verletzungsgefahr für Finger und Hände, wenn diese zwischen die beweglichen Teile des gekennzeichneten Gerätes geraten.

750 Area Velocity Module

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750 Area Velocity Module

Section 1 Introduction

1.1 Overview

The 750 Area Velocity Module is one of Teledyne Isco's interchangeable modules for the Avalanche and 6700 Series Samplers. The module enhances sampler operation by providing flow-pacing and additional sampler enable conditions. The sampler also displays the real-time level, velocity, flow rate, and total flow provided by the module. The sampler records this data for later analysis.

The area velocity (AV) sensor detects the average velocity of a liquid as it moves up or downstream. The sensor, equipped with an internal pressure transducer, also measures the level of the flow stream. Three AV sensor models are available:

- Standard range sensor – has a 25 ft (7.6 m) cable and a pressure transducer with a 10 ft (3.05 m) level measurement range.
- Extended range sensor – has a 50 ft (15.2 m) cable and a pressure transducer with a 30 ft (9.14 m) level measurement range.
- Low profile sensor – has a 25 ft (7.6 m) cable and a pressure transducer with a 10 ft (3.05 m) level measurement range. Its smaller size allows velocity measurements at very low liquid depths.

⚠ WARNING

The 750 module has not been approved for use in hazardous locations as defined by the National Electrical Code. Installation of this module in a hazardous location may cause fire or explosion, resulting in death, personal injury, or property damage. Before installing any device in a dangerous location, review safety precautions in your sampler manual. Check any applicable guidelines, codes, and regulations of federal, state, city, and county agencies.

1.2 Power Sources

We recommend using a Lead-Acid battery or a new 913 or 923 power pack when using the Model 750 Area Velocity Module. A nickel-cadmium battery may not be sufficient to finish a sample routine. For example, a nickel-cadmium battery should be expected to complete five sampling routines of 24 samples, each sample 200 ml, at one sample per hour with a 10 foot suction line and a 5 foot head. But if the routine is changed to flow-paced sampling or enabling the routine with a level, velocity, or flow rate condition, the battery capacity is significantly reduced.

1.3 Principles of Area/Velocity Flow Measurement

Area velocity flow conversion requires three measurements: level, velocity, and channel dimensions. The AV sensor provides the level and velocity measurements. You provide the third measurement, channel dimensions, during module programming.

The flow conversion is best represented as two steps. First, the module calculates the channel cross-section (or area) using the programmed channel dimensions and the level measurement. Next, the module multiplies the channel cross section and the velocity measurement to calculate the flow rate.

1.3.1 Level Measurement

The AV sensor's internal differential pressure transducer measures the liquid level. The transducer is a small piezo-resistive disk that detects the pressures transferred by a stainless steel diaphragm. The outer face of the diaphragm is exposed to the flow stream through the ports at the rear of the sensor. The inner face is exposed, or referenced, to the atmosphere through the internal vent tube that runs the full length of the sensor's cable. The difference between the pressures exerted on the diaphragm is the hydrostatic pressure. The transducer converts the hydrostatic pressure to analog signals. The signals are sent to the module.

Because pressure is proportional to the level of the stream, the module can convert the analog signal to a level measurement. The level measurement, in turn, is applied to the channel cross-section.

1.3.2 Velocity Measurement

The AV sensor measures average velocity by using ultrasonic sound waves and the Doppler effect. The Doppler effect states that the frequency of a sound wave (or other wave) passed from one body to another is relative to both their motions. As the two approach each other, the frequency increases; as they move apart, the frequency decreases.

The AV sensor contains a pair of ultrasonic transducers. One transducer transmits the ultrasonic sound wave. As the transmitted wave travels through the stream, bubbles and particles carried by the stream reflect the sound wave back towards the AV sensor. The second transducer receives the reflected wave.

The module compares the frequencies of the sound waves. An increase or decrease in the frequency of the reflected wave indicates forward or reverse flow. The degree of change is proportional to the average velocity of the flow stream.

1.3.3 Alternative Flow Measurement Systems

Because of the characteristics of area/velocity flow measurement, there may be some installations where this method is either unreliable or inaccurate. In these instances, it is worthwhile to consider using an alternate method of flow measurement.

In addition to the 750 Module, Teledyne Isco offers three other types of plug-and-play flow modules in the 700 Series: the 730 Bubbler Module, the 720 Submerged Probe Module, and the 710 Ultrasonic Module.

Information about these flow modules is available from the factory. Call for more information or visit our Web site at www.isco.com.

1.4 Technical Specifications

The following tables contain technical specification for the 750 module, both Standard Sensors, and the Low-Profile Sensor.

General notes:

- All weights may vary by ± 0.2 lb (0.1 kg).
- All lengths may vary by ± 0.25 inches (0.64 cm)

Table 1-1 Technical Specifications for the 750 Area Velocity Module

Weight	0.9 lbs (.4 kg)
Sensor Dimensions	4.9 × 5.7 × 2.0 inches (12.4 × 14.5 × 5.1 cm)
Material	Polystyrene
Operating Temperature	0° to 140°F (-18° to 60°C)
Storage Temperature	-40° to 140°F (-40° to 60°)
Enclosure Rating	NEMA 4X and 6, IP67
Power	9 to 14 VDC provided by the sampler
Memory	Nonvolatile ROM (Flash). Can be field updated through the sampler.
Level Resolution	0.002 ft (0.0006 m)
Velocity Resolution	0.024 ft/s (0.0073 m/s)
Velocity Accuracy	-5 to +5 ft/s: ± 0.1 ft/s (-1.5 + 1.5 m/s: ± 0.03 m/s) 2% of reading) (1.5 to 6.1 m/s: ±2% of reading)
Readings	Programmable through the sampler at 1, 2, 5, 10, 15, and 30 minute intervals. All readings are stored in the sampler.

Table 1-2 Technical Specifications for the Standard AV Sensor

Weight Standard Range Extended Range	2.1 lbs (.96 kg) 3.9 lbs (1.8 kg)
Sensor Dimensions	Length: 6.6 inches (6.8 cm) Width: 1.6 inches (4.1 cm) Height: 1.2 inches (3.0 cm)
Nose Angle	35° from horizontal

Table 1-2 Technical Specifications for the Standard AV Sensor (Continued)	
Cable Length Standard Range Extended Range	25 ft (7.6 m) 50 ft (15.2 m)
Materials	Sensor: Polybutadiene-based polyurethane, stainless-steel Cable: Polyvinyl chloride (PVC) chlorinated polyvinyl chloride (CPVC)
Operating Temperature	32° to 160°F (0° to 71°C)
Level Measurement Method	Submerged pressure transducer mounted in the flow stream
Transducer Type	Differential linear integrated circuit pressure transducer
Level Measurement Range Standard Range Extended Range	 0.05 to 10.0 ft (0.015 to 3.05 m) 0.05 to 30.0 ft (0.015 to 9.14 m)
Maximum Allowable level Standard Range Extended Range	 20 ft (6.1 m) 40 ft (12.2 m)
Level Measurement Accuracy Standard Range Extended Range	 0.033 to 5.0 ft: ± 0.008 ft/ft (0.01 to 1.52 m: ± 0.008 m/m) >5.0 ft: ± 0.012 ft/ft (>1.52 m: ± 0.012 m/m) 0.05 to 15.0 ft: ± 0.03 ft (0.015 to 4.57 m: ± 0.009 m) 0.05 to 21.0 ft: ± 0.09 ft (0.015 to 6.40 m: ± 0.027 m) 0.05 to 30.0 ft: ± 0.30 ft (0.015 to 9.14 m: ± 0.090 m) @77°F (25°C). Includes non-linearity, repeatability, and hysteresis. Does not include temperature coefficient.
Compensated Temperature Range	32° to 100°F (0° to 38°C)
Temperature Coefficient Standard Range Extended Range	 0.05 to 4.0 ft: ± 0.005 ft/°F (0.015 to 1.22 m: ± 0.0027 m/°C) 4.0 to 10.0 ft: ± 0.007 ft/°F (1.22 to 3.05 m: ± 0.0038 m/°C) 0.05 to 30.0 ft: ± 0.008 ft/°F (0.015 to 9.14 m: ± 0.0044 m/°C) Maximum error over compensated temperature range, per degree of temperature change.
Velocity Measurement Method	Doppler Ultrasonic
Frequency	500 kHz
Typical minimum depth for velocity measurement	0.25 ft (75 mm)
Range	-5 to +20 ft/s (-1.5 to +6.1 m/s)

Table 1-3 Technical Specifications for the Low Profile AV Sensor	
Weight	2.1 lbs (.95 kg) including cable and connector
Sensor Dimensions	Length: 6.00 inches (15.2 cm) Width: 1.31 inches (3.3 cm) Height: 0.75 inches (1.9 cm)
Nose Angle	110° from horizontal
Wetted Sensor Material	Epoxy, chlorinated polyvinyl chloride (CPVC), Stainless-steel
Cable Material	Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC)
Cable Length	25 ft (7.6 m)
Maximum Distance (between sensor and module)	75 ft (22.8 m) with optional extension cables. The distance can be extended up to 1000 ft (300 m) with the optional Quick Disconnect Box.
Operating Temperature	32° to 122°F (0° to 50°C)
Storage Temperature	-40° to 160°F (-40° to 71°)
Level Measurement Range	0.033 to 10.0 ft (0.01 to 3.05 m)
Maximum Allowable level	20 ft (6.1 m)
Level Measurement Accuracy	0.033 to 5.0 ft: ± 0.008 ft/ft (0.01 to 1.52 m: ± 0.008 m/m) >5.0 ft: ± 0.012 ft/ft (>1.52 m: ±0.012 m/m) Accuracy per foot of change from calibrated depth @77°F (25°C). Includes non-linearity and hysteresis.
Temperature Coefficient	±0.0023 ft/°F (±0.0013 m/°C) Maximum error within operating temperature range at zero pressure (per degree of change from calibration temperature).
Maximum Long-term Drift	0.033 ft (±0.010 m)
Velocity Measurement Method	Doppler Ultrasonic
Frequency	500 kHz
Transmission Angle	20° from horizontal
Typical minimum depth for velocity measurement	0.8 ft (25 mm)
Range	-5 to +20 ft/s (-1.5 to +6.1 m/s)
Velocity Accuracy	-5 to +5 ft/s (-1.5 to +1.5 m/s): ± 0.1 ft/s (±0.03 m/s) 5 to 20 ft/s (1.5 to 6.1 m/s): 2% of reading Velocity accuracy for a uniform velocity profile in water with a speed-of-sound of 4850 ft/s.

750 Area Velocity Module

Section 2 Installation and Programming Basics

The 750 can be used in a wide range of applications. In the "Flow Meter" mode of operation, the module will produce sound results if you properly choose an installation site, select an appropriate flow conversion method, and program the module with accurate measurements. Guidelines for each are discussed in the following sections.

If you plan to use the "Level Only" mode of operation, the section Selecting a Flow Conversion Method does not apply.

2.1 Installation Summary

To install the module:

1. Turn the sampler off.
2. Remove the connector cap in the module bay and move it aside.
3. Slide the module into the bay.
4. Push against the module so the connector is fully seated.

To remove the module, turn the sampler off. Press the silver spring button and pull the module from the bay. Replace the connector cap in the module bay.

2.1.1 Installation Checklist

1. Check the desiccant cartridge. Make sure the desiccant is active (blue or yellow in color) and ***remove the red cap***.
2. Install the module and turn the sampler on.
3. Install the AV sensor in the channel.
4. Connect the AV sensor cable to the module.
5. Program the sampler and calibrate the module's level reading.
6. Set up the sampler. See details in the sampler manual.
7. Run the program.

2.1.2 Installation Considerations

⚠ CAUTION

Mounting hardware may have sharp edges. Cuts and abrasions are possible. Injuries from hardware contaminated by sewage may also become infected. To avoid these hazards:

- Wear leather gloves when handling the hardware.
- Clean the mounting hardware between installations.

⚠ CAUTION

Tests have shown that the 750 Module is affected by RF radiation such as that from radio and TV station towers that are located nearby. If sporadic changes in water level occur as indicated on the sampler's display, the instrument will have to be relocated. Walkie talkies or cell phones must not be operated within 3 meters (10 feet) of the instrument for the same reason.

- Abusive handling will damage the sensor. Although the sensor will survive normal handling and installation, treat the sensor with reasonable care. The internal components cannot be repaired.
- There is a vent tube inside the cable which must remain open. Do not kink the cable or overtighten the plastic ties while securing the cable.
- Install the Standard and Extended Range AV Sensors in flow streams where the liquid covers the sensor. These sensors detect levels above approximately 0.05 foot (0.6 inch or 15 mm) and velocities in streams with a minimum depth of 2 to 4 inches (50-100 mm).
- Install the Low Profile AV Sensors in streams where the liquid covers the sensor. Low Profile Sensors detect levels above approximately 0.033 feet (0.4 inch or 1.0 cm) and typically can measure velocities in streams as low as 0.08 ft (25 mm). Streams that run consistently below 1 inch are not a good application for the 750 and sensor.
- Velocity measurements depend on the presence of some particles in the stream; either air bubbles or suspended solids. If the stream lacks these particles, it may be necessary to aerate the water upstream from the sensor.
- You can install the sensor above the bottom of the flow stream or along the side of the channel, if the sensor will be continually submerged. The module can be calibrated to measure level with the sensor at nearly any depth. The sensor cannot, of course, measure a liquid level that falls below its position in the flow stream. Installing the sensor above the bottom has several advantages:
  - It avoids heavy concentrations of silt, sand, or other solids.
  - It aids installation in narrow or hard-to-reach locations.
  - It maximizes level resolution over a specific level range.
  - It can avoid obstructions in the flow stream.
- When the sensor is installed above the bottom of the channel, a "Zero Level Offset" must be entered during

programming. For more information, refer to Section 2.9, Offsets.

- Route and secure the sensor cable so that it does not collect debris or disturb the flow.
- You may use Teledyne Isco's vented 25 foot (7.6 m) extension cables to locate the sensor at greater distances from the sampler. You can combine vented extension cables, as long as the total cable length does not exceed 75 feet (22.8 m).

To locate the sensor more than 75 feet from the sampler and module, use the Area Velocity Sensor Quick Disconnect Box. The disconnect box increases the maximum distance between the module and the sensor to 1,000 feet (305 m).

2.2 Rectangular and Trapezoidal Channels

A flat, anchored mounting plate is a common mounting choice for installing sensors in rectangular or trapezoidal channels. See the *Isco Mounting Rings Installation and Operation Guide* for more information.

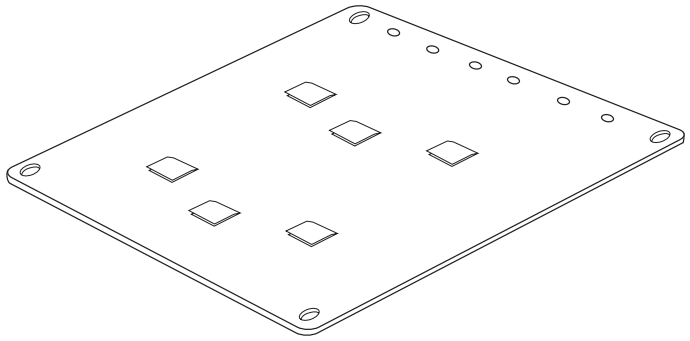


Figure 2-1 Isco Rectangular Mounting Plate

2.3 Mounting Rings for Circular Channels

Consult your Isco Mounting Rings Installation and Operation Guide for detailed hardware information.

The following sections describe sensor installation using the two options available for mounting the Sensor in pipes or round-bottomed flow streams. For pipes up to 15" (38.1 cm) in diameter, **stainless steel self-expanding mounting rings** (**Spring Rings**) are available. For pipes larger than 15" in diameter, Teledyne Isco offers the **Scissor Rings (Universal Mounting Rings)**. Area velocity sensors can also be installed using primary measuring devices.

2.3.1 Spring Rings

To install a spring ring, you compress the ring, slip it inside the pipe, and then allow it to spring out to contact the inside diameter of the pipe. The inherent outward spring force of the ring firmly secures it in place. A typical self-expanding mounting ring (with a probe mounted on it) is shown in Figure 2-2.

These mounting rings are available for use in pipes with inside diameters of 6" (15.2 cm), 8" (20.3 cm), 10" (25.4 cm), 12" (30.5 cm), and 15" (38.1 cm). The Teledyne Isco part numbers for the

various size mounting rings available are listed in Appendix B. These part numbers include not only the ring, but also the miscellaneous hardware necessary to mount the sensor on the ring.

⚠ CAUTION

Always wear leather gloves when handling the rings (either type). The metal is finished, but there is still a possibility of cutting your hands on the edges.

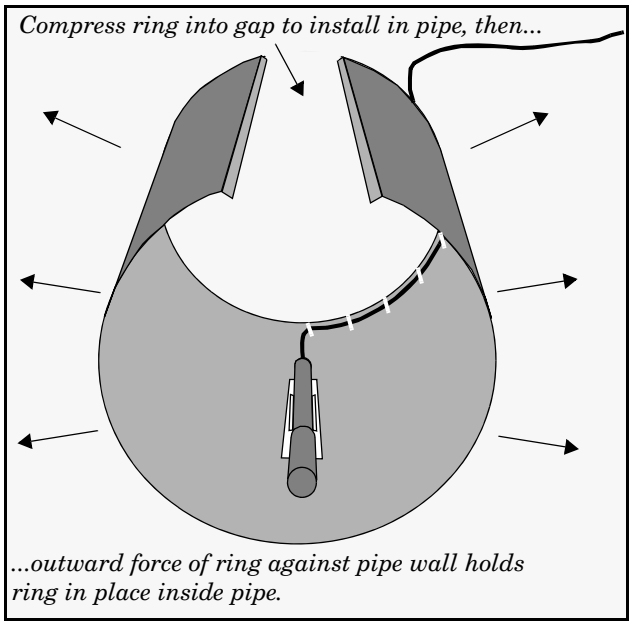


Figure 2-2 Sensor Installed on a Spring Ring

⚠ CAUTION

Make sure the slots on the sensor are completely pressed onto the tabs on the ring. This is particularly important where there is any possibility of reverse flows, or where flows are of high velocity. If the sensor is not fully pressed onto the mounting ring tabs, it might come loose in the stream, and could possibly be damaged or lost.

Completing the assembly

To complete the sensor-spring ring assembly procedure, attach the sensor cable to the downstream edge of the ring. Follow the cable routing shown in Figure 2-2. Other routing directions may affect measurement accuracy. The cable can actually create a stilling well downstream from the sensor, causing the level to read low. Use the self-locking plastic ties supplied with the ring. Install the ring in the pipe by compressing it. Press inward on both sides and slide the ring into the pipe.

Route the sensor cable out of the stream and secure it in position by placing the ties through the holes in the mounting ring and then locking them around the cable, as shown. To prevent debris from catching on the cable, it is important to attach the cable to the mounting ring so it offers as little resistance to the flow as possible.

⚠ CAUTION

Make sure the sensor cable is securely fastened along the back (downstream) edge of the ring. Otherwise, the sensor may provide **inaccurate level readings** under conditions of high velocity.

Do not overtighten the plastic cable ties; they should be tightened just enough to secure the cable in place, without greatly indenting the cable. Overtightening the plastic ties may collapse the reference tube in the cable, blocking it.

The spring ring may need anchoring. Under conditions of high velocity (greater than 5 feet per second or 1.5 meters per second), the ring may not have sufficient outward spring force to maintain a tight fit inside the pipe. The ring may start to lift off the bottom of the pipe in a waving fashion, or may even be carried downstream.

This problem is more prevalent in the larger diameter pipes (10", 12", and 15", and in pipes with smooth inside surfaces, such as plastic pipes). If any of these conditions are present, or if movement of the mounting ring is detected or suspected, you must anchor the ring in place. You can do this by setting screws through the ring into the pipe, or by other appropriate means. If there is a problem with the smaller diameter rings, it may be sufficient to simply increase the outward spring force of the ring by bending it into a less round configuration.

2.3.2 Scissors Rings

For pipes larger than 15" in diameter, Teledyne Isco offers the adjustable Scissors Ring (also known as the Universal Mounting Ring). This device consists of two or more metal strips that lock together with tabs to form a single assembly. There is a base section where the sensors are mounted, one or more extension sections (usually), and a scissors section at the top that expands the entire assembly and tightens it inside the pipe. The scissors mechanism includes a long screw that increases the width as it is tightened.

The assembled rings fit pipe diameters from 16" to 80". Secure the unit in place by tightening the scissors mechanism with a 5/8" socket wrench or other suitable tool. Ring sections are .040" thick half-hard 301 stainless steel sheet. All other parts are also stainless steel, except for the plastic cable ties in the hardware kit.

Each extension, 1, 2, 3, and 4, adds 9.0", 21.5", 31.5", or 41.5", respectively, to the circumference of the ring. Used alone, the base section fits pipe that is approximately 16" to 18" in diameter. The 9.0" (the smallest) extension exists so that in larger pipe sizes, where large variations in circumference can occur, you can use one or two of these extensions to take up or remove slack, to bring the scissors mechanism into a position where it can be effectively tightened.

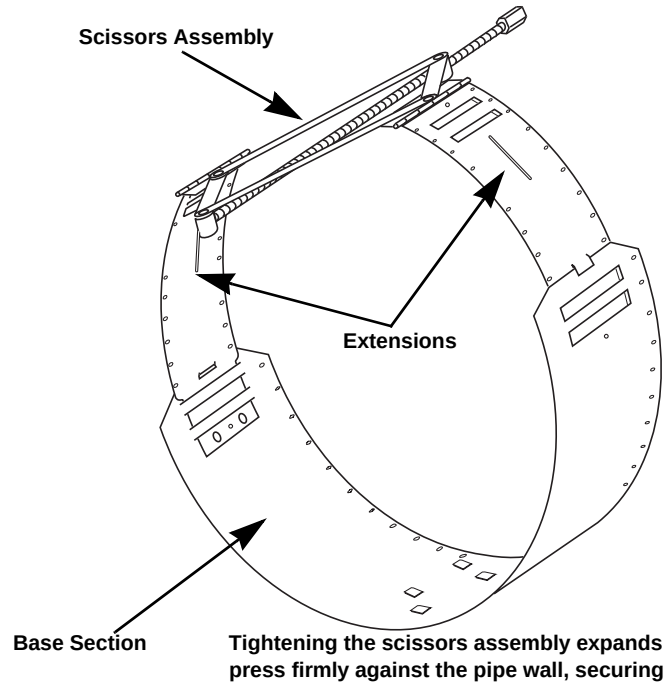


Figure 2-3 Scissors Ring Adjustment

Mounting ring kits are available for different pipe sizes. A kit is also available for partial pipe applications (consult your *Isco Mounting Rings Installation and Operation Guide*). For a listing of part numbers and ordering information, see Appendix A.

2.3.3 Completing the AV Sensor Installation

The AV sensor installation is finished by coiling any excess sensor cable and securing it using cable clamps or other means. The reference tube inside the cable can be restricted or blocked if the cable is kinked, sharply bent, or otherwise pinched. The sensor cable should be handled and mounted with care. Also, if there is any appreciable distance between the point where the sensor cable leaves the mounting apparatus and the location of the flow meter, *be sure* to attach the cable to the flow stream wall to prevent it from vibrating, moving around, tangling, or possibly collecting debris.

⚠ CAUTION

Under no circumstances should you leave any extra length of sensor cable dangling freely in the flow stream where it could trap debris or become tangled.

Use gloves and eye protection when assembling and installing the rings in a pipe. Though deburred, the edges of the stainless steel can cut if improperly handled. *Please read the information on how best to install this device.*

Observe general safety procedures when entering any manhole. See "General Safety Procedures" in the back of the manual for more information on general hazards and necessary precautions.

2.4 Programming Notes

You must install the module before turning the controller on. When the controller is turned on, it looks for a module. The controller will not recognize a newly installed module if it is not seen during this power-up routine. If you install a module while the controller is already on, turn the controller off and then on again to reconfigure the controller for use with the module.

When the controller is configured with the module, it adds the necessary screens for programming. The screens appear in Figures 2-4 through 2-6. These figures outline the steps for module programming and calibration. For 6712 programming and general programming information, see the sampler manual.

2.4.1 Programmed Enable

When the 750 is installed, additional sampler enable options are available. If programmed for LEVEL ONLY, the additional options are LEVEL and VELOCITY. If programmed for FLOW METER, the additional options are LEVEL, VELOCITY, and FLOW. For more information about programmed enables, see the sampler manual.

2.5 Selecting a Site

The 750 is designed to measure flow in open channels without a primary device. A primary device is a hydraulic structure, such as a weir or a flume, that modifies a channel so there is a known relationship between the liquid level and the flow rate.

The area velocity module's use is not limited to channels without a primary device. The software also supports installations where you must install the sensor with a primary device.

☑ *Note*

Primary devices limit the usefulness of the area velocity sensor's readings. In most cases, levels and velocities near these devices do not represent what normally occurs in the channel. If you must use area velocity flow conversion, or if your interest is the stream's velocity, do not install the sensor near a primary device. Move the sensor away to where the flow is unaffected.

When the sensor is installed without a primary device, find a section of channel with a minimum of disturbances to the flow. Avoid areas with elbows, outfalls, inverts, junctions, etc., that create turbulence near the AV sensor. The sensor should be located away from these disturbances to a point where the flow has stabilized. For best results, install the sensor where the flow is most uniform. Uniform flow is a condition where the water surface is parallel to the bottom of the channel.

If the sensor is installed in a primary measuring device, its location depends on the type of primary device. Most primary devices have a specific place for the head (level) measurement device. For more details about the location of the head measuring point, refer to the *Isco Open Channel Flow Measurement Handbook*, or to information provided by the manufacturer of the primary device.

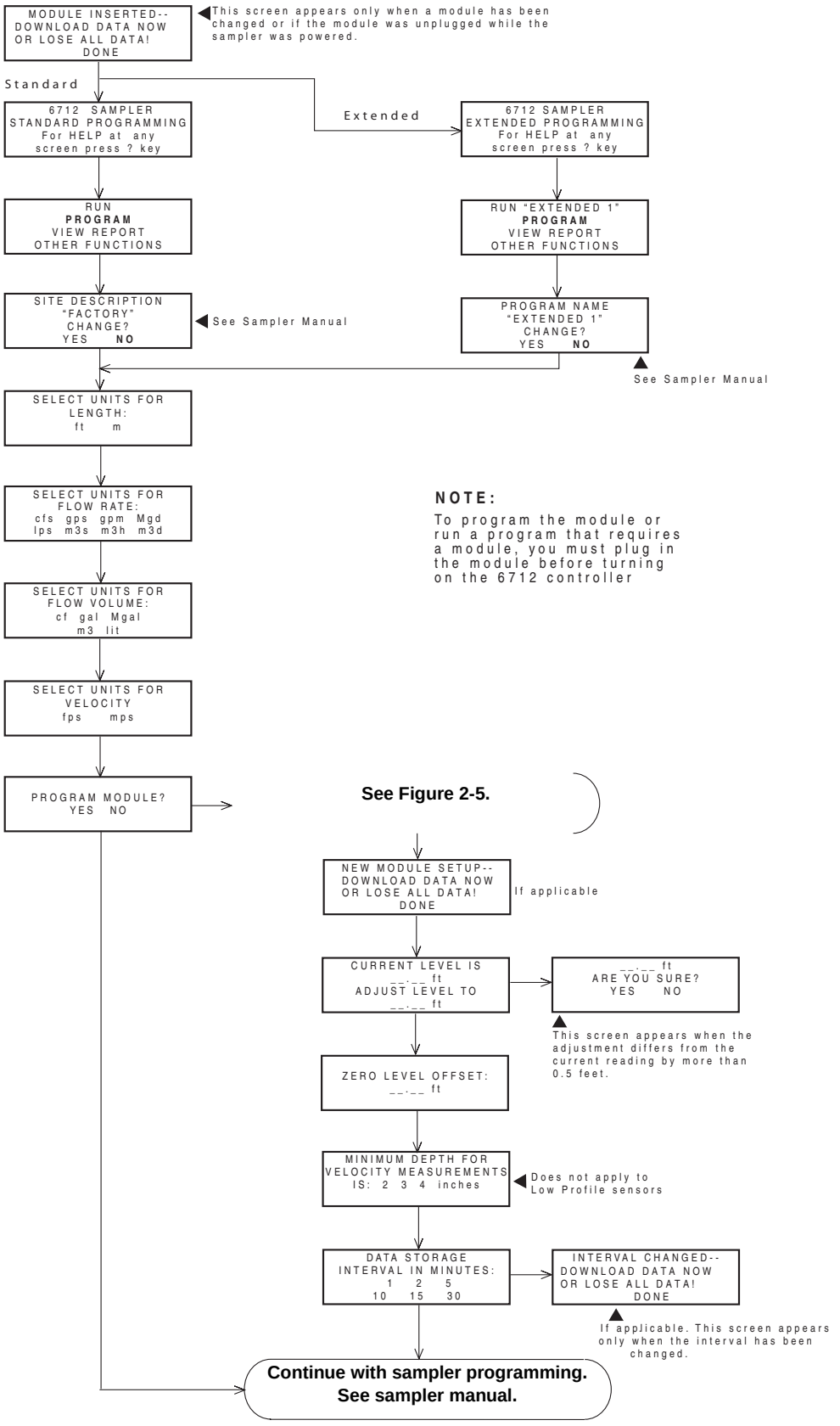


Figure 2-4 6712 Programming: 750 Module Screens

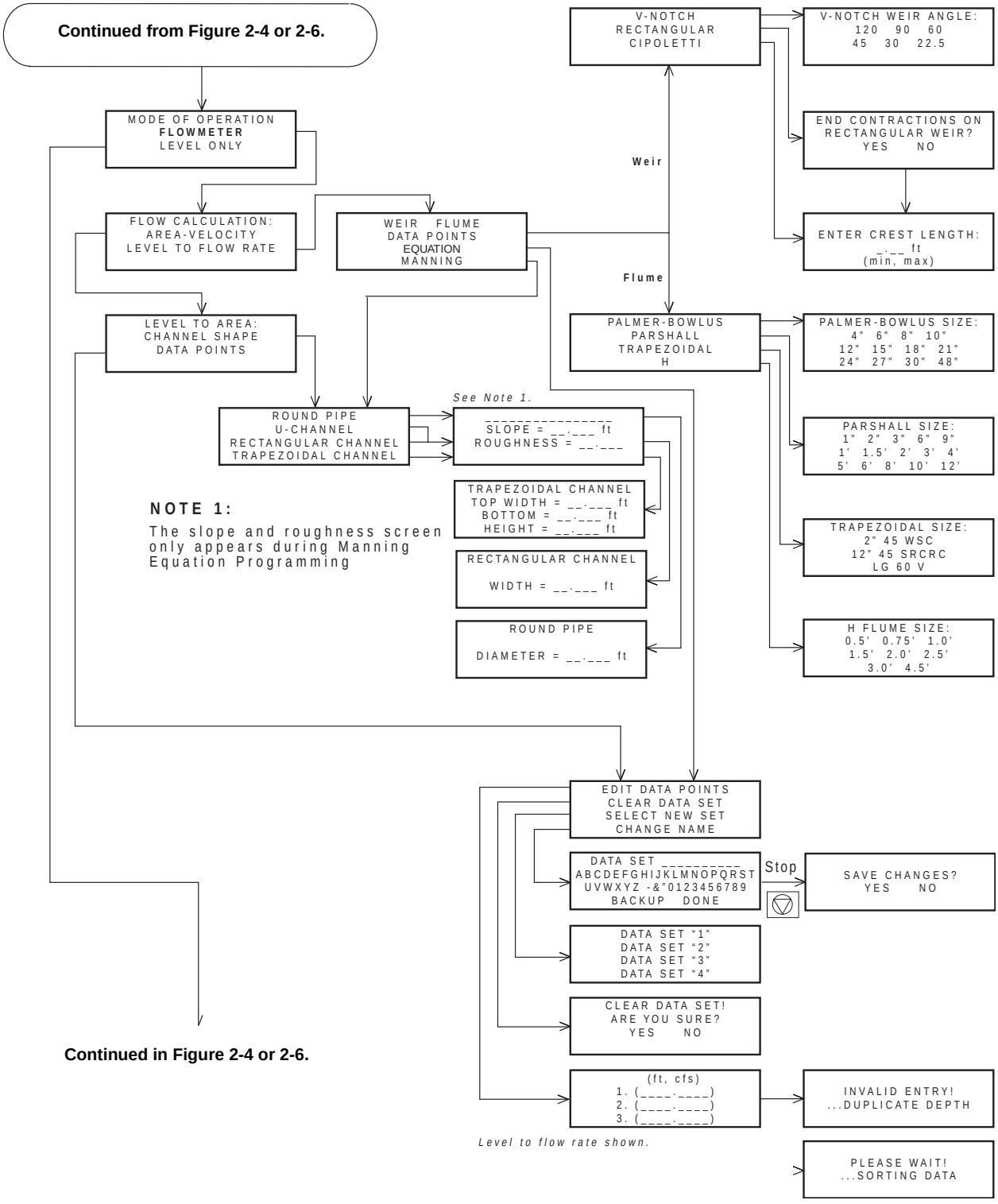


Figure 2-5 6712 Programming: 750 Module Setup Screens

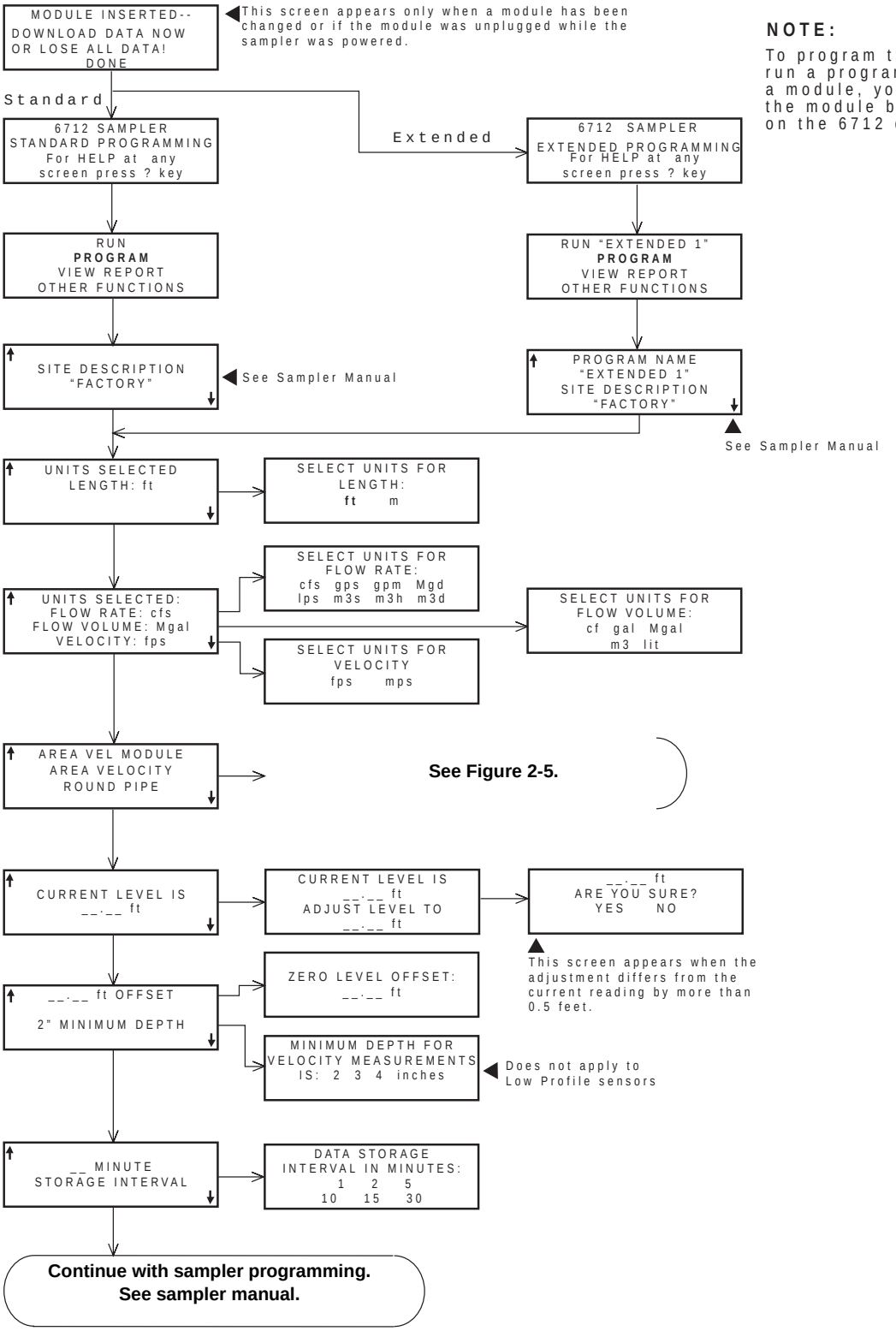


Figure 2-6 6712 Programming: 750 Module Quick View Screens

2.6 Selecting a Flow Conversion Method

The 750 is capable of determining flow rates using either area velocity conversion or level-to-flow rate conversion. A list of available flow conversions appears in Table 2-1, Flow Conversion Methods.

Table 2-1 Flow Conversion Methods

Conversion Type		Device, Formula, or Table	Size or Parameters
Area-Velocity	Channel Shape	Area × Velocity	Round Pipe, U-Channel, Rectangular, Trapezoidal
	Level-to-Area Data Points	User-developed Table	3 to 50 data points
Level to Flow	Weir	V-Notch Weir	22.5, 30, 45, 60, 90, 120 degrees
		Rectangular Weir with end contractions	Crest Length
		Rectangular Weir without end contractions	Crest Length
		Cipoletti Weir	Crest Length
	Flume	Palmer-Bowlus Flume	4, 6, 8, 10, 12, 15, 18, 21, 24, 27, 30, 48 inches
		Parshall Flume	1, 2, 3, 6, 9 inches 1, 1.5, 2, 3, 4, 5, 6, 8, 10, 12 feet
		Trapezoidal Flume	Large 60-degree V 2-inch, 45-degree WSC 12-inch, 45-degree SRCRC
		"H" Flume	0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4.5 feet
	Equation	$Q = a \times H^{b+c} \times H^{d}$	Q = flow H = head a, b, c, & d = entered values
	Level-to-Flow Rate Data Points	User-developed tables for level-to-flow rate	3 to 50 data points
	Manning Equation	Round Pipe	Slope, Roughness, Diameter
		U-Channel Pipe	Slope, Roughness, Width
		Rectangular Pipe	Slope, Roughness, Width
		Trapezoidal	Slope, Roughness, Bottom Width, Top Width

2.6.1 Flow Conversion Without a Primary Device

There are several conversion options if you install the sensor in a channel without a primary device. The method you choose depends on the channel shape or the amount of information available to define the channel's characteristics.

Area velocity flow conversion is the method of choice for round pipe, U-channel, rectangular, and trapezoidal channels. Non-standard channels can still use area velocity flow conversion, but

you must provide at least three level-to-area data points. The data points define the cross-sectional area of the channel at various levels.

2.6.2 Flow Conversion With a Primary Device

The software supports level-to-flow conversion for many common weirs and flumes. Refer to Table 2-1. If your primary device is not listed, use a level-to-flow rate data set. A data set requires at least three data points to specify the level-to-flow rate relationship of your device. This information is normally available from the manufacturer of the primary device.

The software also supports level-to-flow conversion using the Manning formula. To use the Manning formula you must be able to provide the channel slope, a roughness coefficient, and a channel diameter or width. For more information on the Manning formula, refer to the *Isco Open Channel Flow Measurement Handbook*.

2.7 Measurements for Programming

At a minimum, module programming requires a level measurement and a zero level offset. The standard and extended range AV Sensors will also require a minimum depth for velocity measurement. Depending on the selected flow conversion method, you may also need to enter channel dimensions or data points.

The accuracy of the values you enter during programming directly affect your flow conversion results. These values can include the level adjustment, channel dimension measurements, zero level offset, and data points. All subsequent module calculations will be based upon these values.

Significant errors may be introduced if your measurements are inaccurate. We recommend that you take actual measurements from the installation site - do not use nominal values. The example below illustrates the importance of accurate measurements.

Example:

Nominal Pipe Diameter: 10 inches

Actual Pipe Diameter: 10.25 inches

Level Measured Near Outfall: 2.75 inches

Correct Level Measurement: 3 inches

During programming, you enter 10 inches for the round pipe diameter - from the pipe manufacturer's specification. You also enter the 2 3/4-inch level measurement taken behind the sensor near an outfall. Although each value has only a 1/4-inch error, the cumulative flow measurement error may exceed 14%!

2.8 Levels and Channel Dimensions

Channel dimensions and level measurements can vary at different points along the channel. It is important to use measurements from the same point that the AV sensor reads the velocity and level. An ultrasonic sound wave is transmitted in a cone-shaped pattern from the front of the sensor. Your level measurement should be taken at a point inside the ultrasonic cone. Since this cone cannot be seen, a general rule is to measure in front of the sensor along the channel centerline at a distance equal to the liquid depth. For example, if the stream is one foot deep, take the level and channel dimension measurements one foot upstream from the sensor. If the flow at this point is turbulent, consider relocating the sensor.

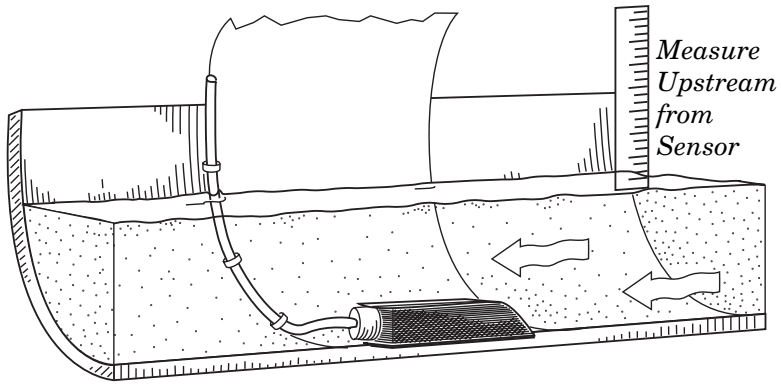


Figure 2-7 Ideal Conditions - Uniform Flow

Do not measure the level and channel dimensions right at the sensor, as the sensor and the mounting ring may cause a slight "jump" or localized rise in the level. At very low levels and high velocities, this jump in the liquid surface may become quite significant. Figure 2-8 shows very poor area velocity measurement conditions. The outfall is drawing down the liquid level and the sensor is disturbing the flow. In this example, the sensor should be moved forward to avoid the drawdown near the outfall. If the jump still exists, average several level measurements or measure the level with the sensor and mounting hardware out of the stream.

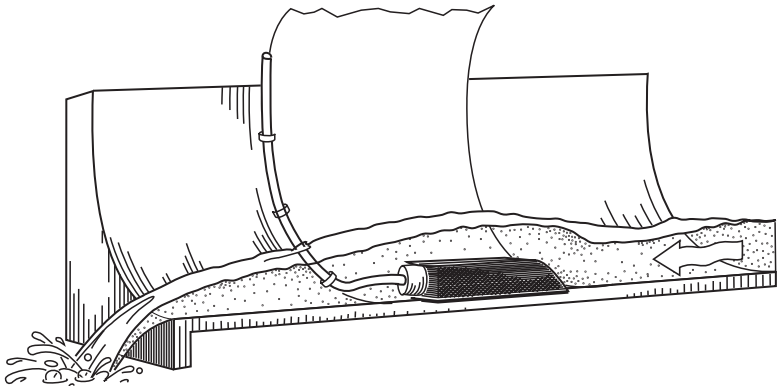
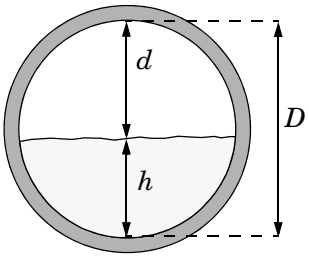


Figure 2-8 Poor Conditions - Disturbed Flow



Level (h) = D – d

In round pipes it is possible to measure the level without disturbing the stream surface. This method is preferred. Refer to the diagram in the margin. First measure the inside diameter of the pipe (D). Then measure the airspace (d) from the liquid surface to the peak of the inside diameter. Average this measurement if the surface is not calm. The level measurement that you enter (h) is calculated by subtracting the distance above the liquid (d) from the diameter (D).

2.9 Offsets

Sensors are sometimes offset to avoid heavy concentrations of silt, or to maximize the level resolution over a specific range. During module programming, you enter an offset measurement. Refer to Figure 2-9. Enter a value for the vertical distance the sensor is installed above the true zero level of the stream. For example, if the sensor is mounted on the side of the pipe one foot higher than the true zero level (the bottom center of the pipe), the Zero Level Offset is one foot. If the sensor is mounted at the bottom of the channel, enter zero.

☑ Note

Do not confuse the circumferential distance between true zero and the location of the AV sensor with the vertical distance (height). If you install the AV sensor at the true zero level of the pipe or channel, you would enter “0” for the offset (ignoring the thickness of the mounting ring).

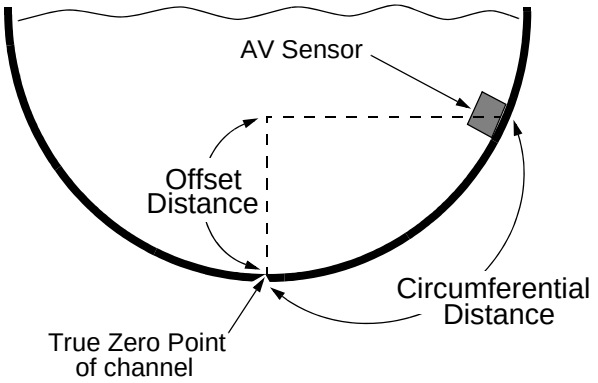


Figure 2-9 Offset Measurements

2.10 Data Points

Data point flow conversion is based on a set of user entered values that define the channel or primary device. A data set is a table of correlating level-to-area or level-to-flow rate data points. The module can interpolate areas or flow rates for all levels using this data set.

The sampler saves up to four different data sets. Each data set holds a minimum of 3 points and a maximum of 50.

The flow conversion accuracy increases with the number of points entered. Keep in mind that you are defining the entire channel shape mathematically; select points that best represent any curves or variations. Compound shapes will need many data points.

The module automatically calculates the maximum head and the flow rate at maximum head. The maximum head is 1.2 times the highest data point entered. For example, the module would calculate a 0.96-foot maximum head if the highest data point was 0.8 feet. The module extrapolates the flow rate at maximum head using the flow curve established by your data set.

To use **Level-to-Area** data points, you must enter at least three data points. Each data point entry contains two values – a level and the cross-sectional area of the channel at that level.

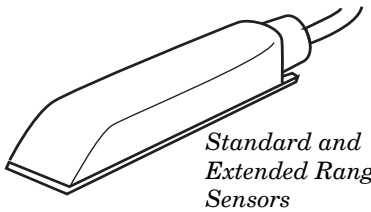
To use **Level-to-Flow** data points, you must enter at least three data points. Each data point entry contains two values – a level and the corresponding flow rate for that level.

Data point entries must use the same units of measure programmed for the sampler's length and flow rate units.

2.11 Minimum Depth for Velocity Measurements

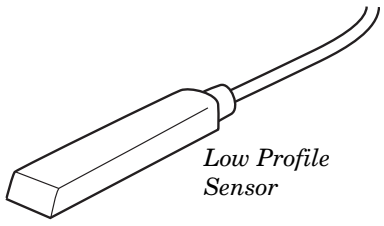
The Minimum Depth is the minimum level of liquid above the bottom of the sensor that is required to obtain a valid velocity reading. The depth varies with the velocity of the flow stream; in the same stream at higher velocities, the depth is greater. Velocity readings taken at too-shallow levels may be inaccurate.

The Minimum Depth setting allows you to program the level below which the module will stop taking velocity readings. When the water level falls below Minimum Depth, the 6712 will display the most recent valid velocity reading, followed by an asterisk (*), and the flow rate will be shown as "0". The asterisk means the velocity information has not been updated; it will disappear when the water rises above Minimum Depth and the module begins to take new readings.



Standard and Extended Range Sensors

Standard Velocity Sensors – Three selections are available for the Minimum Depth for Standard 10-foot and 30-foot range velocity probes: 2, 3, or 4 inches (50, 75, or 100 mm). In most installations, the 3-inch setting will be the optimum selection. You can use the 2-inch option when the channel produces flows of very low velocity. If, after examining the velocity data, you see a sharp decrease in velocity as the level readings approach Minimum Depth, increase the setting to 3 or 4 inches.



Low Profile Sensor

Low Profile Velocity Sensors – For Low Profile probes, the 6712 does not have a menu selection for Minimum Depth. Instead, the Minimum Depth is automatically set to 1 inch.

Probe Identification – When a probe is first connected, the 750 module will not know whether it is a Standard or Low-Profile until it takes a velocity reading. Since the 6712 only retrieves the module status (including probe type) at start-up, it will have to be re-started in order to display the correct probe information.

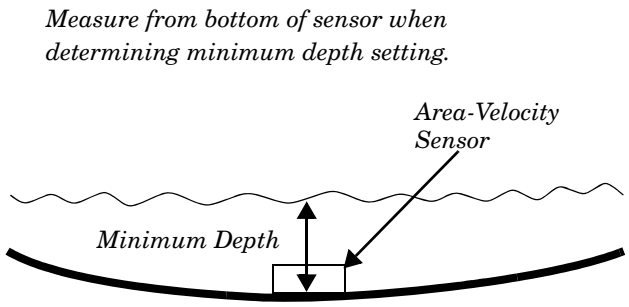


Figure 2-10 Determining Minimum Depth

2.12 Sampler Run Time Screens

BOTTLE 2
AFTER 702.1 cf
1.251 cfs 0.82 ft
00000002898 cf

BOTTLE 2
AFTER 700.8 cf

2.32 fps 0.82 ft

BOTTLE 2
AFTER 699.6 cf
SIGNAL STRENGTH: 85%
SPECTRUM: 63%

While running a sampling program, the sampler displays a variety of messages reporting the program's status. The 750 adds measurement and diagnostic information to these displays. Measurement information includes level, velocity, flow rate, and total flow. The spectrum and signal strength readings are diagnostic aids to help determine if the sensor is operating properly. Percentages near 100 indicate a strong, clear return signal. If both readings are zero, the sensor may not be plugged in, operating, or receiving a signal. Low signal strength or spectrum readings can indicate problems with the sensor, installation, or the characteristics of the flow stream.

The signal strength percentage represents the approximate strength of the return signal. Percentages from 10 to 90 are normal, and percentages from 50 to 90 are typical for sewers. Return signals below 10 percent are weak and the module may have difficulty measuring the stream velocity.

The spectrum percentage represents the approximate amount of noise in the return signal. The typical range of readings for most installations is from 40 to 90 percent. Percentages below 25 indicate a noisy return signal.

2.13 Data Storage

When the sampler is configured for use with the module, a memory partition is reserved. The module readings are stored in this sampler memory partition. For more information on data storage and partition management, see the sampler manual.

2.13.1 Recovering Module Data

The stored module data can be collected or viewed as "reports." Three of the sampler reports contain module information. Refer to the 6712 Sampler Instruction Manual for details on collecting and reading the reports.

Module data is compatible with Flowlink® 3 or 4 software. Flowlink provides additional data reporting options. See the Flowlink Instruction Manual for more information.

☑ Note

An * (asterisk) appears next to the reading if the module was unable to take a reading. If an asterisk appears, the reading displayed is the last available reading.

```
SAMPLER ID# 2215220899  08:55 22-FEB-03
*********** PROGRAM SETTINGS ***********
     ----------

 SITE DESCRIPTION:
    "FACTORY   "

     ----------
   UNITS SELECTED:
     LENGTH: ft


     ----------
   UNITS SELECTED:
   FLOW RATE: cfs
 FLOW VOLUME: Mgal
   VELOCITY: fps
     ----------
  AREA-VEL MODULE:
   AREA*VELOCITY
     ROUND PIPE

     ----------
   0.000 ft OFFSET

  3" MINIMUM DEPTH

     ----------

      1 MINUTE
   DATA INTERVAL

     ----------
  24,  1000 ml BTLS

 10 ft SUCTION LINE

     ----------
      PACING:
    FLOW, EVERY
     0.075 Mgal

     ----------
    DISTRIBUTION:
     SEQUENTIAL

   200 ml SAMPLES
     ----------

 NO DELAY TO START

  RUN PROGRAM ONCE
```

Figure 2-11 Report: Program Settings

```
 SAMPLER ID# 2215220899  08:56 22-FEB-03

AREA-VEL MODULE: 1365
   SITE: FACTORY

  Summary Report for 21-FEB-03 (FR )

        Day's Flow:     003.930582 Mgal
     Average Flow Rate:      19.46 cfs
20:06 Minimum Flow Rate:      2.456 cfs
20:10 Maximum Flow Rate:      33.16 cfs

      Hourly Average Flow Rate
     00:00-01:00:       NO DATA
     01:00-02:00:       NO DATA
     02:00-03:00:       NO DATA
     03:00-04:00:       NO DATA
     04:00-05:00:       NO DATA
     05:00-06:00:       NO DATA
     06:00-07:00:       NO DATA
     07:00-08:00:       NO DATA
     08:00-09:00:       NO DATA
     09:00-10:00:       NO DATA
     10:00-11:00:       NO DATA
     11:00-12:00:       NO DATA
     12:00-13:00:       NO DATA
     13:00-14:00:       NO DATA
     14:00-15:00:       NO DATA
     15:00-16:00:       NO DATA
     16:00-17:00:     19.57 cfs
     17:00-18:00:     19.58 cfs
     18:00-19:00:     19.58 cfs
     19:00-20:00:     19.58 cfs
     20:00-21:00:     19.32 cfs
     21:00-22:00:     19.30 cfs
     22:00-23:00:     19.40 cfs
     23:00-24:00:     19.38 cfs

           *---+---+---+---+---+---+*
     19.60 +                       +
           I                       I
           I                  ###  I
           I                 ####  I
           I                 ####  I
     19.55 +                 ####  +
           I                 ####  I
           I                 ####  I
           I                 ####  I
           I                 ####  I
     19.50 +                 ####  +
           I                 ####  I
           I                 ####  I
           I                 ####  I
           I                 ####  I
     19.45 +                 ####  +
           I                 ####  I
           I                 ####  I
           I                 ####  I
           I                 ####  I
     19.40 +                 ####  # +
           I                 ####  # I
           I                 ####  ##I
           I                 ####  ##I
           I                 ####  ##I
     19.35 +                 ####  ##+
           I                 ####  ##I
           I                 ####  ##I
           I                 ##### ##I
           I                 ##### ##I
     19.30 +                 ########+
           *---+---+---+---+---+---+*
Hour Ending:       08:     16:     24:
           Units are 'cfs'
```

```
SAMPLER ID# 2215220899  08:56 22-FEB-03
 AREA-VEL MODULE: 1365
********** COMBINED RESULTS **********
   SITE: FACTORY
Program Started at 16:36 FR  21-FEB-03
Nominal Sample Volume =  200 ml

                                 FLOW          TOTAL
                                 RATE           FLOW
SAMPLE  BOTTLE TIME    cfs            Mgal
------- ------ ----  ----- -------------
     1      1   16:44  35.34    000.075006
     1      2   16:53  28.27    000.149821
     1      3   17:02  21.20    000.224477
     1      4   17:09  35.34    000.299454
     1      5   17:19  35.34    000.374269
     1      6   17:28  28.27    000.448872
     1      7   17:36  10.01    000.523683
     1      8   17:44  35.34    000.598452
     1      9   17:53  28.27    000.673267
     1     10   18:02  21.20    000.748082
     1     11   18:10  2.062    000.822872
     1     12   18:19  35.34    000.897662
     1     13   18:28  28.27    000.972477
     1     14   18:37  21.20    001.047398
     1     15   18:44  35.34    001.122110
     1     16   18:54  35.34    001.197002
     1     17   19:03  28.27    001.271764
     1     18   19:11  10.01    001.346536
     1     19   19:19  35.34    001.421397
     1     20   19:28  28.27    001.496106
     1     21   19:37  21.20    001.570922
     1     22   19:45  2.062    001.645719
     1     23   19:54  35.34    001.720660
     1     24   20:03  28.27    001.795369
-----------------------------------------
```

Figure 2-12 Summary Report (left) and Combined Results (right)

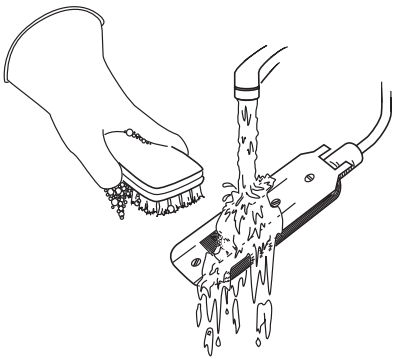
750 Area Velocity Module

Section 3 Maintenance

The area velocity sensor and cable require little maintenance. Because the sensor body offers a streamlined profile to the flow, solid materials rarely collect on the sensor. However, clean the channel up- and downstream from the sensor periodically. This maintains the hydrostatic conditions on which the level-to-area conversion is based.

3.1 Cleaning

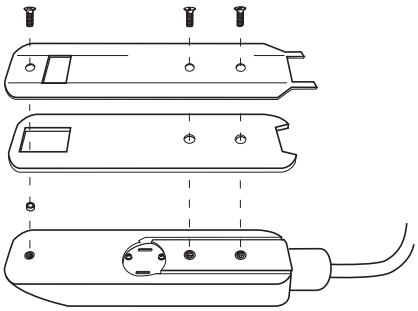
If the flow stream carries a great deal of debris, beware of organic materials that may collect inside the sensor. This material swells as it becomes saturated with water and may exert pressure on the transducer diaphragm inside the sensor. This can damage the diaphragm and permanently disable the sensor.



If the liquid ports in the sensor become blocked, clean the sensor. Cleaning the sensor not only protects t from damage, but assures you that the sensor will respond to the hydrostatic pressure above the sensor instead of the pressure created by swollen material inside.

1. Remove the sensor from its mounting ring or strap.
2. Scrape any accumulated solids off the exterior of the sensor. Use a brush and flowing water.

If the ports are thoroughly blocked or if you need to clean the sensor for storage, continue with steps 3 through 6 for standard and extended range sensors, 5 and 6 for low profile sensors.



3. Remove the mounting plate by unscrewing the three screws that hold the plate in place.
4. Carefully pull the mounting plate and urethane foam gasket away from the sensor.
5. Gently flush the sensor with water to remove any solid materials.
6. The pressure transducer is behind the small, round plate on the bottom of the sensor. *Gently* flush the transducer cavity with water to remove debris. *Do not remove the disk protecting the pressure transducer.*

3.2 Cable Inspection

Periodically inspect the sensor cable and connector for wear caused by abuse or exposure to the elements. A damaged cable can affect the operation of the sensor, particularly if the reference port vent tube inside the cable is collapsed or blocked. In some cases, a damaged connector can be replaced, but damaged cables cannot be spliced or repaired.

⚠ CAUTION

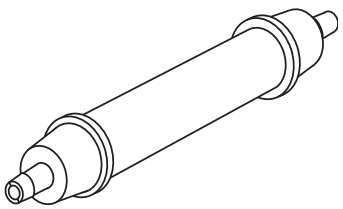
Do not allow the connector end of the probe cable to fall into water, or leave it disconnected without the plastic cap in place. Failure to do so can result in permanent internal water damage to both probe and module.

If the sensor cable is damaged, you must replace the entire assembly, as the sensor, cable, and connector are a factory-sealed unit. Keep the connector clean and dry. In permanent installations, install the cable so that it is not at risk of damage resulting form other activity taking place in the area.

In temporary installations, do not leave cables lying around where they may be run over by heavy equipment. Do not leave extra cable loose in the flow stream where it can trap debris.

In permanent installations, cables repeatedly subjected to abuse will fail and should be installed in conduit for protection. The conduit must be large enough to pass the connector, as you cannot remove or replace it.

3.3 Desiccant Reactivation



Desiccant Cartridge

There is a cartridge on the side of the module to dry the reference air. It contains a silica gel desiccant with a color indicator that changes from blue to pink, or yellow to green, when saturated. Pink or green desiccant cannot remove moisture and must be replaced or reactivated.

⚠ CAUTION

Desiccant may produce irritating fumes when heated. Observe the following precautions:
Use a vented oven in a well-ventilated room.
Do not remain in the room while the regeneration is taking place.
Use the recommended temperature. Avoid heating the desiccant at higher than recommended temperatures.

There have been reports of irritating fumes coming from the desiccant during reactivation. While our efforts to duplicate the problem have been unsuccessful, we still urge you to use caution. Material Safety Data Sheets are in the back of this manual.

To reactivate the desiccant, pour it out of the cartridge into a heat-resistant container. Never heat the plastic cartridge. Heat the silica gel in a vented convection oven at 212° to 350° F (100° to 175° C) for two to three hours, or until the blue or yellow color

returns. Allow the desiccant to cool and then refill the cartridge. The desiccant's ability to remove moisture may lessen with each saturation/reactivation cycle, resulting in a need for more frequent service. After several cycles, the desiccant may no longer be effective as it saturates too quickly. At this point, replace the desiccant.

The foam filters in the end caps keep small pieces of desiccant from falling out of the cartridge. When they become soiled, wash with dish soap and water, then allow to dry.

> ☑ ***Note***
>
> A saturated desiccator will let moisture into the reference tube. The moisture may block the tube and cause reading errors and internal damage. Also, the air in many installations contains fumes that will form acids in the presence of moisture. These acids may corrode internal components.

3.4 Repair of the Module and Probe

The module has no user-serviceable parts. Its case is completely sealed to protect the internal components. To repair the unit, the case must be broken open and replaced.

The velocity sensor's pressure transducer, the ultrasonic transducers, cable, and the electronic components are encapsulated in plastic resin and are not user-serviceable.

If you think your module or probe requires repair, contact Teledyne Isco's Customer Service Department at 800-228-4373 for information on returning it to the factory.

3.5 How to Get Help

If you need help or have repair questions, contact Teledyne Isco's Technical Service department.

Teledyne Isco Technical Service Department

P.O. Box 82531
Lincoln, Nebraska, 68501 (USA)

E-mail: IscoService@teledyne.com

Telephone: (402) 464-0231
Toll Free: 800-775-2965 (Within USA, Canada, and Mexico)

FAX: (402) 464-3001

3.6 Flash Memory and Software Upgrades

The module has Flash memory to store its software. With Flash technology, you can upgrade your module's software without sending it back to the factory or replacing a chip. To update the module software, install the module in a 6712 sampler. Then connect the sampler power source and turn the sampler on. Connect the sampler to a computer and follow the instructions received with your Flash Update program.

750 Area Velocity Module

Appendix A Replacement Parts and Accessories

The following appendix contains the most commonly ordered parts and accessories for the 750 module, including part descriptions and order numbers.

Accessories can be purchased by contacting Teledyne Isco's Customer Service Department.

Teledyne Isco, Inc.
Customer Service Department
P.O. Box 82531
Lincoln, NE 68501 USA

Phone: (800) 228-4373
(402) 464-0231
FAX: (402) 465-3022

E-mail: IscoInfo@teledyne.com

A.1 Sensors

AV Sensor 10' range (with 25' cable) 60-3254-001
AV Sensor 30' range (with 50' cable) 60-3254-003
Low Profile AV Sensor 10' range (with 25' cable) 60-3254-021

A.2 Standard Spring Rings

Spring Ring - 6" Dia 68-3200-007
Spring Ring - 8" Dia 68-3200-008
Spring Ring - 10" Dia 68-3200-009
Spring Ring - 12" Dia 68-3200-010
Spring Ring - 15" Dia 68-3200-011
(Each spring ring includes plastic ties to fasten the cable)

A.3 Standard Scissors Rings

Scissors Ring for 16-23" Pipe 68-3000-042
Scissors Ring for 16-36" Pipe 68-3000-043
Scissors Ring for 39-43" Pipe 68-3000-044
Scissors Ring for 45-49" Pipe 68-3000-045
Scissors Ring for 58 to 63" Pipe 68-3000-046
Scissors Ring for 72" Pipe 68-3000-047
Scissors Ring for 16-80" Pipe 68-3000-048
(Each scissors ring includes a base section, scissors mechanism, extensions, plastic ties, and instructions)
Base Section (with plastic ties & instructions) 60-3004-169

A.4 Street Level Installation System

Multi-section Pole. 60-3204-012
(Includes instruction manual. To complete your system, you must also order a Street Level Mounting Ring)
Street Level Mounting Ring for 6" dia. pipe. 60-3204-014
Street Level Mounting Ring for 8" dia. pipe. 60-3204-015
Street Level Mounting Ring for 10" dia. pipe. 60-3204-016
Street Level Mounting Ring for 12" dia. pipe. 60-3204-017
Street Level Mounting Ring for 15" dia. pipe. 60-3204-018

A.5 Miscellaneous

Sensor Mounting Plate 68-3000-051
(Includes plastic ties and instructions)
L.P. AV sensor carrier 60-3204-029
(adapter to fit the low profile sensor on standard size rings)
Desiccant Cartridge Assy 60-9004-105
Area velocity sensor extension cable. 60-3254-005
Quick Disconnect Box 60-3254-004
Isco Open Channel Flow Measurement Handbook 60-3003-041

750 Area Velocity Module

Appendix B Material Safety Data Sheets

This appendix to the manual provides Material Safety Data Sheets for the desiccant used by the 750 Area Velocity Module.

Teledyne Isco cannot guarantee the accuracy of the data. Specific questions regarding the use and handling of the products should be directed to the manufacturer listed on the MSDS.

Material Safety Data Sheet

Indicating Silica Gel

Identity (Trade Name as Used on Label)

Manufacturer :	MULTISORB TECHNOLOGIES, INC. (formerly Multiform Desiccants, Inc.)	MSDS Number* :	M75
Address:	325 Harlem Road Buffalo, NY 14224	CAS Number* :	
Phone Number (For Information):	716/824-8900	Date Prepared:	July 6, 2000
Emergency Phone Number:	716/824-8900	Prepared By* :	G.E. McKedy

Section 1 - Material Identification and Information

Components - Chemical Name & Common Names (Hazardous Components 1% or greater; Carcinogens 0.1% or greater)	%*	OSHA PEL	ACGIH TLV	OTHER LIMITS RECOMMENDED
Silica Gel SiO_2	98.0	6mg/m^3 (total dust)	10mg/m^3 (total dust)	
Cobalt Chloride	>2.0	0.05mg/m^3 (TWA cobalt metal dust & fume)	.05mg/m^3 (Cobalt, TWA)	
Non-Hazardous Ingredients				
TOTAL	100			

Section 2 - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_20 = 1)	2.1
Vapor Pressure (mm Hg and Temperature	N/A	Melting Point	N/A
Vapor Density (Air =1)	N/A	Evaporation Rate (_____=1)	N/A
Solubility in Water	Insoluble, but will adsorb moisture.	Water Reactive	Not reactive, but will adsorb moisture.
Appearance and Odor	Purple crystals, no odor.		

Section 3 - Fire and Explosion Hazard Data

Flash Point and Methods Used	N/A	Auto-Ignition Temperature	N/A	Flammability Limits in Air % by Volume	N/A	LEL	UEL
Extinguisher Media	Dry chemical, carbon dioxide and foam can be used.						
Special Fire Fighting Procedures	Water will generate heat due to the silica gel which will adsorb water and liberate heat.						
Unusual Fire and Explosion Hazards	When exposed to water, the silica gel can get hot enough to reach the boiling point of water. Flooding with water will reduce the temperature to safe limits.						

Section 4 - Reactivity Hazard Data

STABILITY ☐**Stable** ☐**Unstable**	Conditions To Avoid	Moisture and high humidity environments.
Incompatibility (Materials to Avoid)	Water.	
Hazardous Decomposition Products	Carbon dioxide, carbon monoxide, water	
HAZARDOUS POLYMERIZATION ☐May Occur	Conditions To Avoid	None.

*Optional

Section 5 - Health Hazard Data

PRIMARY ROUTES OF ENTRY	☐Inhalation ☐Skin Absorption	☐Ingestion ☐Not Hazardous	**CARCINOGEN LISTED IN**	☐NTP ☐IARC Monograph	☐OSHA ☐Not Listed
HEALTH HAZARDS	Acute	May cause eye, skin and mucous membrane irritation.			
	Chronic	Prolonged inhalation may cause lung damage.			
Signs and Symptoms of Exposure	Drying and irritation.				
Medical Conditions Generally Aggravated by Exposure	Asthma.				
EMERGENCY FIRST AID PROCEDURES - Seek medical assistance for further treatment, observation and support if necessary.					
Eye Contact	Flush with water for at least 15 minutes.				
Skin Contact	Wash affected area with soap and water.				
Inhalation	Remove affected person to fresh air.				
Ingestion	Drink at least 2 glasses of water.				

Section 6 - Control and Protective Measures

Respiratory Protection (Specify Type)	Use NIOSH approved dust mask or respirator.		
Protective Gloves	Light cotton gloves.	Eye Protection	Safety glasses.
VENTILATION TO BE USED	☐ Local Exhaust	☐Mechanical (General)	☐Special
	☐Other (Specify)		
Other Protective Clothing and Equipment	None.		
Hygienic Work Practices	Avoid raising dust. Avoid contact with skin, eyes and clothing.		

Section 7 - Precautions for Safe Handling and Use/Leak Procedures

Steps to be Taken if Material Is Spilled Or Released	Sweep or vacuum up and place the spilled material in a waste disposal container. Avoid raising dust.
Waste Disposal Methods	Dispose in an approved landfill according to federal, state and local regulations.
Precautions to be Taken In Handling and Storage	Cover promptly to avoid blowing dust. Wash after handling.
Other Precautions and/or Special Hazards	Keep in sealed containers away from moisture. The silica gel will readily adsorb moisture.

*Optional Indicating Silica Gel

MATERIAL SAFETY DATA SHEET

Effective Date March 8, 2005
MSDS Number M163

Section 1 – Product and Company Information

Product Name: **Silica gel, indicating, yellow**

Product Use: Desiccant, absorbent
Grades: Silica gel, indicating
Synonyms: Amorphous silica gel, SiO_2, silicon dioxide (amorphous)

Company; Multisorb Technologies, Inc.
Street Address: 325 Harlem Road
City, State, Zip, Country: Buffalo, NY 14224-1893 USA

Telephone Number: (716) 824 8900 [USA] Monday - Friday (8:00 - 5:00 EDT)
Fax Number: (716) 824 4091 [USA]
Website / E-Mail : multisorb.com

Section 2 – Composition / Information on Ingredients

Component Name	CAS Number	% by Weight
Synthetic amorphous silica gel (SiO_2)	112926-00-8	100
Phenolphthalein	77-09-08	100 ppm

While this material is not classified, this MSDS contains valuable information critical to the safe handling and proper use of this product. This MSDS should be retained and available for employees and other users of this product.

Section 3 – Hazard Identification

Emergency Overview: A yellow bead or granular material that poses little or no immediate hazard. This material is not combustible.

Potential Health Effects:

Eyes: Dust and or product may cause eye discomfort and irritation seen as tearing and reddening.

Skin: The product dust may cause drying of the skin. Silica gel may get hot enough to burn skin when it adsorbs moisture rapidly. Use an excess of water to cool the silica gel.

Ingestion: Material is not toxic and will pass through the body normally.

Inhalation: Slight irritation is possible but none is expected.

Medical Effects Generally Aggravated by Exposure: Respiratory ailments.

Chronic Effects/Carcinogenity: May cause eye, skin and mucous membrane irritation and drying.

Section 4 – First Aid Measures

Eyes: Rinse the eyes well with water while lifting the eye lids. If irritation persists, consult a physician.

Skin: Wash affected area with soap and water.

Ingestion: Ingestion is unlikely, this material will pass through the body normally.

Inhalation: Remove the affected person to fresh air and get medical attention if necessary.

Notes to Physician: Not applicable

Section 5 – Fire Fighting Measures

Flammable Properties: Not flammable

Flash Point: Not applicable **Method:** Not applicable

Flammable Limits: Not flammable

Lower Flammability Limit: Not applicable

Upper Flammability Limit: Not applicable

Autoignition Temperature: Not applicable

Hazardous Combustion Products: Not applicable

Extinguishing Media: Use extinguishing media that is appropriate for the surrounding fire. Silica gel is not combustible.

Fire Fighting Instructions: Not combustible

Unusual Fire and Explosion Hazards: None

Section 6 – Accidental Release Measures

Spill: Sweep or vacuum up and place the spilled material in a waste disposal container. Avoid raising dust. Wash with soap and water after handling.

Section 7 – Handling and Storage

Handling: Avoid raising dust and minimize the contact between worker and the material. Practice good hygienic work practices.

Storage: Store in a cool, dry location. Keep in sealed containers away from moisture. The silica gel will readily adsorb moisture.

Section 8 – Exposure Controls/Personal Protection

Engineering Controls: Use exhaust ventilation to keep the airborne concentrations below the exposure limits.

Respiratory Protection: Use NIOSH approved respirator when the air quality levels exceed the TLV's.

Skin Protection: Light gloves will protect against abrasion and drying of the skin.

Eye Protection: Safety glasses.

Component Name	Exposure Limits		
	OSHA PEL	**ACGIH TLV**	**Other Recommended Limits**
Silica gel	TWA 20 mppcf (80 mg / m^3 % SiO_2)	TWA 10 mg / m^3	NIOSH REL TWA 6 mg / m^3 IDLH 3000 mg / m^3
Phenolphthalein	Not Applicable	Not Applicable	Not Applicable

Section 9 – Physical and Chemical Properties

Appearance: Yellow beads or granules

Odor: None

Physical State: Solid bead

PH: Not applicable

Vapor Pressure: Not applicable

Vapor Density: Not applicable

Boiling Point: 4046° F (2230° C)

Melting Point: 3110° F (1710° C)

Solubility: Insoluble in water

Specific Gravity: 2.1

Section 10 – Stability and Reactivity

Stability: Stable

Conditions to avoid: Moisture and high humidity environments.

Incompatibility: Water, fluorine, oxygen difluoride, chlorine trifluoride

Hazardous Decomposition Products: None

Hazardous Polymerization: Will not occur

Section 11 – Toxicological Information

This product and its components are not listed on the NTP or OSHA Carcinogen lists.

Animal Toxicology Tests for DOT Hazard classification
(Tests Conducted on finely ground silica gel)

1 - hour LC_{50} (rat) > 2 mg / l
48 - hour oral LD_{50} (rat) est. > 31,600 mg / kg
48 - hour dermal LD_{50} (rabbit) est. > 2,000 mg / kg
Considered an ocular irritant

Human Toxicology Silica gel is a synthetic amorphous silica not to be confused with crystalline silica. Epidemiological studies indicate low potential for adverse health effects. In the activated form, silica gel acts as a desiccant and can cause a drying irritation of the mucous membranes and skin in cases of severe exposure. Multisorb Technologies Inc. knows of no medical conditions that are abnormally aggravated by exposure to silica gel. The primary route of entry is inhalation of dust.

Section 12 – Ecological Information

Not known to have any adverse effect on the aquatic environment. Silica gel is insoluble and non-toxic.

Section 13 – Disposal Information

Disposal Information If this product as supplied becomes a waste, it does not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261. Materials of a hazardous nature that contact the product during normal use may be retained on the product. The user of the product must identify the hazards associated with the retained material in order to assess the waste disposal options. Dispose according to federal, state and local regulations.

Section 14 – Transportation Information

U.S. Department of Transportation Shipping Name: Not classified as a hazardous material. Not regulated.

Section 15 – Regulatory Information (Not meant to be all inclusive - selected regulations represented)

TSCA Listed: Yes

DSL/NDSL (Canadian) Listed: Yes

OSHA: TWA 20 mppcf (80 mg / m^3 % SiO_2) for Silica gel

NIOSH: REL TWA 6 mg / m^3 IDLH 3,000 mg / m^3 for silica gel
Animal tests conducted in 1976 - 1978. 18 month exposure at 15 mg / m^3 showed silica deposition in respiratory macrophages and lymph nodes, minimum lung impairment, no silicosis.

ACGIH: TLV - 10 mg / m^3 for Silica gel

DOT: Not classified as a hazardous material.

Section 16 – Other Information

HMIS – Hazardous Materials Identification System

HMIS Rating	
Health	0
Flammability	0
Reactivity	0

0 - minimal hazard, 1 - slight hazard, 2 - moderate hazard, 3 - serious hazard, 4 - severe hazard

This MSDS was prepared by: George E. Mckedy
Senior Applications Development Specialist
Multisorb Technologies, Inc.

This data and recommendations presented in this data sheet concerning the use of our product and the materials contained therein are believed to be correct but does not purport to be all inclusive and shall be used only as a guide. However, the customer should determine the suitability of such materials for his purpose before adopting them on a commercial scale. Since the use of our products is beyond our control, no guarantee, expressed or implied, is made and no responsibility assumed for the use of this material or the results to be obtained therefrom. Information on this form is furnished for the purpose of compliance with Government Health and Safety Regulations and shall not be used for any other purposes. Moreover, the recommendations contained in this data sheet are not to be construed as a license to operate under, or a recommendation to infringe, any existing patents, nor should they be confused with state, municipal or insurance requirements, or with national safety codes.

DECLARATION OF CONFORMITY

CE
ISM1-A

Application of Council Directive:	89/336/EEC – The EMC Directive 73/23/EEC – The Low Voltage Directive
Manufacturer's Name:	Teledyne Isco, Inc.
Manufacturer's Address:	4700 Superior, Lincoln, Nebraska 68504 USA Mailing Address: P.O. Box 82531, Lincoln, NE 68501
Equipment Type/Environment:	Laboratory Equipment for Light Industrial/Commercial Environments
Trade Name/Model No:	750 Area Velocity Probe Module
Year of Issue:	2001
Standards to which Conformity is Declared:	EN 61326-1998 EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use EN 61010-1 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

Standard	Description	Severity Applied	Performance Criteria
EN61000-4-2	Electrostatic Discharge	Level 2 - 4kV contact discharge Level 3 - 8kV air discharge	B B
EN61000-4-3 *	Radiated RF Immunity	80 MHz to 1000MHz 80% AM at 1kHz Level 1 - 10V/m	A
EN61000-4-4	Electrical Fast Transient	Level 2 - 2kV on ac lines	B
EN61000-4-5	Surge on AC Lines	2kV common mode, 1KV differential mode	B
EN61000-4-6 *	Conducted RF on AC lines	150 kHz to 80 MHz, 3V rms, 80% modulated	B
EN61000-4-11	Voltage Dips/Short Interruptions	0.5 cycle, each polarity/100%	B
CISPR11/ EN 55011	RF Emissions	Group 1, Class A Industrial, Scientific, and Medical Equipment	
EN61000-3-2, 3-3	Harmonic, Flicker		

*** Instrument is susceptible to 10V/M from 80MHz to 1000 MHz and 3 VRMS from 150 KHz to 80 MHz**
We, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of March 6, 2001.

William Foster

William Foster
USA Representative

TELEDYNE ISCO
A Teledyne Technologies Company

Williams Foster
Director of Engineering
Teledyne Isco, Inc.
4700 Superior Street
Lincoln, Nebraska 68504

Phone: (402) 464-0231
Fax: (402) 464-4543

60-9002-069
Rev. A

*Teledyne Isco One Year Limited Factory Service Warranty **

Teledyne Isco warrants covered products against failure due to faulty parts or workmanship for a period of one year (365 days) from their shipping date, or from the date of installation by an authorized Teledyne Isco Service Engineer, as may be appropriate.

During the warranty period, repairs, replacements, and labor shall be provided at no charge. Teledyne Isco's liability is strictly limited to repair and/or replacement, at Teledyne Isco's sole discretion.

Failure of expendable items (e.g., charts, ribbon, tubing, lamps, glassware, seals, filters, fittings, and wetted parts of valves), or from normal wear, accident, misuse, corrosion, or lack of proper maintenance, is not covered. Teledyne Isco assumes no liability for any consequential damages.

This warranty does not cover loss, damage, or defects resulting from transportation between the customer's facility and the repair facility.

Teledyne Isco specifically disclaims any warranty of merchantability or fitness for a particular purpose.

This warranty applies only to products sold under the Teledyne Isco trademark and is made in lieu of any other warranty, written or expressed.

No items may be returned for warranty service without a return authorization number issued from Teledyne Isco.

The warrantor is Teledyne Isco, Inc.
4700 Superior, Lincoln, NE 68504, U.S.A.

*** This warranty applies to the USA and countries where Teledyne Isco Inc. does not have an authorized dealer. Customers in countries outside the USA, where Teledyne Isco has an authorized dealer, should contact their Teledyne Isco dealer for warranty service.**

In the event of instrument problems, always contact the Teledyne Isco Service Department, as problems can often be diagnosed and corrected without requiring an on-site visit. In the U.S.A., contact Teledyne Isco Service at the numbers listed below. International customers should contact their local Teledyne Isco agent or Teledyne Isco International Customer Service.

Return Authorization

A return authorization number must be issued prior to shipping. Following authorization, Teledyne Isco will pay for surface transportation (excluding packing/crating) both ways for 30 days from the beginning of the warranty period. After 30 days, expense for warranty shipments will be the responsibility of the customer.

Shipping Address: Teledyne Isco, Inc. - Attention Repair Service
4700 Superior Street
Lincoln NE 68504 USA

Mailing address: Teledyne Isco, Inc.
PO Box 82531
Lincoln NE 68501 USA

Phone: Repair service: (800)775-2965 (lab instruments)
(800)228-4373 (samplers & flow meters)
Sales & General Information (800)228-4373 (USA & Canada)

Fax: (402) 465-3001

Email: iscoservice@teledyne.com **Web site:** www.isco.com

February 1, 2006 P/N 60-1002-040 Rev C

TELEDYNE ISCO
A Teledyne Technologies Company

In-Situ Inc.

Multi-Parameter
Water Quality ***TROLL***®

Multi-Parameter ***TROLL*** *9500*

WQP-100

OPERATOR'S MANUAL

September 2007

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Revision history

Beta draft September 23, 2005
Initial release, October 28, 2005
Rev. 001, April 6, 2006
Rev. 002, November 2006
Rev. 003, April 2007
Rev. 004a, September 2007

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1 INTRODUCTION

GENERAL DESCRIPTION OF THE MP TROLL 9500

Your new Multi-Parameter TROLL 9500 water quality probe uses the latest sensor and electronics technology to provide a robust, durable, and user-friendly instrument.

The MP TROLL 9500 logs data from up to 7 water-level and water-quality sensors, as well as built-in temperature and barometric pressure sensors. Many custom options and versions are available, so your instrument may not look exactly like those we have chosen to illustrate in this manual.

The MP TROLL 9500 provides the convenience of a laboratory-quality measurement instrument for field use, providing true in-situ monitoring of water level and water quality.

HOW TO USE THIS MANUAL

This operator's manual is designed as both a start-up guide and a permanent reference for the features, uses, and applications of the Multi-Parameter TROLL 9500.

Section 1: Introduction to this Operator's Manual and to In-Situ Inc.; contacting us for warranty and repair issues

Section 2: Description of components and features of the Multi-Parameter TROLL 9500

Section 3: Getting Started: setting up the software, connecting for the first time, Quick-Calibrating the sensors, and a summary overview of the setup to start collecting data

Section 4: Control Software: Win-Situ® 4 and Pocket-Situ 4

Section 5: Profiling

Section 6: How to set up tests and start logging data; extracting data to your PC; viewing and graphing data

Section 7: Monitoring Pressure (Water Level): Info on the two basic types of pressure sensors; setting up the pressure channel to obtain the most accurate readings for your altitude and latitude; how to display data as you wish to see it

Section 8: Temperature

Section 9: Barometric Pressure

Section 10: An overview of monitoring water quality with the MP TROLL 9500: Sensor installation and calibration, software options, calibration reports

Section 11: pH

Section 12: Conductivity

Section 13: Dissolved Oxygen: Polarographic (Clark cell)
RDO® Optical Dissolved Oxygen

Section 14: Oxidation-Reduction Potential (ORP)

Section 15: Ammonium

Section 16: Chloride

Section 17: Nitrate

Section 18: Turbidity

Section 19: SDI-12 Operation

Section 20: Low-Flow Monitoring

Section 21: Care and Maintenance advice

Section 22: Troubleshooting: Look here first if you have problems making connections or calibrating . . .

The manual includes a Glossary and a comprehensive Index

CONVENTIONS

Throughout this operator's manual you will see the following symbols.

The check mark highlights a tip about a convenient feature of the MP TROLL 9500

The exclamation point calls your attention to a requirement or important action that should not be overlooked

Typical usage questions and answers that we hope will help you gain a better understanding of your new Multi-Parameter TROLL 9500 and simplify its setup and operation

UNPACKING AND INSPECTION

Your MP TROLL 9500 was carefully inspected before shipping. Check the instrument for any physical damage sustained during shipment. Notify In-Situ and file a claim with the carrier if there is any such damage; do not attempt to operate the instrument.

Please save packing materials for future storage and shipping of your MP TROLL 9500. The shipping boxes have been performance-tested and provide protection for the instrument and its accessories.

Accessories may be shipped separately and should also be inspected for physical damage and the fulfillment of your order.

SERIAL NUMBER

The serial number is located on the large label on the Multi-Parameter TROLL 9500 body, and also on a small label inside the battery compartment. The serial number is programmed into the instrument and displayed when the instrument is connected to a PC running Win-Situ 4 or Pocket-Situ 4. We recommend that owners keep a separate record of this number. Should your Multi-Parameter TROLL 9500 be lost or stolen, the serial number is often necessary for tracing and recovery, as well as any insurance claims. If necessary, In-Situ maintains complete records of original owner's names and serial numbers.

Serial numbers of the water-quality sensors are stored in sensor memory and displayed in the software when sensors are installed.

TO OUR CUSTOMERS . . .

Thank you for your purchase of an In-Situ product. We are glad you chose us and our products to help you with your environmental monitoring needs. In-Situ Inc. has been designing and manufacturing world-class environmental monitoring instrumentation for over 25 years in the Rocky Mountains of the United States. As it was in the beginning, our expectation is that this product will provide you with many trouble-free years of use. To that end, we pride ourselves on delivering the best customer service and support possible—24 hours a day, 7 days a week. We believe that this level of commitment to you, our customer, is imperative in helping you ensure clean, safe groundwater and surface water resources across the globe. We also understand the need for accurate, reliable assessments and we continue to make significant investments in Research and Development to ensure that we deliver the latest product and technological innovations to support your needs.

Whether you are gathering information about your body of water for a few moments, or over a period of years, you can rely upon us to provide you with a quality product and outstanding customer support at a fair price and have that product delivered to you when and where you need it.

We want your experience with In-Situ Inc. to be pleasant and professional, whether you are renting from us, or purchasing from us. We would be pleased to hear from you and learn more about your needs, and your experiences with our products. Again, we thank you for choosing In-Situ Inc. and we look forward to serving your needs now, and in the future.

Bob Blythe, President and CEO
In-Situ Inc.
bblythe@in-situ.com

WHAT WE PROVIDE

WARRANTY PROVISIONS

In-Situ Inc. warrants the Multi-Parameter TROLL 9500 for one year, RDO sensors for three years, and other sensors for 90 days from date of purchase by the end user against defects in materials and workmanship under normal operating conditions. To exercise this warranty contact Technical Support at the phone or e-mail address listed below for a return material authorization (RMA) and instructions. Complete warranty provisions are posted on our website at www.In-Situ.com.

Maintenance & calibration plans as well as extended warranties are available. Contact your In-Situ representative for complete information.

FIRMWARE & SOFTWARE UPGRADES

From time to time In-Situ may make available enhanced versions of firmware and software to its customers over the Internet.

Visit our website at www.in-situ.com to download the latest firmware and software.

HOW TO CONTACT US

Technical Support: 800 446 7488
Toll-free 24 hours a day in the U.S. and Canada

Address: In-Situ Inc.
221 East Lincoln Ave.
Fort Collins, CO 80524
USA

Phone: 970 498 1500
Fax: 970 498 1598
Internet: www.in-situ.com
e-mail: support@in-situ.com

TO OBTAIN REPAIR SERVICE (U.S.)

If you suspect that your Multi-Parameter TROLL 9500 is malfunctioning and repair is required, you can help assure efficient servicing by following these guidelines:

1. Call or e-mail In-Situ Technical Support (support@in-situ.com). Have the product model and serial number handy.
2. Be prepared to describe the problem, including how the instrument was being used and the conditions noted at the time of the malfunction.
3. If Tech Support determines that service is needed, they will ask that your company pre-approve a specified dollar amount for repair charges. When the pre-approval is received, Tech Support will assign an RMA (Return Material Authorization) number.

***TIP:** Please keep your RMA number for future reference.*

4. Clean the Multi-Parameter TROLL 9500 and cable. Decontaminate thoroughly if it has been used in a toxic or hazardous environment. See the cleaning guidelines and form on the following page.

If an instrument returned for servicing shows evidence of having been used in a toxic or hazardous environment, Customer Service personnel will require written proof of decontamination before they can service the unit.

5. Carefully pack your Multi-Parameter TROLL 9500 in its original shipping box, if possible. Include a statement certifying that the instrument and cable have been decontaminated, and any supporting information.
6. Mark the RMA number clearly on the outside of the box with a marker or label.
7. Send the package, shipping prepaid, to

   In-Situ Inc.
   ATTN: Repairs
   221 East Lincoln Ave.
   Fort Collins, CO 80524
   USA

The warranty does not cover damage during transit. We recommend the customer insure all shipments. Warranty repairs will be shipped back prepaid.

Outside the U.S.

Contact your international In-Situ distributor for repair and service information.

CERTIFICATION

The MP TROLL 9500 complies with all applicable directives per the CE and FCC and was tested to the EN 61326 / FCC specifications

CLEANING GUIDELINES

Please help us protect the health and safety of our employees by cleaning and decontaminating equipment that has been subjected to any potential biological or health hazards, and labeling such equipment. Unfortunately, *we cannot service your equipment without such notification*. Please complete and sign the form below (or a similar statement certifying that the equipment has been cleaned and decontaminated) and send it along to us with each downhole instrument.

- We recommend a good cleaning solution, such as Alconox®, a glassware cleaning product available from In-Situ (Catalog No. 0029810) and laboratory supply houses.
- Clean all cabling. Remove all foreign matter.
- Clean cable connector(s) with a clean, dry cloth. Do not submerge.
- Clean the probe body—including the nosecone, restrictor, cable head, and protective caps. Remove all foreign matter.
- Remove and clean all removable sensors. Rinse with deionized or distilled water after cleaning.

If an instrument is returned to our Service Center for repair or recalibration without a statement that it has been cleaned and decontaminated, or in the opinion of our Service Representatives presents a potential health or biological hazard, we reserve the right to withhold service until proper certification has been obtained.

Alconox is a registered trademark of Alconox Inc.

Decontamination & Cleaning Statement

Company Name _____ Phone _____

Address _____

City _____ State _____ Zip _____

Instrument Type _____ Serial Number _____

Contaminant(s) (if known) _____

_____

Decontamination procedure(s) used _____

_____

Cleaning verified by _____ Title _____

Date _____

In-Situ Inc.

2 COMPONENTS & FEATURES

SYSTEM DESCRIPTION

The Multi-Parameter TROLL 9500 is a compact, modular system with a range of components to customize the instrument to various applications and operational modes. Components include the instrument body with a host of options, sensors, a suite of cables for single instrument operation, network boxes and cables for network operation, external power accessories, and consumable items.

STANDARD FEATURES

- 47 mm (1.85 in) diameter
- corrosion-resistant PVC housing with titanium set screws
- 316L stainless steel flow restrictor/sensor buard
- Viton® seals
- Fast data sampling
- Continuous real-time readings (profiling)
- User-replaceable off-the-shelf D-cell alkaline batteries, or In-Situ–supplied 3.6V lithium D-cell batteries
- Fully submersible
- RS485 communications
- Low-power microprocessor
- Permanently installed, factory-calibrated temperature sensor
- Permanently installed, factory-calibrated barometric pressure sensor, for use on vented cable
- Temperature-compensated real-time clock
- Easy-to-use Win-Situ® 4 control software for setup, downloading, text and graphical data display
- Optically isolated communication signals
- Cable available in standard and custom lengths of vented or non-vented polyurethane, Halogen-free polyurethane, or FEP*
- External power capable

OPTIONAL FEATURES

- Profiler and Professional feature sets, both available in ***XP*** with extended parameter capability
- Smart Sensors for water quality measurements—removable, replaceable, field-calibrated
  - Basic Sensors include Dissolved Oxygen (polarographic), pH, combination pH/ORP, Low Conductivity, High Conductivity
  - The Extended Sensor set includes Ammonium, Chloride, Nitrate, Turbidity, RDO® Optical Dissolved Oxygen
- Pocket-Situ full-featured control software for field use on a PDA—take continuous real-time readings, calibrate, program, and download logged data from multiple MP TROLLs
- RuggedReader® handheld PDA
- Temperature-compensated vented or non-vented pressure sensor, available in several ranges, permanently installed and factory-calibrated
- Permanently installed, factory-calibrated turbidity sensor
- Integral data logging capability—up to 4 megabytes flash data-storage memory (about a million individual readings)
- Fast data downloads
- Up to 16-test capacity; linear, event, and linear average measurement schedules
- SDI-12 or RS485 interface—or both
- Flow-Sense low-flow sampling software for automated sampling and report creation
- Optional accessories include low-flow flowcell, user-serviceable turbidity wiper, battery-powered magnetic stirrer for use in stagnant water
- Instrument networking and telemetry

** FEP = fluorinated ethylene propylene, the generic equivalent of DuPont Teflon®.*

MP TROLL 9500

RuggedCable

Twist-Lock Connector

*Sealed **Battery Compartment***

*Sealed **Body***

*Stainless steel **Restrictor** — provides generous openings for circulation of environmental water, unscrews for installation/removal of sensors*

*Acetal **Nose Cone** minimizes sediment buildup and protects the front end from bottoming out on a hard surface; removable for installation of optional accessories*

CABLES

Several basic cable types are used in the MP TROLL 9500 system:

- RuggedCable™, TPU-jacketed (Thermoplastic PolyUrethane)
  - vented or non-vented
  - Halogen-Free vented or non-vented (LSZH-rated, low smoke zero halide)

Vented cable is recommended for applications where accurate barometric pressure measurement is required—for example when calibrating dissolved oxygen, or for measuring DO in percent saturation.

- Vented FEP* cable
- Stainless steel suspension wire for use when cable venting is not required (e.g., with an absolute pressure sensor)
- Communication cables for programming the device/downloading the logged data

RuggedCable™

Cable includes conductors for power and communication signals, a strength member, and a Kellems® grip to anchor the MP TROLL 9500 securely. Available in standard and custom lengths.

Uphole and downhole ends are identical bayonet-type Twist-Lock connectors that mate with the TROLL 9500 body, TROLL Com communication cable, desiccants, and other accessories.

Vented cable is designed for use with vented pressure/level sensors (gauged measurements). The cable vent tube insures that atmospheric pressure is the reference pressure applied to the pressure sensor diaphragm. Vented cable also enables proper functioning of the internal barometric pressure sensor, and improves dissolved oxygen readings.

Non-vented cable may be used with non-vented pressure/level sensors (absolute measurements), or instruments without a pressure sensor.

CABLE DESICCANTS

Small Desiccant

Clear cap of indicating silica gel desiccant seals the uphole end of the RuggedCable during use; protects the cable vent tube and device electronics from condensation. The desiccant is blue when active. It will absorb moisture from the top down and for best results should be replaced before the entire volume has turned pink. Replacements are available from In-Situ Inc. or your distributor.

Large Desiccant

The high-volume desiccant pack may last up to 20 times longer than the small desiccant in humid environments. It attaches to the RuggedCable in the same way. Refill kits are available from In-Situ Inc. or your distributor.

Accessory	Catalog No.
Small desiccant (3)	0052230
Large desiccant, plastic connector	0053550
Large desiccant, titanium connector	0051810
Large desiccant refill kit	0029140

COMMUNICATION CABLES

Comm cables interface between the TROLL 9500 and a desktop/ laptop PC or handheld PDA for profiling, calibrating, programming, and downloading. Both types include 0.9 m (3 ft) polyurethane cable, external power input jack, and vent with replaceable membrane.

TROLL Com (Cable Connect)

Connects a TROLL 9500's RuggedCable to a serial or USB port; Weatherproof, withstands a temporary immersion (IP67).

TROLL Com (Direct Connect)

Connects a TROLL 9500 directly to a serial or USB port. A good choice for permanent connection to a PC, or for programming a non-vented TROLL 9500 that will be deployed without RuggedCable. Not designed for field use.

Accessory	Catalog No.
RS232 TROLL Com, Cable Connect	0056140
RS232 TROLL Com, Direct Connect	0056150
USB TROLL Com, Cable Connect	0052500
USB TROLL Com, Direct Connect	0052510

POWER COMPONENTS

The MP TROLL 9500 operates in 2 power modes

- internal power
- external AC line power

INTERNAL POWER

The MP TROLL 9500 uses:

- two standard 1.5V alkaline D cells, OR
- two 3.6V lithium D cells—recommended for use with an RDO optical dissolved oxygen sensor, and with a turbidity wiper

Use only Saft LSH-20 3.6V lithium D cells. Use of any other lithium battery will void the product warranty.

EXTERNAL POWER

A single MP TROLL 9500 can run exclusively on power supplied from a 9 -12 VDC line power supply connected to a 90-264 VAC input. When line power is enabled, the TROLL shuts down the battery regulator, thus preserving the internal batteries. All TROLL Com models include an external power input jack.

Accessory	Catalog No.
AC Adapter 9V	0031880
Replacement batteries, alkaline (1)	0042020
Lithium battery (2) kit	0048230

***TIP:** Battery life is dependent upon temperature, cable length, and how often the device is recording measurements.*

** FEP = fluorinated ethylene propylene, the generic equivalent of DuPont Teflon®.*

WATER QUALITY ACCESSORIES

Basic Sensors	Catalog No.
pH	0059510
pH/ORP	0059520
Low Conductivity	0033210
High Conductivity	0033220
Polarographic Dissolved Oxygen	0032870

Extended Sensors	Catalog No.
Nitrate	0032050
Ammonium	0032060
Chloride	0032070
RDO Optical Dissolved Oxygen, Delrin	0095160
RDO Optical Dissolved Oxygen, titanium	0095170
Turbidity Wiper	0044510
Battery-Powered Magnetic Stirrer	0042210

Calibration Kits (four liters unless otherwise noted)

Calibration Kit	Catalog No.
Quick-Cal: 4 x 250 mL (for calibrating Basic Sensors)	0033250
Dissolved Oxygen: 1 liter DI water, 500 mL Na_2SO_3	0032110
RDO bubbler cal kit	0048580
Polarographic DO bubbler cal kit	0095150
Conductivity: 147 µS, 1413 µS, 12890 µS, DI water	0032090
Low Conductivity: 2 each 147 µS, 1413 µS	0032630
High Conductivity: 2 each 12890 µS, 58670 µS	0032640
pH: 1 each pH 4, pH 7, pH 10, DI water	0032080
ORP: 1 liter Zobell's Solution	0032100
pH/ORP: 1 each pH 4, pH 7, pH 10, Zobell's Solution	0032120
Nitrate: 1 each 14, 140, 1400 ppm, DI water	0032130
Low Nitrate: 2 each 14, 140 ppm	0032650
High Nitrate: 2 each 140, 1400 ppm	0032660
Ammonium: 1 each 14 ppm, 140 ppm, 1400 ppm, DI water	0032140
Low Ammonium: 2 each 14, 140 ppm	0032670
High Ammonium: 2 each 140, 1400 ppm	0032680
Chloride: 1 each 35.5, 355, 3545 ppm, DI water	0032150
Low Chloride: 2 each 35.5, 355 ppm	0032690
High Chloride: 2 each 355, 3545 ppm	0032700

Individual Calibration Solutions (one liter unless otherwise noted)

Calibration Solution	Catalog No.
Na_2SO_3 (Sodium Sulfite) for DO Cal, 500 mL	0017670
Conductivity, 147 µS	0032560
Conductivity, 1413 µS	0020680
Conductivity, 12890 µS	0020690
Conductivity, 58670 µS	0032580
pH 4	0006370
pH 7	0006380
pH 10	0006390
ZoBell's Solution (ORP)	0032210
Nitrate, 14 ppm as N	0032520
Nitrate, 140 ppm as N	0032230
Nitrate, 1400 ppm as N	0032240
Ammonium, 14 ppm as N	0032510
Ammonium, 140 ppm as N	0032260
Ammonium, 1400 ppm as N	0032270
Chloride, 35.5 ppm	0032500
Chloride, 355 ppm	0032290
Chloride, 3545 ppm	0032300
Turbidity, 10 NTU polymer suspension, 500 mL	0033070
Turbidity, 100 NTU polymer suspension, 500 mL	0033100
Turbidity, 1000 NTU polymer suspension, 500 mL	0033120
Turbidity, 1800 NTU polymer suspension, 500 mL	0033140

Maintenance/Service/Replacement Parts	Catalog No.
Sensor insertion tool	0042310
Sensor removal tool	0042110
Cal cup, PVC	0041440
Replacement wiper head	0044520
Wiper pad replacement kit	0044530
Lithium battery kit (2 "D" cells, 3.6V ea.)	0048230

MP TROLL 9500 Maintenance kit (o-rings, lubricant, dust caps, sensor port plugs) 0095100
DO sensor service kit, 1-mil membranes 0033200
DO sensor service kit, 2-mil membranes 0033440
RDO Maintenance kit 0048250
RDO Foil Replacement kit 0048500
pH & pH/ORP Reference Filling Solution (60 mL) 0056900
pH & pH/ORP Reference Junction Kit 0059620
pH & pH/ORP Sensor Storage Solution (500 mL) 0065370

INSTALLATION ACCESSORIES

- Twist-Lock Hanger: stainless steel hanger to suspend a non-vented TROLL 9500, Level TROLL, or Baro TROLL while taking data; no venting, no communication capabilities
- Cable Extender: connects two lengths of RuggedCable
- Wellcaps, locking and vented
- Well Docks: top-of-well support for 2", 4", or 6" well
- SDI-12 adapter: power and signal management for SDI-12 communication

Accessory	Catalog No.
Twist-Lock Hanger	0051480
Cable Extender	0051490
Locking Wellcap, 2"	0020360
Locking Wellcap, 2" vented	0020370
Locking Wellcap, 4"	0020380
Locking Wellcap, 4" vented	0020390
Top-of-well installation ring	WELLDOCK2", 4", 6"
SDI-12 adapter	0095200, 0095210
Flow Cell for use with Basic sensors	0044710
Flow Cell for use with RDO sensor	0057600

Twist-Lock Hanger

Cable Extender

Locking Wellcap

Well Dock

SDI-12 Adapter

CONTROL SOFTWARE

Win-Situ® 4 enables communication between the MP TROLL 9500 and a desktop or laptop PC.

Win-Situ provides instrument control for calibration, profiling, direct readings, data logging, data extraction, data viewing (text and graphical interface), choice of units and other custom display options, battery/memory usage tracking, interface to networks and telemetry.

System requirements: Microsoft® Windows® 2000, Windows XP, or Windows Vista™; Internet Explorer (IE) 5.0 or later, and a CD-ROM drive.

Pocket-Situ 4 provides Win-Situ's features and functions on a field-portable platform. Requirements: In-Situ RuggedReader® or other supported PDA running Microsoft Pocket PC (Windows Mobile®) 2003 or later, with a serial communications port for connection to the TROLL 9500, and at least 16 megabyte capacity for data storage (SD card, CF card, or the device's built-in non-volatile memory).

For installation and file exchange, Pocket-Situ requires the following installed on an office desktop or laptop computer:

- Microsoft® ActiveSync®,
- Win-Situ 4,
- Optional: Win-Situ Sync (or Pocket-Sync 4, earlier version of Win-Situ Sync)

PRODUCT SPECIFICATIONS

Wetted Materials*	PVC, titanium, Viton®, acetal, 316 SS
Operating Temperature*	-5°C to 50°C (23°F to 122°F)
Storage Temperature*	-40°C to 80°C (-40°F to 176°F)
Pressure Rating*	350 psi (246 m, 807 ft)
Dimensions	47 mm (1.85 in) dia, 57.7 cm (22.7 in) long
with RDO sensor	88.4 mm (3.48 in) dia, 57.7 cm (22.7 in) long
Weight (without cable)	1.4 Kg (3.1 lbs)

Power

Battery type	2 standard alkaline D-cells (1.5 V), or 2 lithium D cells (approx. 3.6 V)
External power input	9-12 VDC (optional)

Data Sampling

Memory type/size (memory -equipped models)	4 megabytes flash data storage, about 1,000,000 individual readings
Fastest linear logging rate	5 seconds (10 seconds with RDO)
Profiling speed	2 seconds

Communications	RS485
Computer interface	RS232

Software

Win-Situ® 4	Desktop/laptop PC with Microsoft® Windows® 2000 SP2 or later (Windows XP, Windows Vista™), Internet Explorer 5.0 or later, serial com port, CD-ROM drive, 16-64 Mb RAM
Pocket-Situ 4	In-Situ RuggedReader® or other supported handheld PDA running Microsoft Pocket PC (Windows Mobile®) 2003 or later

Cable

Jacket options	Polyurethane, halogen-free (HF) polyurethane, FEP (generic Teflon®)
Conductors	6 conductors, 24 AWG, polypropylene insulation
Diameter	6.7 mm (0.265 in)
Connector	Titanium, 18.5 mm (0.73 in) O.D.
Break strength	127 kg (280 lb)
Minimum bend radius	2X cable diameter (13.5 mm, 0.54 in)
Weight	Vented, regular & HF: 14 kg/300 m (32.3 lb/1000 ft) Non-vented, regular & HF: 16 kg/300 m (35.6 lb/1000 ft) Vented FEP: 23 kg/300 m (52 lb/1000 ft)

Factory-Installed Sensors

Pressure/level

Type	Media-isolated piezoresistive silicon strain gauge
Range	15 psig (0-11 m, 0-35 ft) 30 psia/psig (0-21 m, 0-69 ft) 100 psia/psig (0-70 m, 0-231 ft) 300 psia/psig (0-211 m, 0-692 ft)
Accuracy	better than ± 0.1% FS
Resolution	1 mm

Temperature

Type	Platinum resistance thermometer
Range	-5°C to 50°C (23°F to 122°F)
Accuracy	± 0.1°C
Resolution	0.01°C

Barometric pressure

Type	Piezoresistive silicon pressure sensor
Range	0-16.5 psia (854 mm Hg, 33.6 in Hg)
Accuracy	± 0.3% FS (2.54 mm Hg, 0.1 in Hg)
Resolution	0.1 mm Hg, 0.01 in Hg

Turbidity

Type	Nephelometer, 90° light scattering, 870 nm LED, solid-state
Range	0-2000 NTU
Accuracy	± 5% or 2 NTU (whichever is greater)
Resolution	0.1 NTU

Turbidity Wiper

Pressure Rating	350 psi (246 m, 807 ft)
Operating Temp.	-5°C to 50°C

Basic Sensors

Conductivity

Type	4-cell conductivity, AC drive
Operating Range	
Low Range sensor	3 µS/cm to 50,000 µS/cm
High Range sensor	70 µS/cm to 200,000 µS/cm
Accuracy	
Low Range sensor	± 0.5% or 2 µS/cm (whichever is greater) between 14 µS/cm and 20,000 µS/cm when calibrated in region of interest
High Range sensor	± 0.8% + 2 µS/cm between 150 µS/cm and 112,000 µS/cm when calibrated in region of interest
Resolution	Range-dependent
Pressure Rating	350 psi (246 m, 807 ft)
Operating Temp.	-5°C to 50°C (23°F to 122°F)

** Base unit = MP TROLL 9500 & factory-installed sensors*

pH

Type	Glass sensing bulb, single-junction electrode, replaceable ceramic junction, refillable reference electrolyte
Range	0 to 12 pH units
Pressure Rating	300 psi (210 m, 692 ft)
Operating Temp.	0°C to 50°C (32°F to 122°F)
Accuracy	± 0.1 pH unit
Resolution	0.01 pH unit

pH/ORP

Type	Glass sensing bulb, platinum wire, single-junction electrode, replaceable ceramic junction, refillable reference electrolyte
Range	± 1400 mV, 0 to 12 pH
Pressure Rating	300 psi (210 m, 692 ft)
Operating Temp.	0°C to 50°C (32°F to 122°F)
Accuracy	± 5 mV, ± 0.1 pH unit
Resolution	1 mV, 0.01 pH unit

Dissolved Oxygen (polarographic)

Type	Clark polarographic
Range	0 to 20 mg/L, 0 to 200% saturation
Pressure Rating	350 psi (246 m, 807 ft); submersion & retrieval at up to 4 ft per second
Operating Temp.	-5°C to 50°C (23°F to 122°F)
Accuracy	± 0.2 mg/L
Resolution	0.01 mg/L

Extended Sensors

Dissolved Oxygen (optical, RDO)

Type	Optical, fluorescence quenching
Range	0 to 20 mg/L, 0 to 200% saturation
Pressure Rating	exceeds that of MP TROLL 9500
Operating Temp.	0°C to 40°C (32°F to 104°F)
Accuracy	± 0.1 mg/L @ 0-10 mg/L ± 1% of reading @ 10-20 mg/L
Resolution	0.01 mg/L

Ammonium (NH_4^+)

Type	PVC membrane sensing element, double junction Ag/AgCl reference half-cell, reference electrolyte gel
Range	0.14 to 14,000 ppm N (0.1 to 18,000 ppm NH_4^+)
Pressure Rating	20 psi (14 m, 46 ft)
Operating Temp.	-5°C to 40°C (23°F to 104°F)
Accuracy	± 10%
Resolution	0.01 ppm

Chloride (Cl^-)

Type	Solid-state sensing electrode, double junction Ag/AgCl reference half-cell, reference electrolyte gel
Range	0.35 to 35,500 ppm Cl (2 to 35,000 ppm Cl^-)
Pressure Rating	100 psi (70 m, 231 ft)
Operating Temp.	-5°C to 50°C (23°F to 122°F)
Accuracy	± 15%
Resolution	0.01 ppm

Nitrate (NO_3^-)

Type	PVC membrane sensing element, double junction Ag/AgCl reference half-cell, reference electrolyte gel
Range	0.14 to 14,000 ppm N (0.4 to 62,000 ppm NO_3^-)
Pressure Rating	20 psi (14 m, 46 ft)
Operating Temp.	-5°C to 40°C (23°F to 104°F)
Accuracy	± 10%
Resolution	0.01 ppm

Typical Battery Life @ 20°C

	Sample interval			
Battery/Installed sensors	60 min.	15 min.	20 min.	20 sec.
2 alkaline D-cells				
Pressure, temperature, baro, pH/ORP, conductivity, polarographic (Clark) D.O.	76 days	73 days		
All of the above plus turbidity	75 days	70 days		
All of the above plus turbidity & wiper	63 days	52 days		
2 lithium D-cells				
Pressure, temperature, baro, pH/ORP, conductivity, Clark D.O., turbidity & wiper		373 days		
Pressure, temperature, baro, pH/ORP, conductivity, RDO*, turbidity & wiper		338 days		
Pressure, temperature, baro, pH/ORP, conductivity, RDO*, turbidity, no wiper			432 days	58 days

** Lithium batteries are required for operation of the RDO Optical dissolved oxygen sensor*

3 GETTING STARTED

This section provides a quick overview of the initial steps necessary to get the Multi-Parameter TROLL 9500 ready to take measurements.

You will need—

- Power
- Sensors
- Software
- Cable

  TROLL Com for communication
  cable for deployment
- Calibration Kit—one for each sensor to be calibrated, or the QuickCal Kit for the Basic Sensor set (pH, ORP, polarographic D.O., Conductivity)

TIP: *When the unit ships with a Polarographic Dissolved Oxygen sensor installed, alkaline batteries are pre-installed in the device to power the D.O. sensor and keep it conditioned.*

PROVIDE POWER

Install batteries in the Multi-Parameter TROLL 9500 as follows:

1. Unscrew and remove the battery compartment cover. Slide it up over the cable (if attached).

2. Insert two D-size batteries negative side first, positive side up.

3. Replace the battery compartment cover and tighten to compress the o-ring seals.

Screw the cover down firmly to compress the o-rings and create a waterproof seal. When properly assembled, the o-rings will not be vsible.

TIP: *The MP TROLL 9500 uses standard off-the-shelf 1.5V alkaline D-cells. For best performance with an RDO optical dissolved oxygen sensor, and with a turbidity wiper, we recommend 3.6V lithium D cells. Lithium batteries are shipped separately for customer installation in the device.*

Use only Saft LSH-20 3.6V lithium D cells. Use of any other lithium battery will void the product warranty.

INSTALL SENSORS

Basic water-quality sensors—pH or pH/ORP, polarographic D.O., Conductivity—may arrive installed in the instrument's sensor ports. Proceed to **Cable** if there are no additional sensors to be installed.

Install sensors in the Extended Sensor Set and any sensors shipped separately as follows:

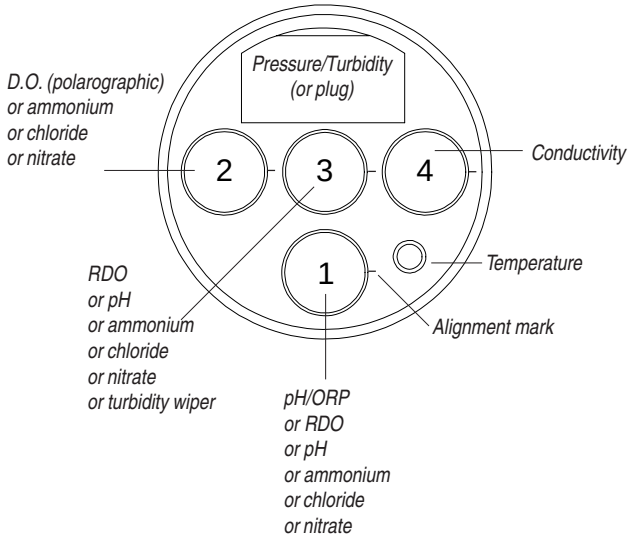
TIP: *The RDO® Optical Dissolved Oxygen sensor has special installation requirements. Please refer to the RDO Quick Start guide, or see Section 13 of this operator's manual for complete information.*

1. Remove the restrictor or Cal Cup from the front end of the MP TROLL 9500.

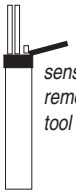
   This allows access to the sensor block depicted in the drawing below.

   There are four sensor ports, 1 – 4, plus a permanently installed pressure and/or turbidity sensor or plug.

End view of sensor block



2. Remove the sensor's protective cap or storage bottle and set aside for future storage of the sensor. If the connector end is covered with a cap, remove it also.
3. Remove any moisture or dirt from the area around the port where you will install the sensor, then use the sensor removal tool to remove the plug from the port. Retain the plug for use when with fewer than 4 removable sensors installed.



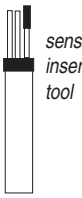
4. Remove any moisture or dirt from the port connector with a clean swab or tissue.
5. Check lubrication of the sensor o-rings.

   The sensor o-rings require generous lubrication before installation. New sensors will be lubricated at the factory. If the o-rings appear dry, apply a silicone lubricant before installation.

6. Align the mark on the side of the sensor with the mark on the correct port (see diagram), or visually align the sensor connector pins with the port connector pins.

   If the sensing element is at the end of the sensor, be careful to handle the sensor by the sides. Use the insertion tool to press the sensor into the port at step 7.

7. Press the sensor firmly into the port until you feel it dock with the connector at the bottom.



   When the sensor is properly inserted, a small gap (the width of the sensor removal tool) remains between the instrument body and the widest part of the sensor, for ease of removal.

   After installing a polarographic D.O. sensor, we recommend conditioning it for 2-4 hours, preferably overnight, before calibrating. For more on D.O. sensor conditioning, see Section 13.

INSTALL THE SOFTWARE

WIN-SITU 4

Install Win-Situ 4 from the In-Situ software CD or the In-Situ website:

- Click on Win-Situ 4 and follow the instructions to install Win-Situ 4 to your local hard drive.

USB TROLL COM DRIVERS

- Select the option to install USB TROLL Com drivers during the Win-Situ installation. Two drivers will be loaded to your hard drive, (USB TROLL Com, USB TROLL Com serial port).

POCKET-SITU 4

For communication using a RuggedReader® handheld in the field, install the desktop component of Pocket-Situ 4 from the CD or website. The desktop component is the "Win-Situ Software Manager," and helps you install Pocket-Situ on the RuggedReader at any time.

- Click on Pocket-Situ 4 and follow the instructions to install the Win-Situ Software Manager to your local hard drive.

To install Pocket-Situ on the RuggedReader: When convenient, connect the RuggedReader to the PC, establish a connection in Microsoft ActiveSync®, launch the Win-Situ Software Manager, and follow the instructions.

WIN-SITU SYNC

If you plan to synchronize data files from the RuggedReader back to a desktop PC after collecting data in the field, also install Win-Situ Sync from the CD or website.

USB TROLL Com

When you plug in a USB TROLL Com, the USB drivers downloaded during Win-Situ installation will be installed as follows:

- Windows 2000, Windows Vista: When new hardware is detected, the drivers are installed automatically.
- Windows XP: Follow the instructions in the Found New Hardware Wizard. Select the option "Install software automatically."

After installation, you will need to determine which COM port the connected USB TROLL Com is using:

- Windows 2000 & Windows XP: Control Panel > System > Hardware > Device Manager > Ports. Click the plus sign to display the ports.
- Windows Vista: Control Panel > System > Device Manager (Administrator permission required) > Ports. Click the plus sign to display the ports.

REMEMBER THE COM PORT NUMBER! You will need it when connecting to the TROLL 9500 in software.

CONNECT THE HARDWARE

TROLL 9500 TO TROLL COM

Connect the TROLL 9500 to the appropriate TROLL Com as shown.

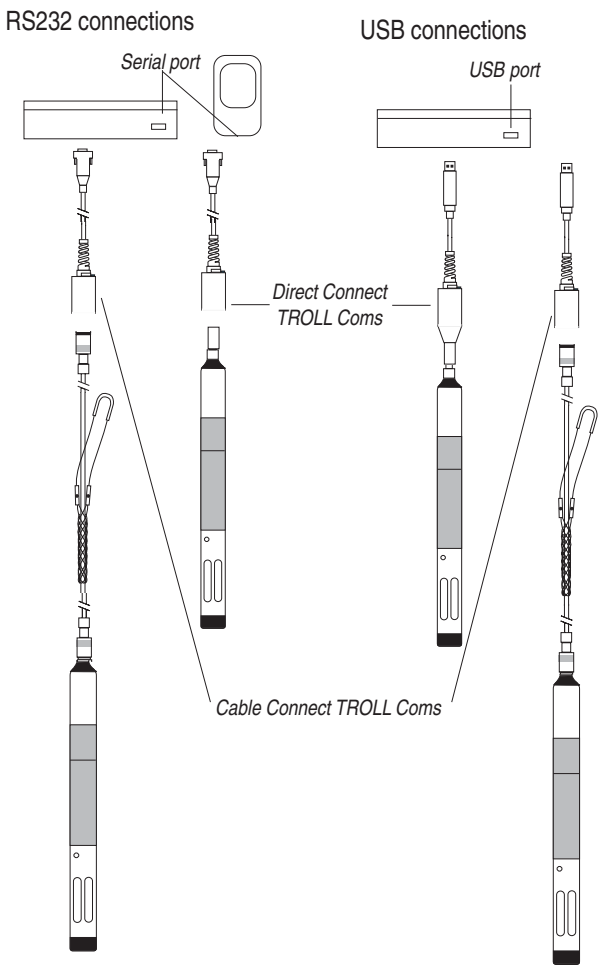
- Connect a **Direct Connect** model simply by pressing onto the connector at the back end of the TROLL 9500.
- Attach a **Cable Connect** model via locking Twist-Lock connector to the TROLL's RuggedCable—see the box on the next page.

TROLL COM TO COMPUTER

Plug an RS232 TROLL Com into a serial port on a desktop/laptop PC or a RuggedReader.

Plug a USB into a USB port on a desktop/laptop PC. Install drivers and check the virtual COM port—see the box below.

After connections are made, you are ready to launch the software and program the MP TROLL 9500.



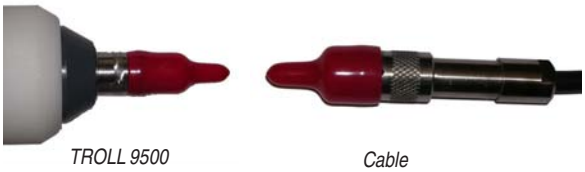
(continued on page 16)

TWIST-LOCK CABLE CONNECTIONS

RuggedCable mates to the TROLL 9500 and to Cable Connect TROLL Coms with a bayonet-type Twist-Lock connector.

1. Remove the soft protective caps from the TROLL 9500 and the cable.

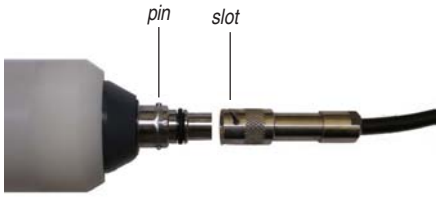
TIP: *Keep the dust caps to protect the connector pins and o-ring when the connectors are not mated.*



TROLL 9500 (or Cable Connect TROLL Com) *Cable*

2. Take a moment to look at the connectors. Each has a flat side.

Note the pins on the body connector (one on each side) and the diagonal slots on the cable connector (one on each side).



3. Slide back the sleeve on the cable connector.

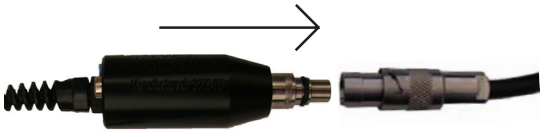
4. Orient the flat sides so they will mate up, and insert the body connector firmly into the cable connector.

5. Slide the sleeve on the cable toward the body until the pin on the body pops into the round hole in the slot on the cable.

6. Grasp the textured section of the cable connector in one hand and the body in the other. Push and twist firmly so that the pin on the body slides along the slot on the cable and locks securely into the other hole. The “click” ensures the cable is securely attached.

To attach a Cable Connect TROLL Com, first remove the desiccant from the cable (if present): Grasp the textured section of the cable connector in one hand and the desiccant in the other. Twist in opposite directions to unlock the desiccant from the cable.

Orient the “flats” so they will mate up, and insert the TROLL Com connector firmly into the cable connector.



Push, twist, and click to lock.

ESTABLISH COMMUNICATION WITH THE MP TROLL 9500

1. Start Win-Situ 4 by double-clicking the shortcut created on the desktop during installation.

   Or tap the Pocket-Situ 4 shortcut on the PDA Start Menu.

2. The Connection Wizard starts to help you set up the port:
   - **Connection type:**
     - Direct, for use when the Multi-Parameter TROLL 9500 is attached directly to the host PC
     - Modem for a dial-up modem
     - Spread-Spectrum Radio
   - **Devices connected:** Select "one" to speed up connection to a single device, or "more than one" for a network.
   - **Port:** Select the COM port to which the device is attached. If using a USB TROLL Com, be sure to select the correct COM port (see the box on page 14). For a Modem connection, enter the phone number—up to 40 characters; a comma designates a pause.
   - **Baud Rate:** Select any rate (19,200 is the default); baud rates are automatically synchronized between devices and the host PC.
   - **Name (optional):** A default connection name is suggested.
   - To have the wizard connect automatically to the attached device(s), be sure the option **Connect and find devices on "Finish"** is checked.
3. When you finish the Wizard, the software "finds" (connects to) the device, and displays it in the Navigation tree.

TIP: *For an introduction to the appearance and controls of the user interface, turn to Section 4, Control Software.*

What do I do if the MP TROLL 9500 does not appear in the Navigation tree?

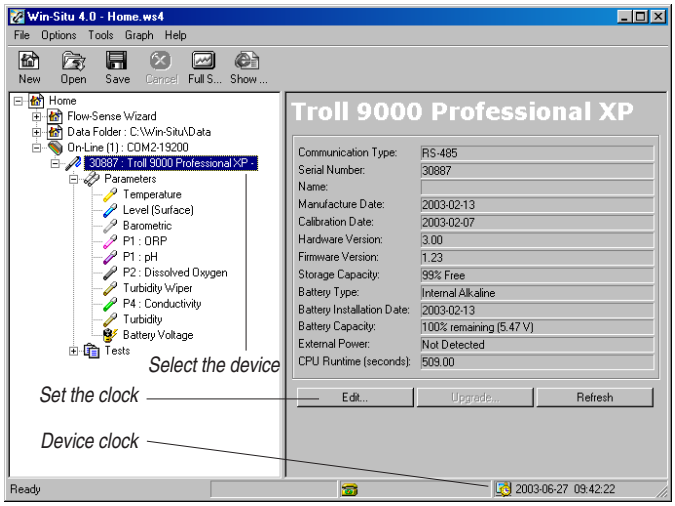
First try double-clicking the connection. If the device still does not appear, there may be a communication problem. Check these likely culprits:

- *Be sure you selected the correct COM port for your PC.*
- *Check that all cable connections are tight.*
- *Be sure the MP TROLL 9500 has sufficient battery power, or that external power is being supplied.*

SET THE REAL-TIME CLOCK

Data collection schedules depend on the device's real-time clock, shown in the lower right corner of the desktop PC interface. If the device clock is wrong, be sure to correct it before scheduling tests. Set the clock as follows:

1. With the device selected in the Navigation tree, press ***Edit***.
2. In the Device Wizard, select ***Clock.***
3. Follow the instructions to synchronize the MP TROLL 9500's internal real-time clock to the host computer.
4. When you finish the Wizard, Win-Situ sends the information to the device and updates the display.



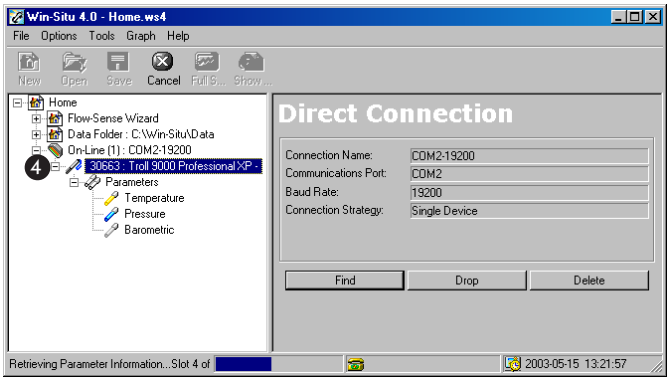
TIP: *Due to the size of the PDA screen, the device clock is not displayed in the Pocket-Situ interface. We recommend you edit the device—Tap the device, tap Edit, tap Clock—to synchronize the device clock to the PDA clock.*

QUICK-CAL THE BASIC WATER-QUALITY SENSORS

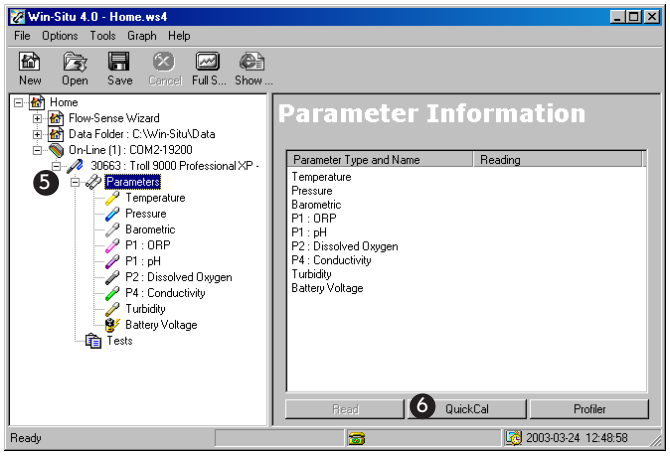
You will need:

- MP TROLL 9500 with Basic sensors installed (pH or pH/ORP, polarographic D.O., Conductivity), plugs in any unused ports.
- Cal Cup. Remove sponge if present.
- Quick Cal solution, at room temperature. Shake well before use.

1. Fill the Cal Cup with the Quick Cal solution. See guidelines in the sidebar on this page.
2. Remove the restrictor (if attached) and insert the front end of the MP TROLL 9500 into the Cal Cup. Thread the Cal Cup onto the body until seated against the o-ring, then back off slightly to avoid overtightening.
3. Connect the MP TROLL 9500 to a PC and establish a connection in Win-Situ 4 or Pocket-Situ 4.
4. Select the MP TROLL 9500 in the Navigation tree. The software will automatically detect and display the installed sensors.



5. In the Navigation tree, click on Parameters.



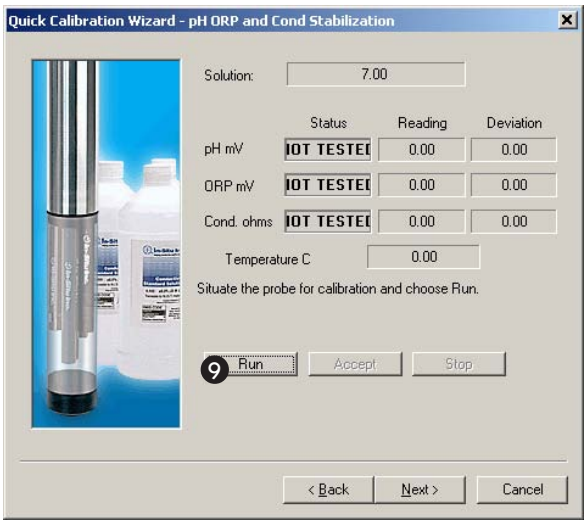
6. In the Information pane, select **QuickCal**.

Quick-Cal Tips

- A Quick Cal is the fastest way to calibrate pH, conductivity, polarographic D.O., & ORP. But for best results, if your software supports it, we recommend traditional calibration for pH, conductivity, and D.O., as described in Sections 11-13.
- Be sure to condition a new polarographic D.O. sensor for 2-4 hours, preferably overnight, before calibrating. See Section 13 for information. If the sensor is installed when you receive the instrument, it is conditioned and ready to calibrate.
- Guidelines for filling the Cal Cup with Quick Cal solution:
  - With a full complement of sensors installed, use the lower line as a guide (about half full).
  - With 1 or 2 sensors installed, fill to the upper line.
  - When calibrating a high-range conductivity sensor, insure the side ports are immersed in solution. Dislodge any bubbles that may appear. For a Quick Cal with a full set of sensors, we suggest you fill the Cal Cup above the line labeled "Recommended Fill Line - High." Use about a half-inch of additional fluid, depending on the sensor load. Some experimentation may be needed.
- When Quick-Calibrating polarographic D.O. with a high-range conductivity sensor installed, the increased fill level suggests handling with care when you invert the Cal Cup at step 11—allow the excess fluid to spill into a sink, or remove the Cal Cup from the instrument and pour some fluid out, re-attach the Cal Cup, then invert it and loosen the end cap to achieve the correct atmospheric pressure for a polarographic D.O. calibration. The D.O. sensor membrane should be in air, the temperature sensor should be completely sugmerged.
- For best accuracy, conductivity sensors should be wetted for 15-30 minutes immediately prior to calibration. This immersion can be in either clean water or the Quick Cal solution.
- For best results at temperatures at or below 15°C, de-select the conductivity sensor when perfoming a Quick-Cal; follow up with a single-parameter calibration uisng 8000 microSiemens/cm.
- If an RDO Optical Dissolved Oxygen sensor is installed, use the special soft plastic cal insert (it has an orange base) to Quick Cal the standard sensors, since the standard Cal Cup will not fit when the RDO sensor is installed. Fill the cal insert with calibration solution, slide it up around the sensors, including the RDO cable, and use the RDO restrictor as a support during calibration.
- If your MP TROLL 9500 includes a turbidity wiper, insure the pad does not absorb Quick Cal solution. **Either** carefully remove the wiper head (see Wiper Maintenance in Section 18), **or** soak the front end of the TROLL in water before calibrating; allow the pad to become saturated.
- Quick Cal is not available for these sensors: Nitrate, Ammonium, Chloride, Turbidity, Optical D.O. Traditional calibrations should be performed for best results from these sensors.

The Quick Calibration Wizard starts. A screen like this is displayed.

7. Insure there is a check bewide the sensors you wish to Quick-Cal.
8. Click **Next**. The pH, ORP, and Conductivity screen appears.



9. Click **Run** to start the calibration.

The display will continuously update as readings are taken and compared against the stabilization criteria (see sidebar).

All 3 parameters must indicate NOMINAL or STABLE before the calibration can continue.

- When pH, ORP, and conductivity are STABLE, the polarographic D.O. calibration screen is displayed automatically if a polarographic D.O. sensor is installed.

Status indicators during stabilization:

NOT TESTED may be displayed before the calibration begins.

UNSTABLE indicates the sensor response does not meet the criteria for a valid calibration point. All parameters start out at "Unstable" status.

NOMINAL indicates the change in the sensor response over time meets a relaxed stability criterion. "Nominal" stability will occur first, and can be accepted to shorten the calibration time.

STABLE indicates the change in the sensor response over time meets the stability criteria for a Quick Cal.

Reading: Current sensor response (in indicated units).

Deviation: Change in response between the last two readings. This enables you to follow the progress of the stabilization, but deviation from the previous reading is not necessarily the best indicator of stability as the software is looking at longer-term trends.

Run button: Starts the calibration

Accept button: Becomes available when Nominal stability is reached (see below)

Stop button: Stops the current phase of the calibration

Back button: Goes to the previous screen (when available)

Next button: Proceeds to the next screen (when available)

Cancel button: Cancels the calibration

What is the difference between NOMINAL and STABLE?

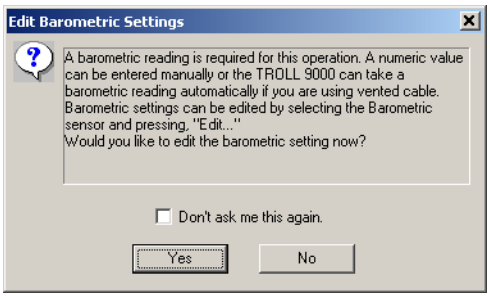
To meet the criteria for a valid calibration point, the change (deviation) in sensor response is monitored over time. The software is looking for the calibration solution temperature and the sensor readings to settle over a specific time period. The criteria for STABLE are designed to meet the published specifications. The NOMINAL criteria are designed to shorten the calibration time when an approximate calibration is acceptable. When the deviation falls within the limits of the "loosened" specifications, NOMINAL is displayed in the Status area, and the Accept button becomes available to store the current calibration point.

Accepting a NOMINAL value may save considerable time. In some cases, especially if the sensors have been soaking in the solution for several minutes prior to calibration, the accuracy achieved by accepting a nominal value may be very similar to that obtained by waiting for complete stability.

- Alternatively, you may click Accept to store the early values. The Accept button becomes available when NOMINAL or STABLE is indicated for all 3 parameters.
- If there is no polarographic D.O. sensor, the Quick Cal is complete. Go to step 14.

If performing a **Polarographic Dissolved Oxygen** calibration, continue with steps 10-13.

10. **Polarographic Dissolved Oxygen**: Before the D.O. segment of the Quick Cal Wizard starts, you will be asked how you want to handle barometric pressure.



Barometric pressure is important in converting measurement of D.O. concentration to percent saturation. If this TROLL 9500 will be used with vented cable, an accurate barometric pressure value can be read automatically from the onboard barometric pressure sensor. If the TROLL will be used with non-vented cable, then a barometric pressure value should be entered manually.

Do one of the following in this screen:

- If the TROLL 9500 is on **vented** cable now and will take measurements using **vented** cable, click No — and you may want to check the "Don't ask me this again" box.
- If the device is on **vented** cable now but will take measurements on **non-vented** cable, click Yes. In the Edit Barometric Channel screen, check the box indicating non-vented cable for measurements but vented cable for calibration/programming. For help, see Section 9, Monitoring Barometric Pressure.
- If the device is on **non-vented** cable now and will take measurements on **non-vented** cable, click Yes. In the Edit Barometric Channel screen, check the box indicating non-vented cable for measurements and enter a barometric pressure value. For help, see Section 9, Monitoring Barometric Pressure.

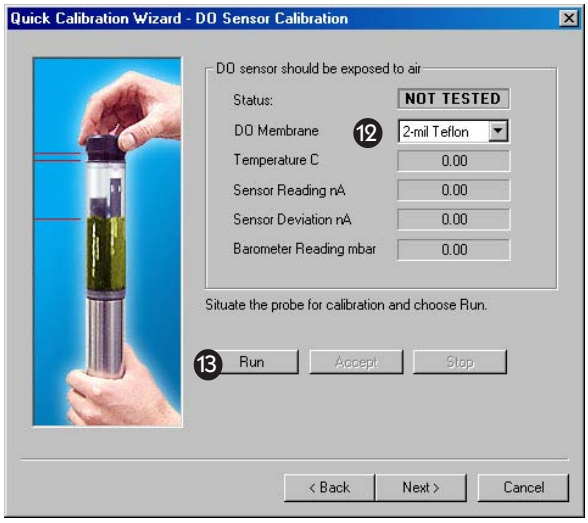
11. To complete the calibration, **expose the polarographic D.O. sensor to air**: Without disconnecting the cable, invert the probe so that the membrane at the tip of the sensor is in air and the temperature sensor is immersed in fluid. This will probably require you to remove the end cap from the Cal Cup and pour some fluid out.

While you have the cap off, remove any droplets on the membrane by blotting gently with a clean swab or the corner of a tissue. Re-attach the end cap **loosely** to insure the volume is not pressurized.

TIP: *For proper venting, loosen the end cap until a small hole in the threads near the o-ring is at least partly visible.*

12. In the DO calibration screen, select the membrane type, stamped on the membrane module (if not indicated, select 1-mil Teflon).

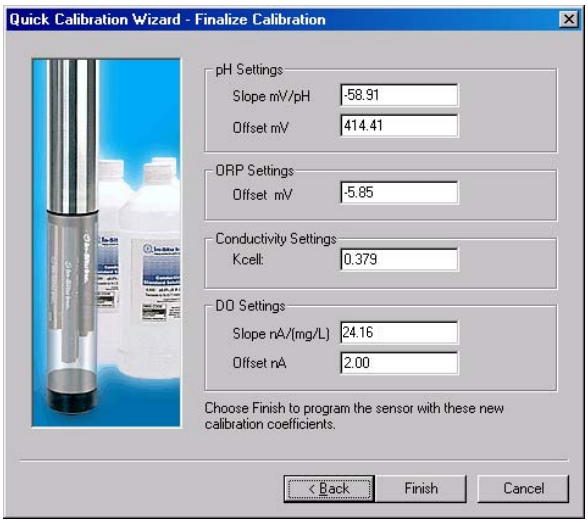
13. Click **Run** to begin the stabilization.



The display will continuously update as readings are taken and compared against the stabilization criteria (see sidebar on the previous page).

14. When the sensor response is STABLE (or alternatively, when you accept the nominal value), the Quick Cal procedure is complete.

    The Wizard displays a final calibration screen like the one below at the end of the Quick Calibration procedure. This information is also stored in the Calibration Report. Click **Finish** to continue. When you click **Finish,** the calibration information is written to the sensors.



The calibrated sensors are ready to take measurements.

Ideally, you chould calibrate just before using the MP TROLL 9500. However, if the the instrument will not be put to use immediately, store it as follows:

- Leave the sensors installed. Remove the Cal Cup and rinse it and the sensors. Add about 50-100 mL of tap water to the Cal Cup. Return the probe to the Cal Cup for transport to the field.

CALIBRATE THE EXTENDED SENSORS

For some sensors, the Quick-Cal procedure is not available. A traditional calibration is recommended. To calibrate, select the sensor in the Parameters list and click or tap ***Calibrate*** to launch a Calibration Wizard. Complete calibration information is in the following sections of this manual:

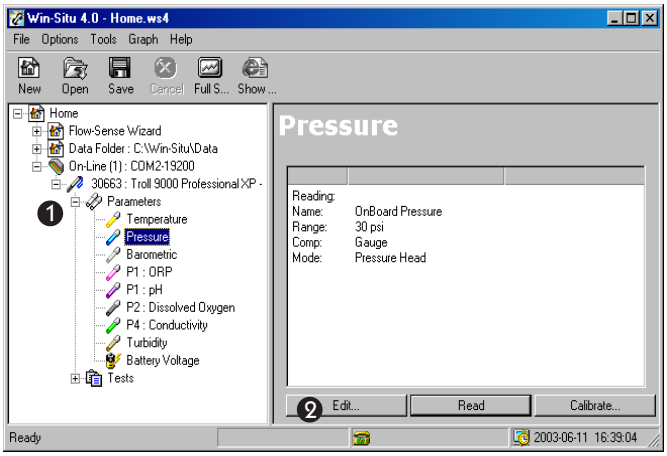
RDO Optical Dissolved Oxygen	Section 13 (second part)
Ammonium	Section 15
Chloride	Section 16
Nitrate	Section 17
Turbidity	Section 18

SET UP CUSTOM PRESSURE/LEVEL MEASUREMENTS

You can configure a pressure channel to display measurements just the way you want them—as raw pressure head above the sensor, as depth, or as water level with a reference. The specified settings are easily changed from one mode to another, and any choice can be redone or undone later, when viewing test data.

1. With the MP TROLL 9500 connected to a host PC, select the pressure parameter in the Navigation tree.

2. Click or tap ***Edit...***.



   The Parameter Wizard will help you enter the required information. The choices are explained in greater detail in Section 7 below.

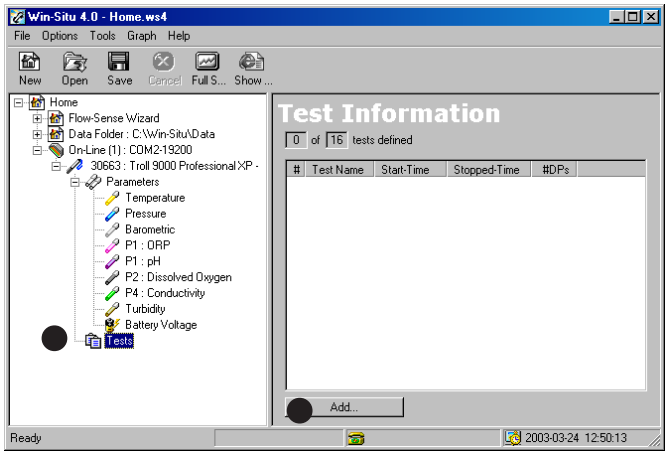
3. When you finish the Wizard, the information is written to the device and the display is updated. The pressure channel is ready to take measurements.

TIP: *For complete information on setting up the pressure parameter, refer to Section 7 of this operator's manual.*

SET UP TO LOG DATA (SET UP A TEST)

A "test" is a set of instructions to the instrument's internal data logger for collecting a set of data—including which parameters to measure, how often, and when to start. Section 6 below contains detailed information on setting up tests.

1. With the MP TROLL 9500 connected to a host PC, click or tap Tests in the Navigation tree.
2. Click or tap **Add...**.



The Test Wizard will help you enter the information. The choices are discussed in detail in Section 6 below.

3. When you finish the Wizard, Win-Situ sends the information to the device and updates the display.

   If you added a "scheduled" test (indicated by in the Navigation tree), it will start at its programmed time.

   If you set up a test for a manual start (indicated by in the Navigation tree), you can start it at any time by pressing the Start button while connected in software.

TIP: *For complete information on setting up tests, refer to Section 7 of this operator's manual.*

COMPLETE THE SETUP

If real-time readings are not required, remove the TROLL Com from the cable after programming.

Protect the "uphole" end of the cable with the cable dust cap or optional MAXUM desiccant.

The cable dust cap is not waterproof. Be sure it is positioned above the highest anticipated water level. Avoid areas that may flood.

If cable will not be used, attach a Twist-Lock Hanger to the TROLL 9500.

The instrument is now ready for transport to the site where it will be used to take meaurements.

4 CONTROL SOFTWARE

The interface from a desktop or laptop computer (PC) to the Multi-Parameter TROLL 9500 is provided by instrument control software called Win-Situ® 4. Instrument control is accomplished through a familiar, easy-to-use Navigation Tree interface.

For field use on a hand-held computer (PDA), optional Pocket-Situ 4 provides all of Win-Situ's functionality and features in a convenient field-portable platform.

Use Win-Situ or Pocket-Situ for these tasks:

- to calibrate water-quality sensors
- to convert pressure measurements to depth or level readings
- to set up data collection schedules ("tests")
- to take direct "manual" readings
- to take continuous real-time readings (Profiling)
- to transfer data from the Multi-Parameter TROLL 9500 to the host computer
- to view logged data in text or graph format
- to delete data from the Multi-Parameter TROLL 9500 in order to free up memory
- to monitor battery and memory usage
- to set the device clock
- to upgrade device firmware (when available)
- to choose measurement units and other custom display options
- to monitor indicator water-quality parameters during low-flow pumping
- to schedule automatic remote transmissions (if available)

TIP: *For software system requirements, see Section 2, Components & Features. Software installation is covered in Section 3, Getting Started.*

LAUNCHING THE SOFTWARE

WIN-SITU 4

Use one of the following methods:

- Double-click the shortcut

created on the desktop during installation.
- Select Win-Situ 4 from the In-Situ Inc program group on the Windows Start menu.

POCKET-SITU 4

Tap Start to display the RuggedReader's Start Menu. Select Pocket-Situ 4.

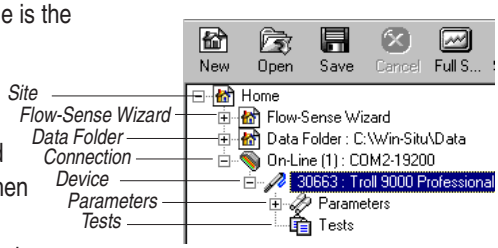
- If you don't see a shortcut, tap Programs and select Pocket-Situ 4
- If it launches in "demo" mode, you can activate it with the license key and activation code from your In-Situ License Agreement

THE USER INTERFACE

Win-Situ 4 and Pocket-Situ 4 use the familiar "Navigation tree" to display your instrument network. The tree appears on the left of the screen in Win-Situ, and at the top of the screen in Pocket-Situ. The remainder of the screen is an "Information pane" with details about the "node" you have selected in the tree. The selected node and its information constitute a "view" in the interface.

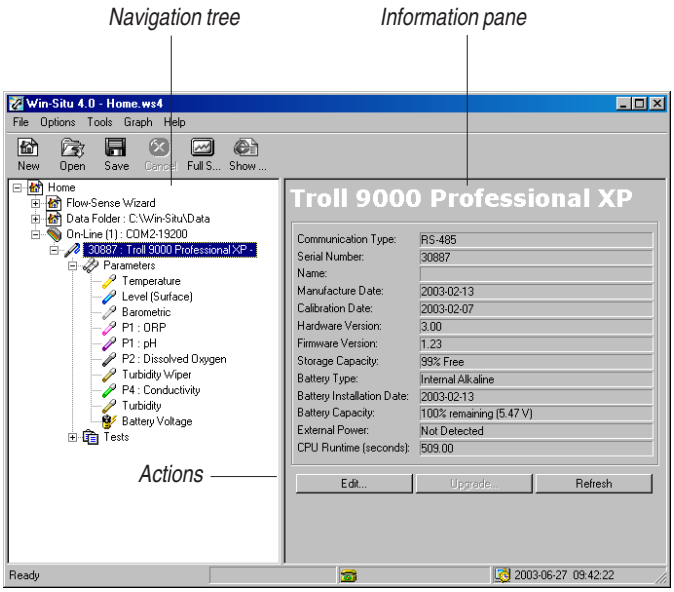
THE NAVIGATION TREE

At the top of the tree is the "Home" site (the host computer). Below this is the Flow-Sense Wizard (see Section 20), then the Data Folder containing tests that have been extracted from the device to the host computer. This is followed by one or more connections (COM ports), and then one or more devices (Multi-Parameter TROLLs or other In-Situ instruments) accessible through each COM port. The Device node is further expandable to show the parameters the device can measure and the tests contained in the device's memory.

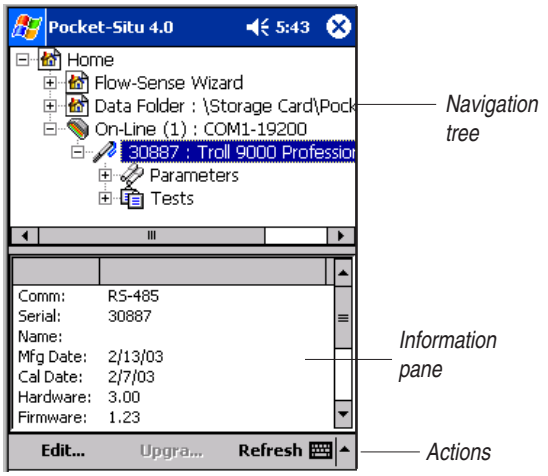


The site, wizard, data folder, connection, devices, parameters, and tests are all "nodes" in the Navigation tree. The symbol + means a node can be expanded to show more nodes below it. Each selection results in a unique "view" in the Navigation tree.

The Win-Situ 4 Application Window (desktop/laptop PC)



The Pocket-Situ 4 Application Window (PDA)



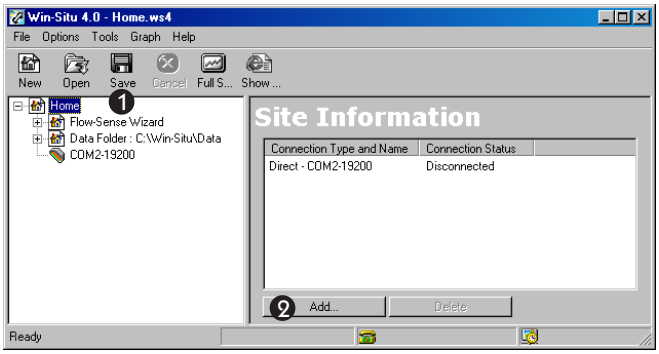
SOFTWARE FUNCTIONS

CONFIGURING THE PORT

When you start Win-Situ or Pocket-Situ for the first time, a new, empty site called "Home" is displayed at the top of the Navigation tree. The Connection Wizard starts automatically to help you add a connection to the site, specifying your computer's COM port, desired baud rate, and other port properties.

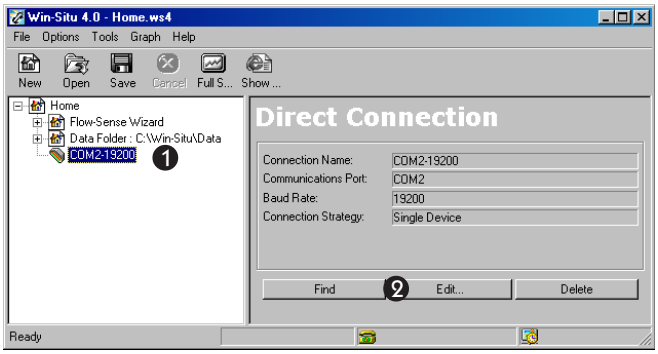
To add a new connection to the site—or if the Connection Wizard does not start automatically for some reason—proceed as follows:

1. Select the site.
2. Click or tap ***Add....***



To change the properties of a connection:

1. Select the connection.
2. Click or tap ***Edit....***



To delete a connection from the site:

1. Select the connection.
2. Click or tap ***Delete.***

For additional information on the port properties prompted by the Connection Wizard, refer to Section 3, Getting Started.

ESTABLISHING COMMUNICATION WITH THE MP TROLL 9500

New Connection

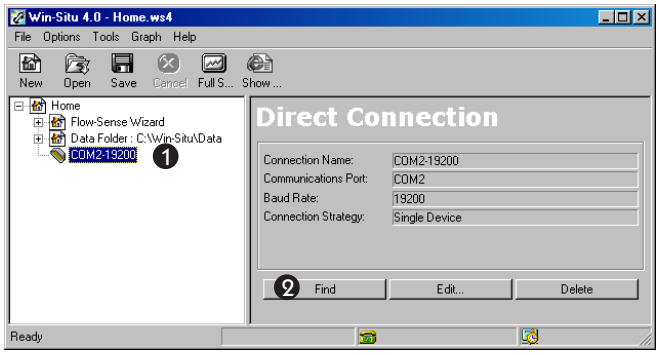
The last option in the Connection Wizard is to **Connect and find devices on "Finish."** If you select this option, the software will automatically establish communication with the MP TROLL 9500.

If you did not select this option, proceed as for an existing connection .

Existing Connection

Each time you launch the software, the site and the connection saved in your last session are displayed in the Navigation tree. To connect:

1. Select the connection.
2. Click ***Find***. Or just double-click the connection.



Win-Situ or Pocket-Situ will open the connection, synchronize the baud rate, locate the device, and display it in the Navigation tree.

3. Click to select the MP TROLL 9500 in the Navigation tree.

If the device's remaining battery capacity is 5% or less, the device may not be displayed in the tree. Replace the batteries before continuing.

DISPLAYING DEVICE INFORMATION

When you select the MP TROLL 9500 in the Navigation tree, the software first retrieves information about the device, then automatically detects the installed sensors and displays them in the tree.

TIP: *If one or more sensors is incorrectly installed, an error message will be displayed. Simply remove the sensor and install it in the correct position, then "refresh" the device to display the sensors in the Parameters list.*

With the MP TROLL selected in the Navigation tree, the Information pane displays a wealth of information about the device, as shown in the Win-Situ screen on the following page. You may need to scroll to view all the information in Pocket-Situ.

The Information pane also provides buttons for actions you can perform, such as upgrading the device features (if available), editing the device properties (including the real-time clock), and refreshing the connection.

Battery Capacity display: On battery power, the "loaded" battery voltage is reported (i.e., the device is drawing current from the batteries).

If external power is detected, an artificially high battery voltage may be reported depending on the device hardware. Hardware versions earlier than 3 report a constant, regulated voltage (aproximately 3.3 V). Hardware version 3 will report the true battery voltage, but since switching to external power removes the load from the battery the number may change when you switch from external to battery and vice-versa.

UPGRADING FIRMWARE AND FEATURES

Firmware Upgrade

New software releases may include a new version of firmware for the MP TROLL 9500. If the software detects a newer version of firmware than that currently loaded in the device, you will be prompted to upgrade device firmware when you connect to the MP TROLL 9500. The upgrade process is brief and software-assisted.

For best performance, we recommend you upgrade to new firmware when prompted by the software.

***TIP:** In order for the software to detect it, the new firmware must be located in the Firmware folder in the folder where Win-Situ or Pocket-Situ is installed. Firmware is automatically copied to these locations when new software is installed.*

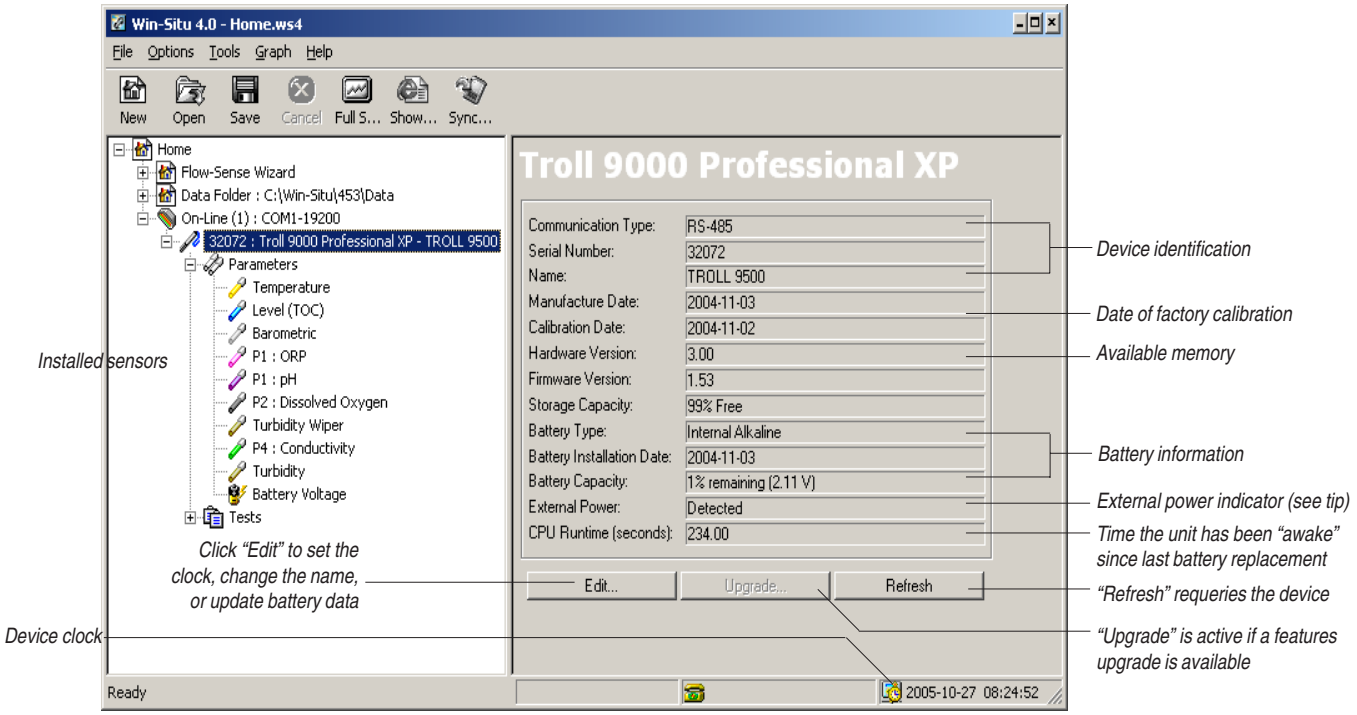
Features Upgrade

The MP TROLL 9500 is available in several models, each offering a different feature set. Some models may be field-upgraded to take advantage of a wider range of features. The field upgrade involves keying in an upgrade code, issued by In-Situ when an upgrade is purchased for a specific instrument serial number.

If you have an upgradable feature set, the Upgrade button will be available in the Information pane when the device is selected in the Navigation tree. If you have purchased a features upgrade for your MP TROLL 9500, press ***Upgrade*** and key in the upgrade code issued by In-Situ Inc. Follow the instructions in the Upgrade Wizard.

Device View of an MP TROLL 9500

The device displays its "family," TROLL 9000, in the Navigation tree



EDITING THE DEVICE PROPERTIES

Setting a Device Name

The software recognizes each device on the network by its type and serial number. In addition, you can assign a meaningful description—a well or site name, location coordinates, etc. This name will be displayed in the Navigation tree and in the header of test data files.

1. With the MP TROLL 9500 connected to a host PC and selected in the Navigation tree, press ***Edit...***.
2. In the Device Wizard, select ***Name,*** then **Next**.
3. Enter a new name for the device (up to 16 characters).
4. When you finish the Wizard, the information is sent to the device and the display is updated.

Setting the Real-Time Clock

Data collection schedules depend on the device clock, shown in the lower right corner of the desktop PC interface. If the clock is not correct, set it as follows:

1. With the MP TROLL 9500 connected to a host PC and selected in the Navigation tree, press ***Edit...***.
2. In the Device Wizard, select ***Clock,*** then **Next**.
3. Follow the instructions to synchronize the MP TROLL 9500's internal real-time clock to the host computer.
4. When you finish the Wizard, the information is sent to the device and the display is updated.

TIP: Due to the size of the PDA screen, the device clock is not displayed in the interface. We recommend you edit the device as above to synchronize the device clock to the PDA clock.

Setting Battery Information

After replacing the batteries, update the device battery information:

1. With the MP TROLL 9500 connected to a host PC and selected in the Navigation tree, press ***Edit...***.
2. In the Device Wizard, select ***Battery Information,*** then **Next**.
3. Select the appropriate battery type and enter the installation date.
4. When you finish the Wizard, the information is sent to the device and the display is updated.

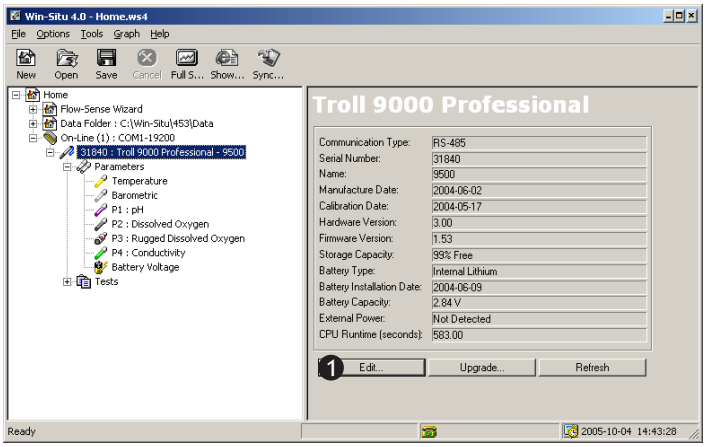
SDI-12 and ASCII Mode Preferences

Preferences for these communication modes may be set in the Device Wizard.

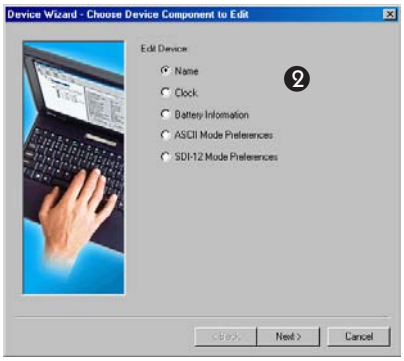
1. With the MP TROLL 9500 connected to a host PC and selected in the Navigation tree, press ***Edit...***.
2. In the Device Wizard, select the desired mode to edit, then **Next**.
3. Change the settings as appropriate.

*To communicate via SDI-12, insure SDI-12 is **enabled** (factory default) in the device. For telemetry applications, SDI-12 should be disabled.*

Editing the Device Properties



1. *Select the device in the Navigation tree and click Edit.*



2. *Select the device property to edit.*

CHOOSING MEASUREMENT UNITS AND OTHER PREFERENCES

Preferences can be set at any time, and are saved with the site. A connection to the instrument is not required.

User-selectable preferences include:

- Parameter measurement units & elapsed time units
- Data file view—report or graph
- Calendar date & time of day format
- Metric or English units for the Flow-Sense Wizard

The following Settings Options are also available:

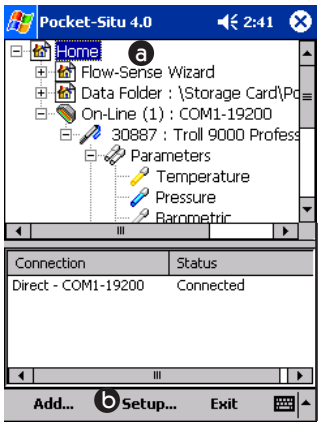
- Start the application in Profiler mode
- Specify desired Profiling rate
- Re-display the "Don't Ask Again" dialogs

To display the Preferences window, do one of the following:

- In Win-Situ, select Preferences from the Options menu.
- In Pocket-Situ:

  a. Tap the Home site in the Navigation tree...

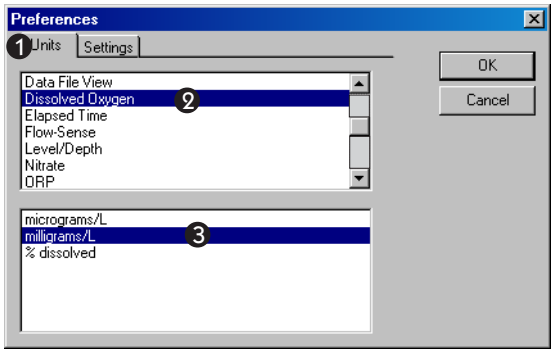
  b. then tap **Setup...** in the command bar.



Units

Default units are used for the display of data unless you specify other preferences. To set unit preferences, first display the Preferences window as above.

1. Select the Units tab.
2. In the top of the Units window, select a parameter whose unit you wish to change.

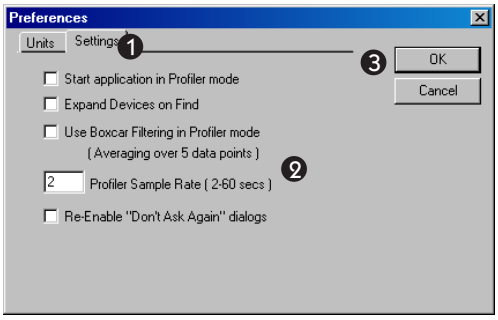


3. In the bottom of the window, select the unit you want for the highlighted measurement. Repeat for as many units as you like.
4. Do one of the following:
   - Click ***OK*** to apply the new units and close the window.
   - Click the Settings tab to change other settings.

Other Preferences

To change other aspects of Win-Situ/Pocket-Situ operation, first display the Preferences window as above.

1. Click the Settings tab.



2. Select the options you want:
   - Start application in Profiler mode. This will take effect at your next session.
   - Expand Devices on Find. This will take effect the next time you click "Find." The software will automatically display all nodes in the device tree without any further action from you.
   - Set desired Profiling rate—the Profiler default rate is 2 seconds, but you may select any rate from 2 to 60 seconds.
   - Re-display the "Don't Ask Again" dialogs. This appears if you have selected "Don't ask me this again" in any WIn-Situ or Pocket-Situ dialog boxes.

     Boxcar filtering is no longer available.
3. Select ***OK*** to close the window and apply the settings.

TIP: *Preferences are saved with the site (on the PC), not in the device.*

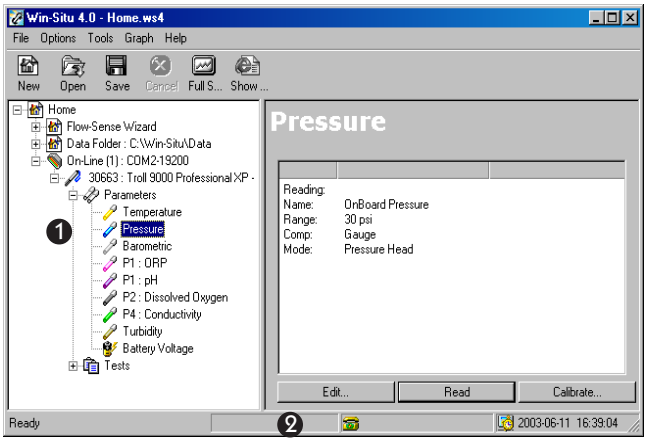
CHOOSING PRESSURE DISPLAY & CONVERSION OPTIONS

Measurements from the optional pressure sensor may be displayed as raw pressure head above the sensor, as depth, or as water level with a reference. When measuring depth or level, you have a choice of methods for conversion from pressure measurements. The specified settings are easily changed from one mode to another, and most choices can be redone or undone later, when viewing test data.

TIP: *For more on the pressure channel setup, refer to Section 7.*

To set the custom display options and pressure-to-level conversion options for a pressure channel:

1. With the MP TROLL 9500 connected to a host PC and selected in the Navigation tree, expand the Parameters node and select the pressure parameter.
2. Click ***Edit...***.



   The Parameter Wizard starts. Refer to Section 7 for complete information on the display and conversion options.

3. When you finish the Wizard, the information is sent to the device and the display is updated.

PERFORMING WATER-QUALITY CALIBRATIONS

Although satisfactory results may be achieved in some cases without field-calibrating the water-quality sensors, for best results we recommend a preliminary calibration procedure before the first field use, and periodic checks and recalibrations as necessary.

The software provides several options for sensor calibration. Choose a method based on the time you are willing to spend calibrating and the accuracy you wish to achieve.

- **Traditional Calibration** guided by software wizards can achieve accuracy and resolution equivalent to laboratory-based meters. Some sensors require a single-point calibration, some present a choice of single- or multi-point, requiring more than one calibration standard.

  A detailed, step-by-step description of each water quality calibration may be found in the relevant parameter section (Sections 11-18) of this manual.

- **Quick Cal** calibrates the basic sensors (pH, ORP, polarographic D.O., conductivity) simultaneously to achieve adequate performance with minimal labor.

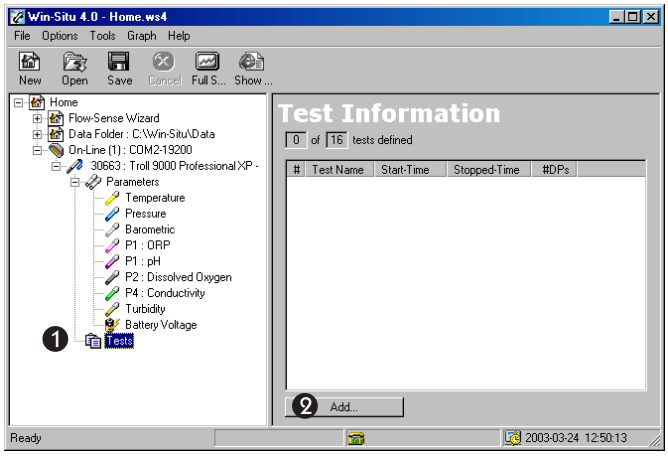
  Refer to Section 3, Getting Started, for the Quick Cal procedure.

LOGGING DATA (ADDING A TEST)

Logging data with the MP TROLL 9500 is called "running a test." To tell the instrument how to run the test—which parameters to measure, how often, when to start, etc.—you "add" a test to the device.

TIP: *For more on logging, extracting, viewing, and deleting data, refer to Section 6.*

1. With the MP TROLL 9500 connected to a host PC and selected in the Navigation tree, click or tap Tests.
2. Click or tap ***Add...***.



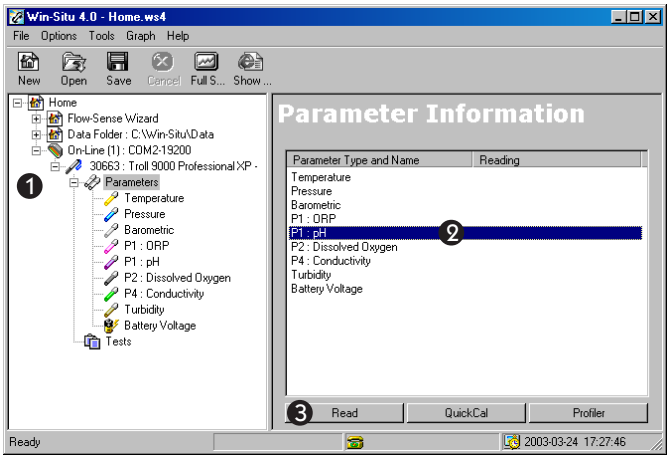
The Test Wizard starts. See Section 6 for a description of the elements that constitute a complete test definition.

3. When you finish the Wizard, the information is sent to the device and the display is updated.

TAKING "MANUAL" READINGS

The MP TROLL 9500 collects data in "tests" but you can get a quick "manual" reading from any device apart from a test, even while a test is running.

1. With the MP TROLL 9500 connected to a host PC and selected in the Navigation tree, click or tap Parameters.
2. In the Information pane, select one or more parameters to read. To select multiple parameters, hold the Control key while selecting. (To display the CTRL key on a PDA, tap the keyboard symbol in the Command bar.)



3. Click or tap ***Read***.

TIP: *For continuously updated real-time "manual" readings of all parameters, select* ***Profiler*** *in the Information pane. Refer to Section 5 for Profiler information.*

EXTRACTING AND VIEWING DATA

Logged data ("tests") reside in the MP TROLL 9500 until you "extract" them. The extract operation copies test data from the device memory to the host computer. Once a test has been extracted to the host computer, it can be viewed. A test can be extracted and viewed at any time, even while it or another test is running.

TIP: *For more on logging, extracting, viewing, and deleting data, refer to Section 6.*

To extract a test:

1. With the MP TROLL 9500 connected to a host PC and selected in the Navigation tree, expand the Tests node to display all the tests in the device.
2. Select a test and click or tap ***Extract***.
3. To view the test immediately, select the **View** option at the end of the download.

TIP: *After the test has been extracted to the host computer, it will appear in the Data Folder node in the Navigation tree. A connection to the instrument is not required to view the extracted data.*

DELETING DATA FROM INSTRUMENT MEMORY

The Extract operation copies a test data file to the host PC, but does not remove it from the MP TROLL 9500. Test data files remain in the Multi-Parameter TROLL 9500's memory until you delete them. Deleting tests frees up device memory.

CAUTION: *Be sure to extract data you want to save before deleting from the device. Once a test is deleted, the data cannot be retrieved!*

1. With the MP TROLL 9500 connected to a host PC and selected in the Navigation tree, expand the Tests node to display all the tests in the device.
2. Select a test and click ***Delete***.
3. Click ***Yes*** to confirm your selection.

The selected test is deleted and the display is updated.

TIP: *If a test is running in the device, the Delete button is not available. You must stop the running test before tests can be deleted. See "Stopping a Test" in Section 6.*

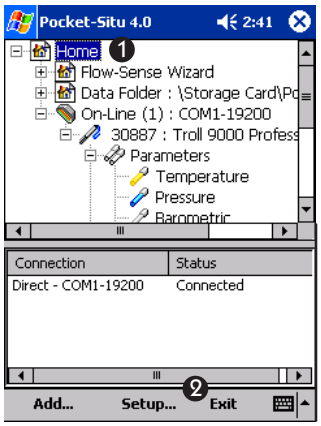
EXITING THE SOFTWARE

WIN-SITU 4

Select **Exit** from the File menu.

POCKET-SITU 4

1. Tap the Home site in the Navigation tree...
2. then tap **Exit** in the command bar.



CAUTION: *Be sure to Exit Pocket-Situ as described above after each session. This releases allocated resources used by Pocket-Situ, assuring that the COM port is available the next time you connect to the MP TROLL 9500, or to a desktop PC using ActiveSync.*

5 PROFILING

All models of the Multi-Parameter TROLL 9500 include a software feature called the Profiler that delivers instant real-time readings on all available channels. Readings are continuously updated as long as the Profiler is running. This provides a convenient way to characterize surface waters using a hand-held controller running Pocket-Situ.

PROFILER FEATURES

- Auto detect—the software automatically identifies all properly connected sensors
- Continuously updated readings from all available channels
- Optional data logging to the connected PC
- Optional start device in Profiler mode
- Optional selectable Profiler interval (2-60 seconds)

You will need—

- MP TROLL 9500 with water quality sensors installed and calibrated
- Quick-Connect Submersible cable
- ComIT or comm cable
- PDA running Pocket-Situ 4

STARTING THE PROFILER

TIP: *If you set up the software to start in Profiler mode, steps 1-4 are done automatically when launching Win-Situ or Pocket-Situ. For details on this setting, see Choosing Measurement Units and Other Preferences in Section 4.*

1. Connect the MP TROLL 9500 to a host PC and establish communication in Win-Situ 4 or Pocket-Situ 4.

Q: Can I do profiling if the MP TROLL 9500 is running a test?

A: Yes, but you may need to wait to get a reading if the test measurement interval is short. The Profiler will defer to the test measurement schedule.

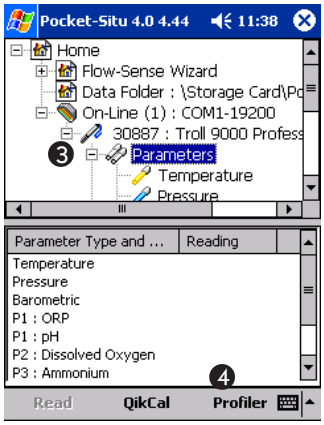
2. Click to select the MP TROLL 9500 in the Navigation tree.

   The software will automatically detect the installed sensors and display them in the Information pane.

   If one or more sensors is incorrectly installed, an error message will be displayed. Remove the sensor, install it in the correct position, and refresh the display before continuing.

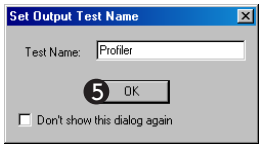
3. Click or tap Parameters in the Navigation tree.

4. Click or tap ***Profiler*** to start the Profiler.



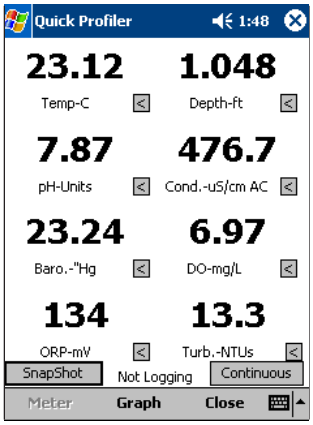
5. You will be asked if you want to set a filename for logged Profiler data (logging the data is optional)

   - To use the default name click **OK**.
   - To specify another name, key it in and click **OK**.
   - To avoid this question each time you start the Profiler, check the option box and click **OK**.



   In a moment, each active channel will be read sequentially, and the readings will be displayed. Up to 8 channels can be shown.

TIP: *Don't let the PDA time out while Profiling. To locate this setting in most PDAs, display the Start menu, select Settings, System tab, Power.*



- Readings are updated approximately every 2 seconds as the Profiler cycles through the available channels in turn.
- The currently selected measurement unit is shown below each reading.

TIP: *You can use the Setup option to change the Profiler's reading rate and/or the displayed units. See Customizing the Profiler later in this section for details.*

- A window without a reading indicates the channel is not available to read, usually because there is no sensor installed in the port.

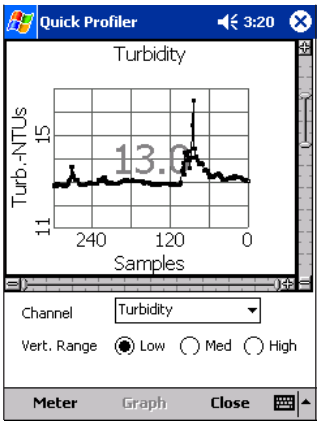
TIP: *If a channel you wish to see is not displayed, click the* < *symbol below a reading you can do without and select the channel you want to add from the list of available channels. This is particularly useful for RDO readings.*

GRAPHING PROFILER DATA

To see a graph of any channel during the current Profiler session, do one of the following:

- Click or tap any reading.
- Click or tap **Graph**, and select the channel from the drop-down list.

Readings for the selected channel since the start of profiling will be displayed in graphical format.



The profiler can graph up to 300 readings. A range slider (scroll bar) on the right side of the graph allows you to change the range of visible data. Like the channel display, the graph will be continuously updated. A range slider at the bottom of the graph lets you zoom in on a narrower time period.

To switch back to the display of active channels, click Meter.

PROFILING DISSOLVED OXYGEN

The ability of the polarographic D.O. sensor to respond to a change in the dissolved oxygen content of the medium—for the sensor to accurately "see" a change—varies with the membrane thickness.

- A 1-mil membrane responds in about 1–2 minutes to significant DO changes;
- A 2-mil membrane responds in about 1.5–3 minutes to significant DO changes.

The RDO Optical D.O. sensor response time ranges from about 6 seconds (T63, when the oxygen level is increasing) to 57 seconds (T95, when the oxygen level is decreasing)

PROFILING PRESSURE OR DEPTH

Profiler readings from a pressure channel are displayed as pressure head or depth according to the pressure channel setup. Refer to Section 7 below for pressure display and conversion options. Level mode readings with a user-entered reference are primarily for use in aquifer tests.

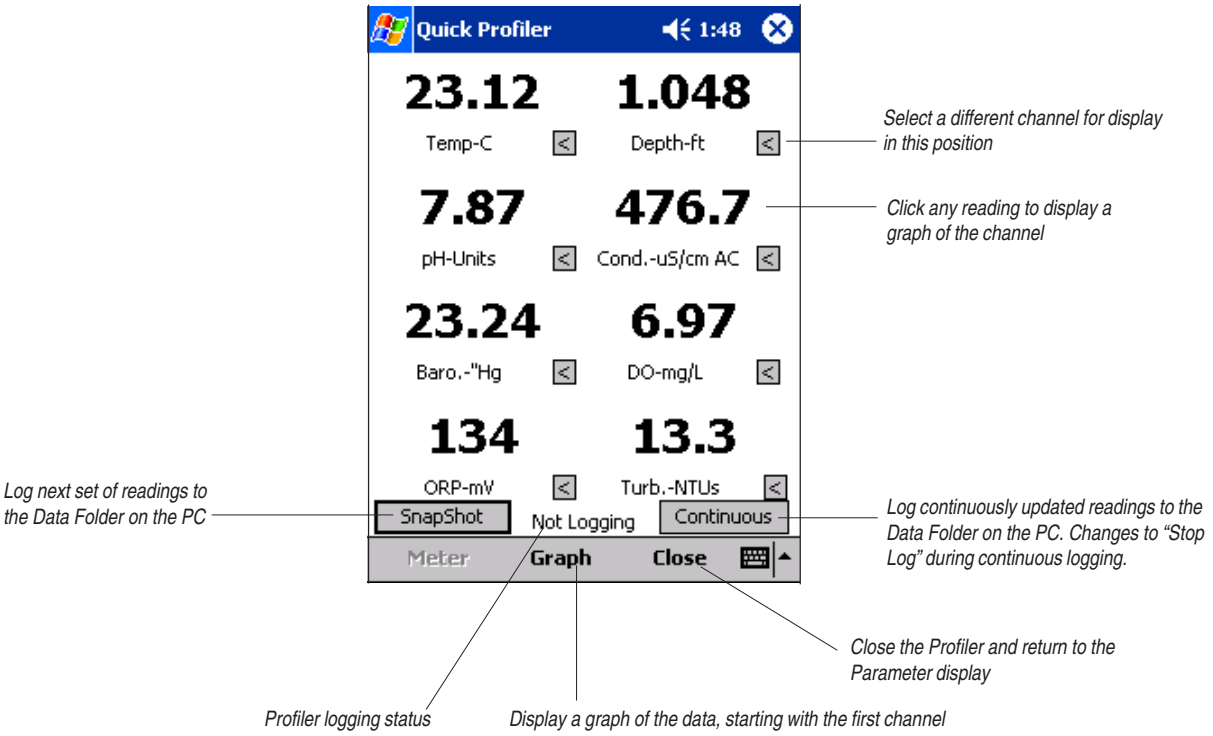
TIP: *Profiling with the MP TROLL's default pressure settings (no channel setup) will display pressure head in psi (pounds per square inch). To display depth, edit the pressure channel as described in Section 7.*

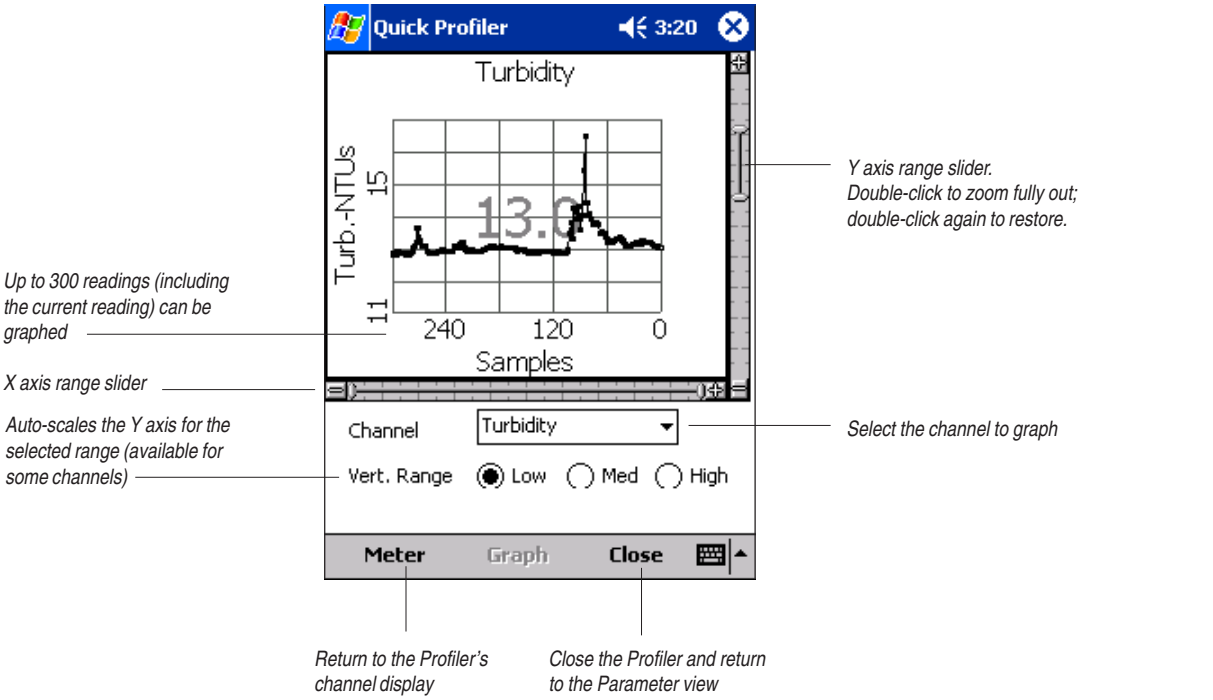
PROFILING TURBIDITY

The turbidity sensor requires a 5-second warmup before the first reading. Subsequent readings do not require a warmup.

If a turbidity wiper accessory is installed in the TROLL 9500, it performs an initial wipe of the sensor optics—this takes about 15 seconds—then displays the first turbidity reading. If the profiling rate is longer than 15 seconds, this 15 second wipe will happen before each reading. To avoid this delay, set the profiling rate to less than 15 seconds. See Customizing the Profiler later in this section for details.

Section 18 below has additional information on the turbidity wiper.


Quick Profiler
1:48
23.12
Temp-C
1.048
Depth-ft
7.87
pH-Units
476.7
Cond.-uS/cm AC
23.24
Baro.-"Hg
6.97
DO-mg/L
134
ORP-mV
13.3
Turb.-NTUs
SnapShot
Not Logging
Continuous
Meter
Graph
Close
Select a different channel for display in this position
Click any reading to display a graph of the channel
Log next set of readings to the Data Folder on the PC
Log continuously updated readings to the Data Folder on the PC. Changes to "Stop Log" during continuous logging.
Close the Profiler and return to the Parameter display
Profiler logging status
Display a graph of the data, starting with the first channel


Quick Profiler
3:20
Turbidity
Turb.-NTUs
15
11
13.6
240
120
0
Samples
Channel
Turbidity
Vert. Range
Low
Med
High
Meter
Graph
Close
Y axis range slider.
Double-click to zoom fully out; double-click again to restore.
Up to 300 readings (including the current reading) can be graphed
X axis range slider
Auto-scales the Y axis for the selected range (available for some channels)
Select the channel to graph
Return to the Profiler's channel display
Close the Profiler and return to the Parameter view

CUSTOMIZING THE PROFILER

Changing the Channels Displayed

The arrow ◁ below each Profiler reading displays a drop-down list that may be used to assign a different channel to each position, if desired. You can use this button to add a channel, such as RDO Optical Dissolved Oxygen, that is not displayed by default. However, only 8 channels can be shown.

Changing Measurement Units

Close the Profiler. In Win-Situ, select Preferences on the Options menu. In Pocket-Situ, select the Home site, then tap Setup in the command bar.

Changing the Sample Rate

Close the Profiler. In Win-Situ, select Preferences on the Options menu, then select the Settings tab. In Pocket-Situ, select the Home site, tap Setup in the command bar, then select the Settings tab. You may select any sample rate between 2 and 60 seconds.

Starting in Profiler Mode

In Win-Situ, select Preferences on the Options menu, then select the Settings tab. In Pocket-Situ, select the Home site, tap Setup in the command bar, then select the Settings tab. Check ✔ Start application in Profiler mode. This will take effect at your next session (or exit and re-start to apply this setting).

LOGGING PROFILER DATA

Profiler data may be logged to the connected PC while in the "Meter" view.

- **Snapshot:** To log a single set of Profiler readings, click or tap the **SnapShot** button in the "Meter" view.
- **Continuous:** To log continuous readings, click or tap the **Continuous** button in the "Meter" view. Readings will be logged until you cancel the operation by clicking **Stop Log**.

Can I see Dissolved Oxygen readings in mg/L and % saturation at the same time?

Yes, so long as your preferred unit for DO is mg/L. Select Dissolved Oxygen for one window, and Dissolved Oxygen % Saturation for another window.

TO STOP LOGGING

The Snapshot function logs a single set of readings and stops logging automatically.

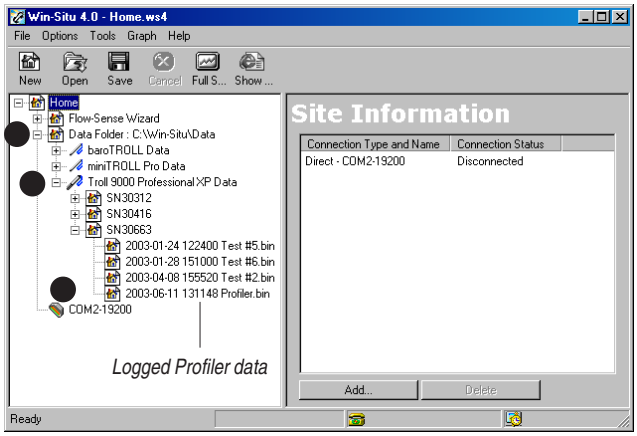
In Continuous mode, click **Stop Log**. Note that this does not stop Profiling; readings will continue to be updated on the screen.

RETRIEVING LOGGED PROFILER DATA

In either Snapshot or Continuous mode, Profiler data are logged to the connected PC and accessible through the Data Folder. The data may be retrieved at any time. A connection to the instrument is not necessary.

To retrieve logged Profiler data:

1. Expand the Data Folder in the Navigation tree by tapping the **+**.
2. Expand the node for the device type and serial number.
3. Look for a data file named with date and time of the profiler reading, and with the ending profiler.bin—or whatever custom name you may have specified when starting the Profiler.



***TIP:** The time shown in the filename of a Profiler log is the time the Profiler started, which may be different from the time of the first data point logged. Similarly, the Elapsed Time indicated in the Report view of a continuous Profiler log is the elapsed time since the Profiler started.*

For additional information on viewing data in the Data Folder, see the section "Viewing Logged Data" at the end of Section 6 below.

EXITING THE PROFILER

When you are ready to exit the Profiler, click **Close**. The Parameters view will return to the screen.

6 LOGGING DATA

Memory-equipped Professional models of the MP TROLL 9500 are ideal for monitoring and recording water quality data. Logging schedules can be set up in advance, and the collected data stored in the device's storage memory until needed.

Collecting a set of data with the instrument is called "running a test." A "test" is initially a set of user-defined instructions to the logger about how to collect the data:

- which parameters to measure
- how often to measure
- when to start taking and logging measurements

After it has "run," the completed test consists of a data file that was logged following the instructions above.

Many of the things you do through Win-Situ or Pocket-Situ control software can be visualized as actions performed on tests. For example,

- to give the device instructions for collecting data: **add** a test.
- when you want the device to end data collection: **stop** a test.
- to copy test data from the device to a host computer: **extract** the test.

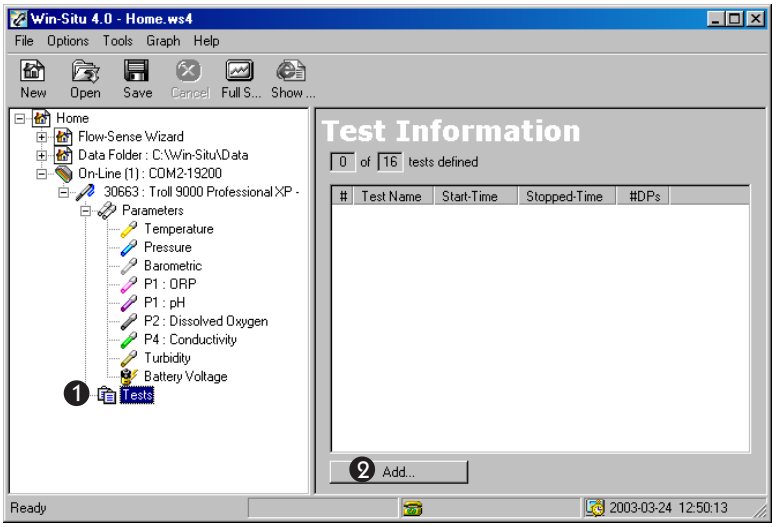
These actions are initiated by buttons in the Information pane when the device's Tests node (group view of all tests) or a Single test is selected in the Navigation tree.

Advantages of the Tests node (group view): *(1) the Add action is available, and (2) group operations such as delete and extract can be performed on multiple tests simultaneously. For illustrations, see the box on page 39.*

ADDING A TEST TO A DEVICE: THE TEST WIZARD

The Add action programs the MP TROLL to collect data. The Test Wizard starts automatically to help you enter the required information.

1. With the MP TROLL 9500 connected to a host PC and selected in the Navigation tree, click or tap Tests.
2. Click or tap **Add**. The Test Wizard starts. The choices are discussed below.
3. When you finish the Wizard, the information is written to the device and the display is updated.



To add a test, (1) select the Tests node in the Navigation tree, (2) click Add.

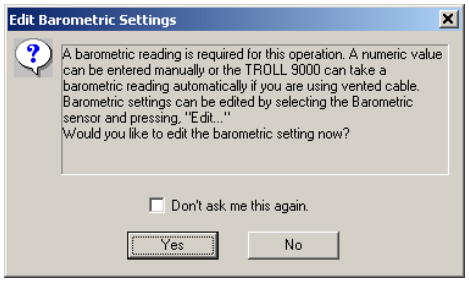
TIP: *Defining a test, setting up a test, adding a test—these terms all mean the same thing and may be used interchangeably in this manual.*

With a D.O. sensor installed (polarographic or optical)—

Before the Test Wizard starts, you will be asked how you want to handle barometric pressure. Cable venting is essential to obtain accurate measurement from the device's internal barometric pressure sensor, and the software cannot tell if this cable is vented, so please take a moment to supply this information.

The dialog box shown below asks if you wish to edit the barometric settings in the absence of vented cable. Do one of the following:

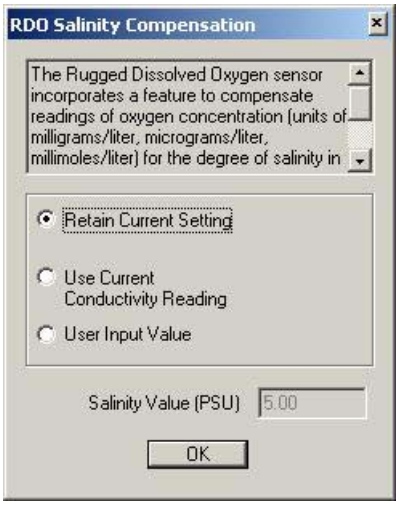
- If the TROLL 9500 is on **vented** cable now and will take measurements using **vented** cable, click No — and you may want to check the "Don't ask me this again" box.
- If the device is on **vented** cable now but will take measurements using **non-vented** cable, click Yes. In the Edit Barometric Channel screen, check the box indicating non-vented cable for measurements but vented cable for calibration/programming.
- If the device is on **non-vented** cable now and will take measurements on **non-vented** cable, click Yes. In the Edit Barometric Channel screen, check the box indicating non-vented cable for measurements and enter a barometric pressure value. For help in supplying information if the cable is not vented, see Section 9, Monitoring Barometric Pressure.



With an RDO® optical D.O. sensor installed—

Before the Test Wizard starts, you will be asked how you want to handle salinity compensation. The sensor does not react to changes in salinity. To compensate for the lower solubility of oxygen in salty water, a salinity value stored in the sensor can be applied. This insures that the reported concentration of dissolved oxygen in the presence of significant water salinity is accurate. The compensation algorithm is applied internally before concentration is reported by the sensor.

- Retain Current Setting (shown below).
- Use Current Conductivity Reading: If a conductivity sensor is present: you may select the second option. This can provide good results in dynamically changing salinity (e.g., estuaries). However, the conductivity sensor is subject to fouling, and any conductivity errors thus created will be transmitted to the RDO sensor.
- User Input Value: When working in waters with a constant and known salinity, and a conductivity sensor is not present, select this option and enter the salinity value (in PSU, Practical Salinity Units). The fixed value is effective in situations where the salinity variability is low. The value can be changed at any time by selecting the RDO sensor in the Navigation tree and clicking "Edit," then Edit Salinity.



TEST SETUP PARAMETERS

A complete test definition has five parts. The choices available in each screen are tailored to reflect your selection in earlier screens.

1. Test Name (Optional)

You may enter up to 16 characters to identify the test. A default name is proposed. The test name is displayed in the Navigation tree, in the test data file, and in the filename of tests extracted from the device to the Data Folder on the host PC.

2. Parameters to Include

All available parameters are selected ☑ by default. De-select any parameter you do not want to measure during this test by clearing the checkbox. Remaining choices will be tailored to your selection.

The barometric pressure and temperature channels are automatically included when water-quality channels are selected so that their readings are available for compensating the measurements.

3. Measurement Schedule

The available schedules depend on your device's firmware and the parameters selected for inclusion in the test. This list is a quick overview. Additional details are given later in this section.

- **Linear.** All measurements are evenly spaced at a user-specified interval, and all measurements are stored in the device memory.
- **Event.** Measurements are evenly spaced, but you can record an "event" and conserve memory by having the device *store* only measurements that differ from the previous stored measurement of a designated parameter by a specified amount. Any available

parameter may be selected for event comparisons, and the "delta" or difference amount is prompted in the current basic parameter unit.

- **Log.** *Not available for the MP TROLL 9500.*
- **Linear Average.** This type of test can smooth out anomalous highs and lows that may occur, for example, when a water wave passes over the instrument. Each stored measurement is the average of several rapid measurements.

4. Measurement Interval

The interval specifies how often measurements will be taken during this test. Enter any combination of Days, Hours, Minutes, & Seconds. The minimum (fastest) allowable interval depends on your choice of measurement schedule and the parameters included in the test. For most parameters, the minimum interval is 5 seconds. If RDO Optical Dissolved Oxygen is included, the minimum interval is 10 seconds.

5. Start Mode

Choose one of the following options for starting this test:

- **Manual.** A manual test can be started at any time while the MP TROLL 9500 is connected to a PC by pressing the ***Start*** button. This mode is useful when you want to synchronize the start of data collection with an external event like starting a pump.
- **Scheduled.** A scheduled start test will start at the date and time you specify. The time proposed by the software is the next hour on the hour, calculated from the current device time plus 10 minutes. Arrows beside the list boxes may be used to change the start time and date, or key in the desired start time and date.

TIP: *In entering the Scheduled Start time, keep in mind that when this test starts, it will stop a running test.*

The time proposed for a Scheduled start is the next hour on the hour, calculated from the current device time plus 10 minutes. In Pocket-Situ this is your only indication of the device time. If the proposed time is wrong, cancel test setup and set the device clock before scheduling tests.

ENDING SETUP

After you select the test options and click ***Finish***, the information will be sent to the device and the new test will appear in the Navigation tree.

To let you know which tests can be started with the Start button, the software displays a different symbol for each start type:

Manual start test (you start)

Scheduled start test (starts by itself)

Where do I enter the stop time for the test?

You will not be asked for a stop time because the end of a test cannot be programmed in advance. In most cases, the only way to stop data collection is to connect to a PC, select the test in the Navigation tree, and press the Stop button.

Exceptions: A test stops automatically under these conditions:

- *when another scheduled test starts.*
- *when the device's memory is full. In this case the test may indicate "ABEND" (ABnormal END) in the Navigation tree.*
- *if a loss of power occurs. In this case, the test may indicate "ABEND" in the Navigation tree.*

TIP: *If you wish to schedule the end of data collection, try this: Before starting your test, define another test to start at the time you want the "real" test to stop. Select a linear test with a long measurement interval—hours or days—and minimal sensors to conserve battery power. Schedule this test to start at the time you want the "real" test to end. The test will start at its scheduled time, stopping the earlier test and kicking into a sparse sampling schedule.*

MORE ON MEASUREMENT SCHEDULES

LINEAR

In Linear sampling, all selected channels are measured at the same Measurement Interval; all measurements are stored in memory.

EVENT

All selected parameters are measured at your chosen Measurement Interval, but a data point (reading from all active channels) is stored *only if the measurement on the designated "event" channel exceeds a user-defined value*. This value is called "Delta" because it relates to a change in the measurement. Here's how it works:

Delta

Each measurement on the selected "event" channel (pressure, for example) is compared to a reference. The initial reference is taken at the start of the test. When a pressure measurement varies from the reference by less than the Delta amount, the data point is not stored. When a pressure measurement varies from the reference by more than the Delta amount, the data point (all channel measurements) is stored. The stored pressure measurement is called a "Delta point" and **becomes the new reference for comparison**.

In an Event test, then, small and essentially insignificant changes are not stored, but larger and more significant changes are. This scheme will minimize the size of a data file by storing meaningful data.

EVENT (*continued*)

Minimum Delta Values

System accuracy is a function of many variables. It is theoretically possible to choose a Delta value so small that random system noise, however slight, might "look" significant. We recommend that you enter a reasonable Delta value for the parameter being measured to avoid triggering an event storage when no event has occurred.

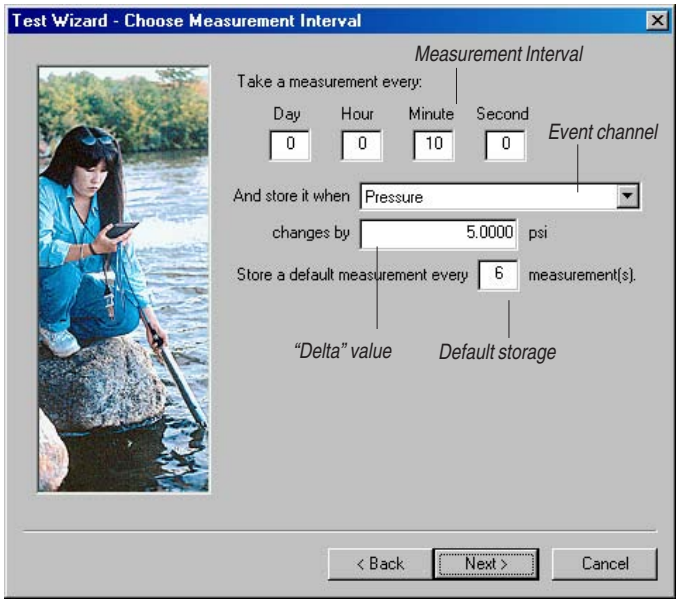
TIP: *Units for the Event channel should be set to the "basic" parameter unit (e.g., psi); derived (software-calculated) units are not available.*

Default Storage

Consider a situation where there is virtually no change through time in measured value. In this case, it is possible that almost no data would be stored to the data file. To avoid the possiiblity that a test may contain little or no stored data, sparse linear sampling also occurs whereby data points are stored to the data file every *n* measurements regardless of the measurement comparisons that are occurring. This type of data is called "default storage." For example, if the Measurement Interval is 10 minutes and you specify a Default storage every 6 measurements—as shown in the event test setup screen below—then data will be logged every hour regardless of the Delta comparisons.

Data gathered in an Event test consist of both "Delta points" and "default storage." There is no distinction made between them in the actual data file since they both represent measurements of the same physical property (pressure, temperature, conductivity, etc.).

Event Test Setup



LINEAR AVERAGE

This type of test can eliminate anomalous highs and lows that may occur—for example, if a wave passes over the instrument at the time a measurement is made. For every measurement stored in the data file, the device takes a specified number of measurements at a specified interval, averages them, and stores the average value.

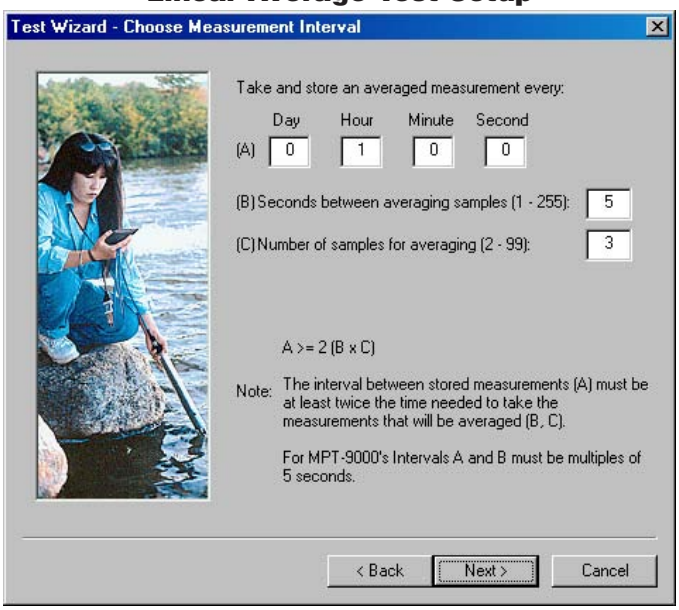
You are prompted for

- **A** the storage interval (how often an averaged measurement will be stored in the data file)
- **B** the interval between the rapid measurements that will be averaged (1-255 seconds)
- **C** the number of measurements that will be averaged for each stored measurement (2-99)

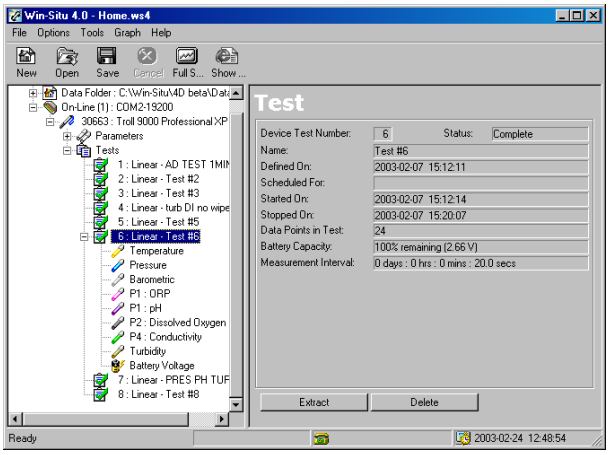
TIP: *The storage interval (A) must be at least twice as long as the rapid interval (B) times the number of measurements for averaging (C). In the example shown below, 5 seconds x 3 = 15 seconds, so the storage interval would have to be at least 30 seconds.*

In the linear average test example shown in the screen below, a measurement will be logged every hour (A). The logged measurement will consist of the average of 3 measurements (C) taken 5 seconds apart (B).

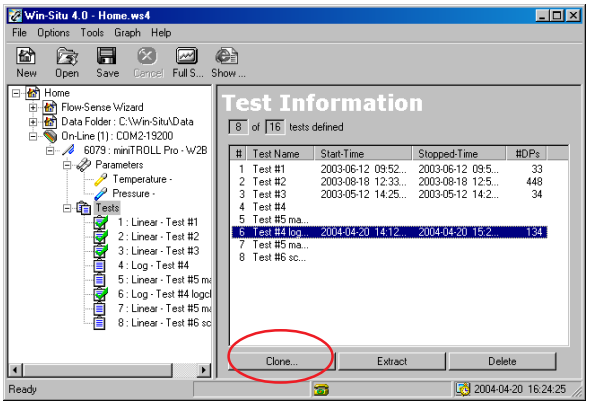
Linear Average Test Setup



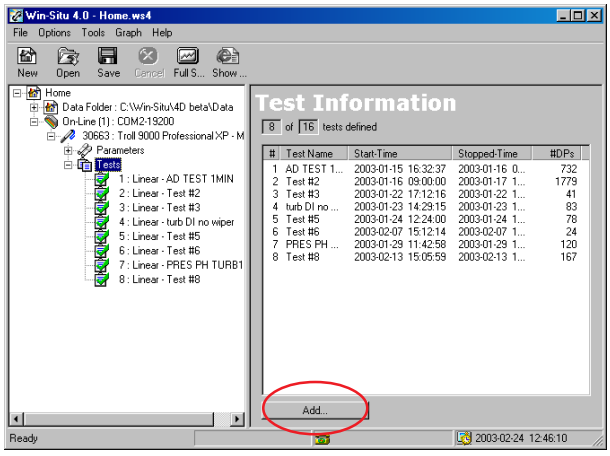
Single test view vs. Multiple test view



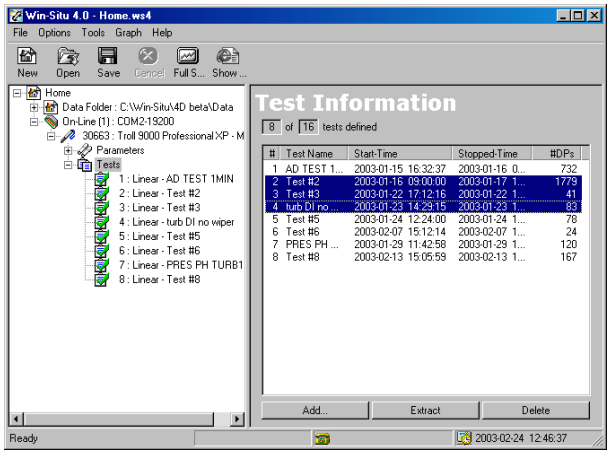
When a single test is selected in the Navigation tree, the Information pane shows details about the selected test.



*When a test is selected in the Information pane, the **Clone...** button is available to copy the test definition—saves time in setting up tests.*



*When the Tests node (group view) is selected, the Information pane shows all tests and displays the **Add...** button. #DPs is the number of data points logged.*



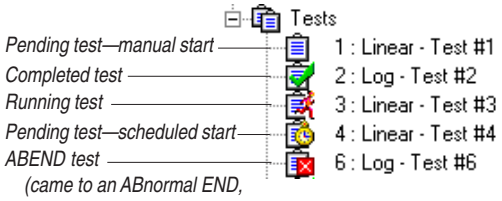
When multiple tests are selected in the Information pane, multiple tests may be extracted or deleted simultaneously.

OTHER TEST OPERATIONS

There are six basic test operations:

- **Add...**—programs the instrument to collect data. See the first part of this section for details.
- **Edit...**—allows you to change the pre-programmed test setup before the test runs. Editing a test launches the Test Wizard. See the first part of this section for details.
- **Start**—starts the selected test if it has been defined for a manual start.
- **Stop**—stops a running test.
- **Extract**—copies the selected test data from the instrument to the host computer. A copy of the data remains in the instrument.
- **Delete**—deletes the selected test from the instrument.
- **Clone**—makes a copy of the selected test definition setup.

The operations available depend on the status of the selected test. A dfiferent symbol is displayed for each test status:



STARTING A MANUAL START TEST

1. With the MP TROLL 9500 connected to a host PC, select a pending manual test in the Navigation tree.
2. Click or tap ***Start***.

TIP: *If a test is running in the device, the Start button is not available. You must stop the running test before you can start a new one. See "Stopping a Test" below.*

3. You will be asked to confirm your selection.
4. After you confirm, the test starts and the display is updated.

TIP: *Once a test starts, the following actions will not be available: Add, Delete, Edit (device, parameter, test), Clone, Calibrate.*

STOPPING A TEST

The end of a test cannot be programmed in advance. In most cases, the ***Stop*** button is the only way to stop a running test. Exceptions: A test stops automatically when any of the following occurs:

- when another test starts
- if the device memory fills up
- if power is lost.

1. With the MP TROLL 9500 connected to a host PC, select a running test in the Navigation tree.
2. Click or tap ***Stop***. You will be asked to confirm your selection.
3. After you confirm, the test stops and the display is updated.

RETRIEVING LOGGED DATA

Retrieving, downloading, uploading, transferring—these terms are sometimes used interchangeably to mean the act of copying data from the place where it was logged to a host PC. The Extract operation in Win-Situ or Pocket-Situ retrieves test data from the MP TROLL 9500 memory and saves it to a file on the host computer. You may view the file immediately after the download, or later.

1. With the MP TROLL 9500 connected to a host PC and selected in the Navigation tree, click or tap Tests.
2. In the Information pane, select one or more tests to extract. To select multiple tests, hold the CTRL key while selecting. (To display the CTRL key on a PDA, tap the keyboard symbol.)

Where do my extracted data files go?

Win-Situ 4 extracts tests to a folder named "Data" in the folder where Win-Situ 4 is installed. The file structure looks like this:

Win-Situ \ Data \ SN30701 2004-02-12 150000 Test #3.bin

- *Device serial number*
- *Test start date (yyyy-mm-dd)*
- *Test start time (hhmmss)*
- *Test name*
- *File type*

TIP: *On a PDA, the Pocket-Situ \ Data folder is located in the device's non-volatile storage.*

3. Click or tap ***Extract*** to extract the test(s).

When the extraction is complete, the name(s) and locations of the test data file(s) on the host computer are displayed (see box on the next page). If a selected test has been extracted previously, only data logged since the last download is extracted and is automatically appended to the original file.

The software presents two options after the extraction:

- ***View*** launches the data viewer to view the selected file.
- ***Done*** returns to the Tests view in the software.

TIP: *The "Extract" operation puts a copy of a test data file on your PC, but does not delete the test from the device. To free up device memory, see Deleting Tests, next.*

TIP: *When extracting a large test to a PDA on battery power, avoid letting the PDA time out during the transfer. To locate this setting in most PDAs, display the Start menu, select Settings, System tab, Power.*

DELETING TESTS

Tests are stored in the device memory until you delete them. The Delete operation **permanently** removes selected tests from the device, and reorganizes the memory to optimize future data storage. Depending on how full the memory is, the process may take several minutes.

1. With the MP TROLL 9500 connected to a host PC and selected in the Navigation tree, click or tap Tests.
2. In the Information pane, select one or more tests to delete. To select multiple tests, hold the CTRL key while selecting. (To display the CTRL key on a PDA, tap the keyboard symbol in the Command bar.)
3. Click or tap ***Delete***. You will be asked to confirm your selection.

TIP: *If a test is running in the device, the Delete button is not available. You must stop the running test before tests can be deleted. See "Stopping a Test" above.*

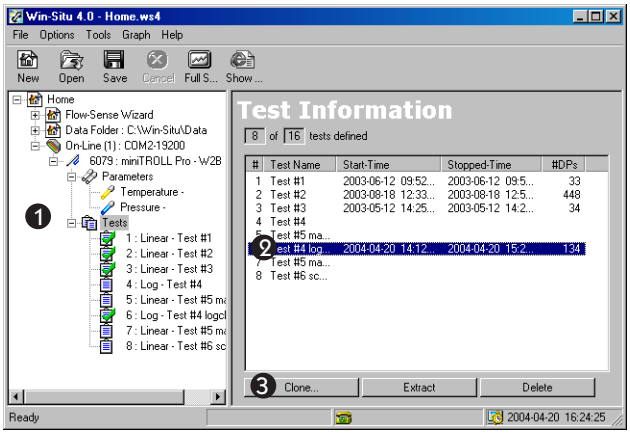
4. After you confirm, the selected test(s) are **permanently removed** from the device.

TIP: *The Delete procedure can be used to cancel a pending scheduled test* .

CLONING A TEST

The Clone function lets you copy all the elements of an existing test—the test name, selected channels, measurement schedule and interval—without having to define a new test "from scratch." You can clone a pending test or a completed test.

1. With the MP TROLL 9500 connected to a host PC and selected in the Navigation tree, click or tap Tests.
2. In the Information pane, select a test to clone.



3. Click or tap ***Clone*** to preview the test definition. The Wizard will still present all the screens, but you can just click Next to get through them quickly (or make any changes you want).

TIP: *The proposed start type for a cloned test will always be Manual, regardless of the start type of the original test. This is to avoid scheduling a test to start in the past.*

4. Click ***Finish*** to end the wizard. The information will be sent to the device and the new test will appear in the Navigation tree.

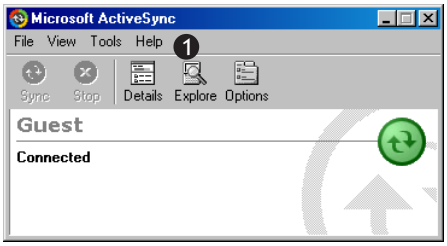
TRANSFERRING FILES FROM A PDA TO A DESKTOP PC

If Win-Situ Sync (or its earlier release, Pocket-Sync 4) is installed on your desktop PC, file transfer can be done automatically each time the computers are connected in ActiveSync.

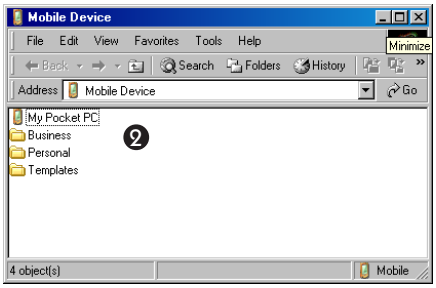
To transfer files "manually" proceed as follows. **NOTE THAT MICROSOFT ACTIVESYNC IS NEEDED TO CONNECT THE COMPUTERS even with an In-Situ synchronization utility installed (Win-Situ Sync or Pocket-Sync 4).**

TIP: *Install Microsoft ActiveSync on the desktop PC* ***before*** *the first connection to the PDA. Be sure to exit your last Pocket-Situ session. The following procedure is performed from the desktop PC side.*

1. With the computers connected and ActiveSync running, open up Explore on the ActiveSync tool bar.

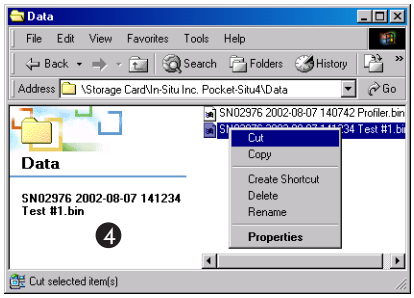


2. Double-click on "My Pocket PC."



3. Browse to the folder where Pocket-Situ Data is stored. On some PDAs this will be in a folder called "Storage Card" or "SD Card." On the RuggedReader, look in Built-in Storage. Open the Pocket-Situ Data folder (double-click) to display a listing of your extracted data (.bin) files.

4. Right-click the file(s) you want to transfer and select **Copy** or **Cut**. Selecting Cut will remove the data file from the PDA.



5. Open My Computer or Windows Explorer for the desktop PC and navigate to the folder where you want to place the data file(s). When the cursor is in the desired folder, right-click, and select **Paste**.

   We recommend placing the files in the following locations to ensure that they will be displayed properly in the Data Folder branch of the Win-Situ Navigation tree. The In-Situ synchronization utility, if used, will put the files in the proper locations automatically.

Test data files	Data folder in the folder where Win-Situ 4 is installed (normally, C:\Win-Situ\Data)
Low flow files	LowFlow subfolder of the Data folder
Calibration reports	Calibration Reports folder in the folder where Win-Situ 4 is installed. These will be accessible from Win-Situ's Tools menu.

VIEWING LOGGED DATA

Logged data sets from the Multi-Parameter TROLL 9500 are called "tests." Tests reside in the instrument until you extract them to the host computer. Any test that has been extracted can be viewed in text or graphical format. A test can be extracted and viewed at any time, even while it or another test is running.

The software provides two routes to view test data:

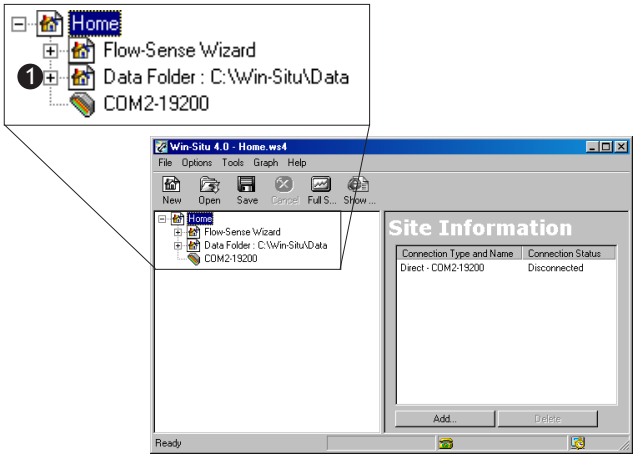
- If the test is in the instrument's memory, extract it and select the **View** option at the end of the download. This launches the data viewer.
- If the test has been extracted to the host computer, it will appear in the Data Folder node in the Navigation tree. A connection to the instrument is not required in order to view extracted data.

SELECTING DATA IN THE DATA FOLDER

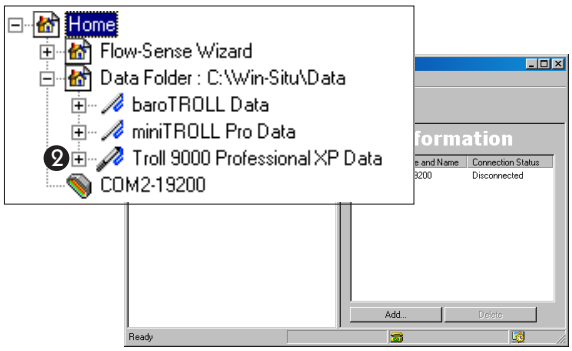
The Data Folder appears below the Home site in the Navigation tree. After data files have been extracted from the MP TROLL 9500 to the Data Folder, the node can be expanded to show device type, serial number, and extracted data files.

To view extracted test data:

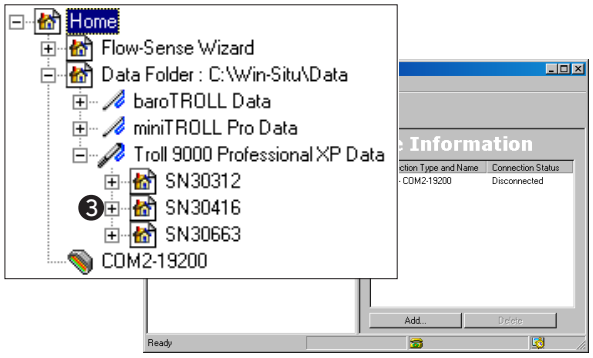
1. Click the + sign beside the Data Folder to expand the listings.



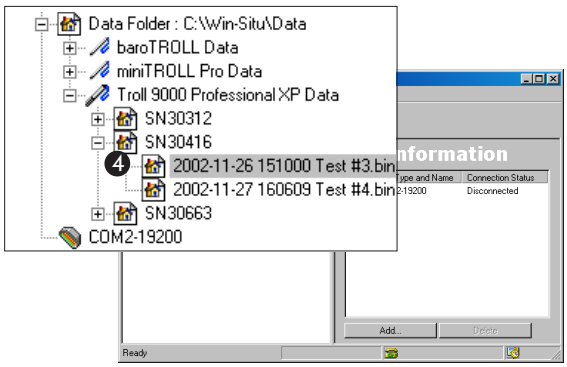
2. The Data Folder has a node for data from each device type—for example, miniTROLL Pro Data, TROLL 9500 Professional XP Data. If tests from more than one type of device have been extracted, click the + to expand the TROLL 9500 listing.



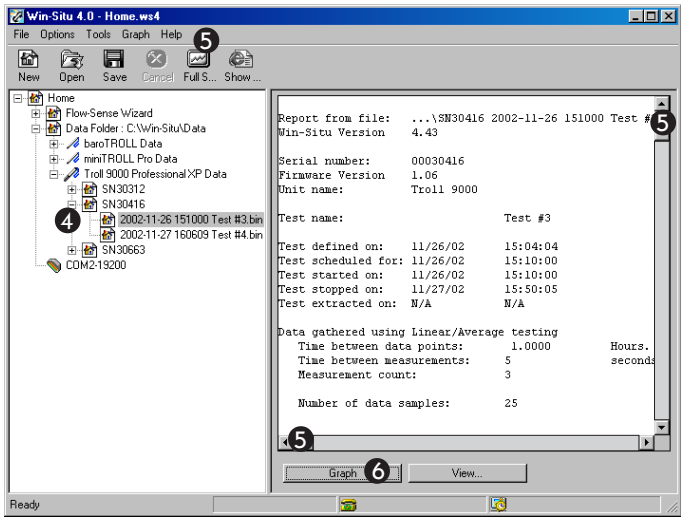
3. Device nodes are further subdivided by serial number. If tests from multiple TROLL 9500s have been extracted, the serial number of each will be displayed. Click the + beside the the serial number of the unit whose data you want to view.



4. The serial number node contains the extracted tests and logged Profiler data. Click to select the test you want to view.



The selected test is displayed in the Information pane—to the right of the screen in Win-Situ, or at the bottom in Pocket-Situ.



TIP: The data file may appear in Report view or Graph view, depending on the preferences saved in your last Win-Situ or Pocket-Situ session.

5. To view the test data below the header in Report view:
   - Use the vertical and horizontal scrollbars to scroll through the data file.
   - Or click Full Screen in the shortcut bar to enlarge the text display, and then use the scrollbars.

GRAPHING DATA

6. Click or tap **Graph** to display the individual parameter data in graph format. See the sidebar on this page for Win-Situ graphing controls, and on the next page for Pocket-Situ graphing controls.

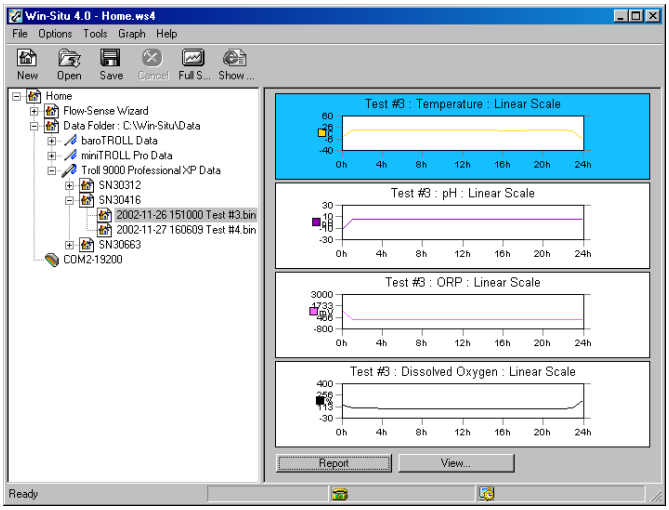
*TIP: You can easily switch from Graph view to Report view and back using the **Graph** and **Report** buttons in the Information pane. However, the view chosen in this way is not "persistent" into your next session. To change the view so it always comes up as Graph or Report, specify the desired Data File View in Preferences (Options Menu) in Win-Situ or Setup in Pocket-Situ.*

Win-Situ provides a range of options for viewing data in graph format. Here are some things you may wish to try:

- To enlarge the selected graph: Click Full Screen in the toolbar, then go to the Graph menu and select a different Number of Graphs
- To show two channels on the graph: select Graph Settings on the Graph menu, select a Primary channel and a Secondary Channel

Win-Situ Graphing Controls

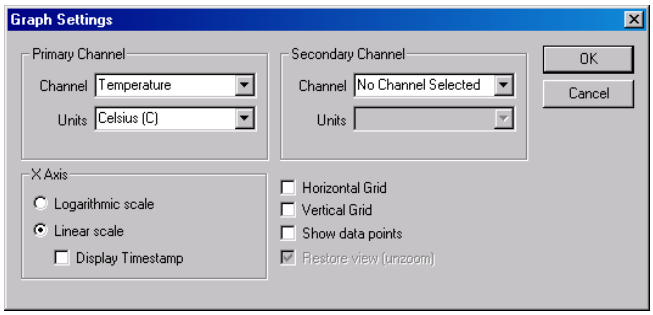
The Graph button displays data from the first four test channels in graph format. Time is shown on the X axis in the currently selected unit. The axes are auto-ranged. Click any graph to select it for formatting.



Each graph can display one, two, or all test channels. To change the appearance and content of any graph, display the Graph menu or right-click a graph. This provides access to the graph formatting options:

- change or add channels
- add data point indicators
- add grid lines to one or both axes
- add a logarithmic time scale
- change the range of the Y (data) axis
- change the parameter units
- add a time stamp to the X (time) axis
- zoom in on the graph

Many of these options can be set in the Graph settings window:



- To show all channels on the graph: select Graph Settings on the Graph menu, choose All Channels Selected

Pocket-Situ Graphing Controls

Pocket-Situ displays all the test channels in one graph. Time is shown on the X axis in the currently selected unit. The axes are auto-ranged.

The left Y axis represents the first channel in the test (usually temperature), or the first channel selected in the **View...** option in the command bar. The right Y axis represents the second channel.

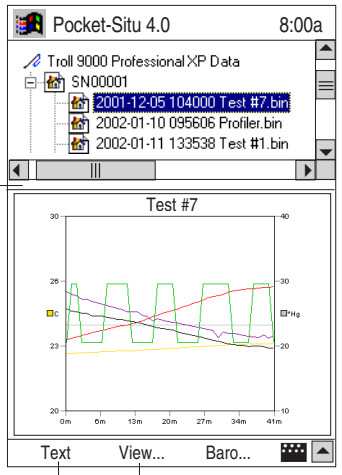
Tap **Graph** or **Text** in the command bar to change the view.

The graph area may be resized as follows:

With the stylus (or other suitable pointer), press on the line that separates the Navigation tree from the Information pane and drag it up or down to resize the screen.

The **View...** option in the command bar launches wizards to help you change the way test data are displayed.

- Select Channels to View: Tap Next, then tap a check box to show or hide a channel. Tap Finish to return to the graph. The Y axes will reflect your selection.
- Change Units and other preferences.
- Change Channel Settings: Redefine the display options for a pressure channel. Refer to Section 7 for details on the settings.



To resize the graph, drag the dividing line with the stylus.

Switch to text view

Select channels, change units and other preferences

CHANGING THE DATA DISPLAY

The **View** button launches wizards to let you change the way test data are displayed.

- Select Channels to View (Report view): Tap Next, then tap a check box to show or hide a channel. Finish returns to the Report view.
- Change Units and other preferences.
- Change Channel Settings: Redefine the display options for a pressure channel. Refer to Section 7 for details on the settings.

TRANSFERRING DATA TO EXCEL FROM WIN-SITU 4

1. Select Report view.
2. On the File menu, select Export to Excel. If Microsoft® Excel® is properly installed on your PC, the data file will open in an Excel spreadsheet.

PRINTING DATA IN WIN-SITU 4

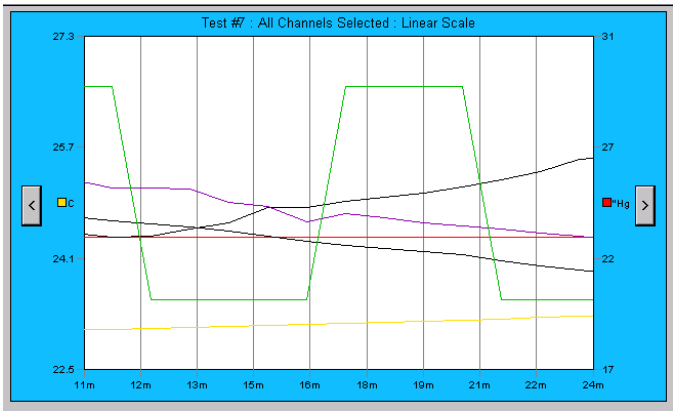
To print the graph or report as currently displayed:

1. Select Graph or Report view as desired.
2. On the File menu, select Print graph or Print report.

Addtional information is available from your printer documentation.

SAVING TEXT FILES FROM WIN-SITU 4

1. Select Report view.
2. On the File menu, select Save Report.
3. In the window that opens, supply a filename in the usual way; the report will automatically be given a .TXT file type.



This graph was created with the following controls: Number of Graphs: One Graph, All channels selected, Zoomed in on 11-22 minutes, Vertical grid.

7 MONITORING PRESSURE (WATER LEVEL)

WHY MONITOR PRESSURE?

Water level or pressure head readings are taken for a number of reasons. In aquifer characterization, this type of data will help the user determine important hydrologic parameters of an aquifer, including hydraulic conductivity, transmissivity, permeability, storage coefficient, dispersivity, and porosity. Some or all of these parameters are important in the design of wells and well fields for various purposes.

In the design of a remediation system, the proper placement of wells for monitoring or extraction is of paramount importance if the system is to function effectively. Accurate data from slug and pump testing is one of the primary tools employed for aquifer characterization in the design process.

Step testing and constant-rate pump testing yield significant data in determining proper pumping rates. Improper rates can lead to aquifer depletion, salt water intrusion, and several other problems. Accurate data in designing the system and monitoring the system is essential for long-term success of the well and the proper maintenance of the aquifer.

The collection and use of water level measurements in the mining and coal bed methane industries are essential for the success of the mines and wells. Data derived from pilot testing of water wells constructed for coal bed methane extraction provide necessary information on bottom-hole pressure and appropriate pumping rates to accomplish the de-watering necessary to release the methane gas. Monitoring of water levels assures efficient production.

Water level measurements of surface water by pressure measurements yield significant data about the overall health of the hydrologic cycle. This information is also useful to government, agriculture, and industry as well as the scientific community when planning water use and when adjudicating water rights issues.

THE PRESSURE SENSOR

The optional pressure sensor of the Multi-Parameter TROLL 9500, if included, is permanently-installed and factory-calibrated. If your MP TROLL 9500 was ordered without a pressure or turbidity sensor, there will be a permanently installed plug in the pressure sensor slot. A pressure sensor can be added at the factory.

Do not try to remove the pressure sensor or permanently installed plug.

FACTORY CALIBRATION

The pressure sensor is calibrated across full pressure over a range of -5° to 50°C. The pressure reference is provided by a pressure control and measurement system (PCMS) that supplies a calibrated and certified pressure to the pressure sensor. The temperature reference is provided by a water bath with a thermal homogeneity of 0.0008 °C and measured with calibrated and certified digital thermometers. The calibration process results in a data set of raw analog to digital conversions (A/D readings) for both pressure and temperature from the device versus actual pressure and actual temperature from the calibrated references.

Pressure sensor

From a two-dimensional data set of temperature A/D versus reference temperature, and a three-dimensional data set of pressure A/D versus temperature A/D and reference pressure, numerical coefficients are generated to equations that map the MP TROLL performance across all temperatures and pressures.

OPERATING PRINCIPLE

A pressure transducer senses changes in pressure, measured in force per square unit of surface area, exerted by a column of water or other fluid above an internal media-isolated strain gauge. Common measurement units are pounds per square inch (psi) or newtons per square meter (Pascals).

NON-VENTED (ABSOLUTE) VS. VENTED (GAUGED) SENSORS

A non-vented or "absolute" pressure sensor measures all pressure forces detected by the strain gauge, including atmospheric pressure. Its units are **psia** (pounds per square inch "absolute"), measured with respect to zero pressure. Absolute pressure sensors are sometimes called "sealed gauge" sensors.

Absolute pressure measurements are useful during vacuum testing, in very deep aquifers where the effects of atmospheric pressure are negligible, and in unconfined aquifers that are open to the atmosphere.

With vented or "gauged" pressure sensors, a vent tube in the cable applies atmospheric pressure to the back of the strain gauge. The basic unit for vented measurements is **psig** (pounds per square inch "gauge"), measured with respect to atmospheric pressure. PSIG sensors thus exclude the atmospheric or barometric pressure component.

This difference between absolute and gauged measurements may be represented by a simple equation:

$$P_{gauge} = P_{absolute} - P_{atmosphere}$$

If your MP TROLL 9500 includes a pressure sensor, it is either absolute or gauged. The pressure sensor type is not software-selectable.

However, psia measurements from absolute pressure sensors can be readily compensated for atmospheric pressure in the software due to the presence of the MP TROLL 9500's onboard barometric pressure sensor, as long as the instrument is connected to vented cable. See "Correcting Absolute Pressure Readings for Barometric Pressure" later in this section.

PRESSURE VS. DEPTH VS. LEVEL

Display options for pressure measurements are completely software-selectable. Pressure sensor data may be displayed as raw pressure head, as depth, or as water level with a reference. When choosing depth or level, the software presents additional options for converting from pressure readings (in psi) to depth or level (in feet or meters), including a very accurate conversion that compensates pressure readings for fluid density, altitude, and latitude.

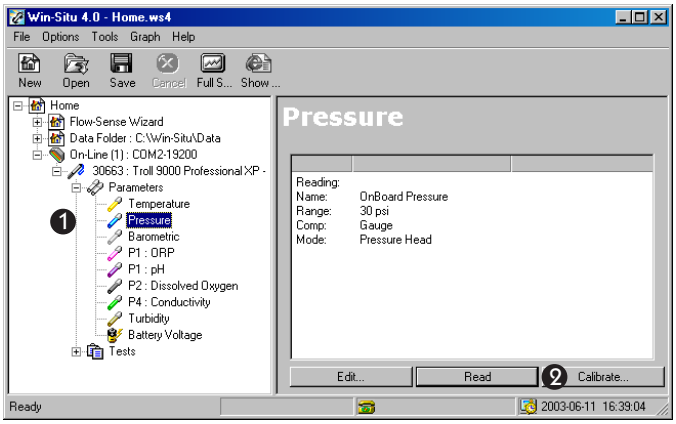
ZEROING THE PRESSURE SENSOR

The following procedure may be used, **with caution,** to "zero" the offset of a pressure sensor to correct for electronic drift. The drifted offset is visible when the sensor is in air and reading other than zero.

It is recommended you **do not** zero the offset if it is outside the specified accuracy of your pressure sensor, as shown in the table below. If the reading in air deviates from zero by more than the amounts shown, you may want to consider a factory recalibration. See the Appendix for additional information on electronic drift.

Sensor range	Accuracy (% full scale)	Acceptable Offset from zero
15 psig	± 0.05% FS	± 0.0075 psig
30 psig	± 0.05% FS	± 0.015 psig
100 psig	± 0.05% FS	± 0.05 psig
300 psig	± 0.05% FS	± 0.15 psig

1. With the MP TROLL connected to a host PC and selected in the Navigation tree, click or tap the Pressure parameter in the Parameters list.
2. Click or tap **Calibrate**. You will be prompted to ensure the device is in air.



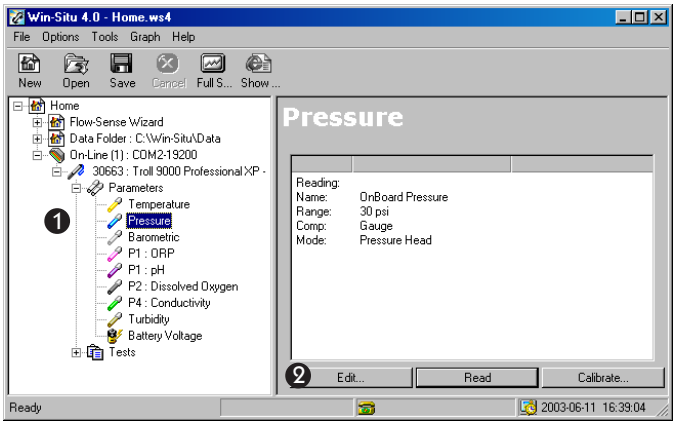
3. When the device is in air, click Yes.

The current pressure reading will be set to zero. To check this, take a reading with the "Read" button.

SETTING UP PRESSURE MEASUREMENTS: THE PARAMETER WIZARD

Win-Situ's Parameter Wizard can help you configure a pressure channel to display measurements just as you want them. The specified settings are easily changed from one mode to another, and any choice can be redone or undone later, when viewing test data.

1. With the MP TROLL connected to a host PC and selected in the Navigation tree, select the pressure parameter.
2. Click or tap ***Edit...***. The Parameter Wizard starts. The choices are discussed below.



3. When you finish the Wizard, Win-Situ sends the information to the device and updates the display.

PRESSURE SETUP CHOICES

Win-Situ prompts for the following when editing a pressure channel. You may not see all of these depending on your early choices.

What do I get with out-of-the-box pressure measurements (no setup)?

The pressure channel defaults in Win-Situ and Pocket-Situ result in the following measurements, with no setup:

- *Pressure head is measured*
- *Default units are psi*
- *No conversion from psi to depth/level*

Remember that all these settings can be changed quite easily when you view the data after the test.

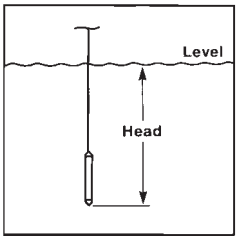
1. NAME (OPTIONAL)

The pressure channel name is displayed in the Information pane and in test data files. A default name is proposed. If you choose, you may enter a custom name (up to 16 characters).

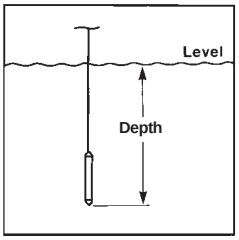
2. DISPLAY MODE

Select one of the following. Subsequent screens will be tailored to your choice.

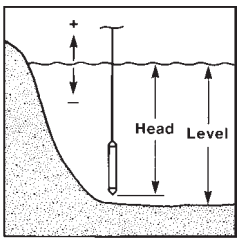
- **Pressure Head** displays the raw pressure exerted by the column of water above the pressure sensor, in kiloPascals or pounds per square inch (psi). If you choose this mode, click Finish to end the Wizard. Then select units on Win-Situ's Options menu.



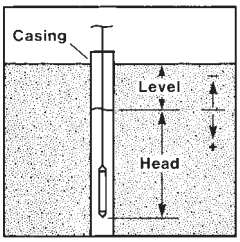
- **Depth** converts the pressure of the water column to a depth reading, in meters, centimeters, feet, or inches. If you choose this mode, you will be asked to choose a method for converting pressure to depth. Then select units on Win-Situ's Options menu.



- **Level - Surface:** Commonly used for surface water elevations. Data file readings are "positive up." Increasing water levels will result in increasing readings. Decreasing water levels correspond to decreasing readings.



- **Level - Top Of Casing:** Commonly used for drawdown in groundwater wells. This mode is "positive down." *Decreasing* water levels correspond to *increasing* readings, because the water level is getting further from the top of the well casing. *Increasing* water levels result in *decreasing* readings.



If you select depth or a level mode, you will be asked to choose a method for converting pressure to depth or level. For a level mode, you will be prompted to enter a level reference.

3. CONVERTING PRESSURE TO DEPTH OR LEVEL

The conversion from pressure in pounds per square inch (psi) to depth or level in meters or feet requires some knowledge of the properties of the fluid being monitored and optionally of the device's location on the earth's surface.

Conversion Using Specific Gravity

Pressure may be adequately converted to feet or meters of fluid using a dimensionless specific gravity value. A specific gravity of 1.0 (characteristic of pure water at 4°C) is adequate for many groundwater applications.

Conversion Using Density, Latitude, and Elevation

Pressure in the English unit psi is first converted to the SI unit Pascal (Pa). Conversion from Pascals to meters or feet requires two additional values:

- **Liquid Density.** Pure groundwater at 20°C has a density of 0.998 g/cm^3. A table of density by temperature appears on this page. The Appendix includes a method to experimentally determine liquid density if the working fluid is not pure water.
- **Gravitational Acceleration.** The acceleration due to gravity that an object experiences is location-specific. Given your latitude and elevation, Win-Situ can calculate a value for gravitational acceleration for your location.

TIP: *Either specific gravity or density, latitude & elevation may be used to convert from pressure (psi) to depth/level (meters or feet). A gain in accuracy may be realized by selecting the density, latitude & elevation option.*

4. LEVEL REFERENCE

If you selected a level display mode (Surface or Top of Casing), you will be prompted to enter a level reference. This is a user-specified starting point for level display modes, and can be any value you choose. Here are some examples:

- Surface: If you calculate the water level above mean sea level (MSL) and enter this as the Level Reference, then data will be displayed as elevations above MSL.
- Top of Casing: If you measure the distance to the water surface (DTW) from the top of the well casing and enter this number as the Level Reference, then data will be displayed as DTW values.
- A Level Reference of 0 is equivalent to "zeroing" the probe. Data will be displayed as changes, either positive or negative, from the starting water level.

Reference Time

The MP TROLL takes a "snapshot" of the sensor's raw pressure reading, then your Level Reference is substituted. You can specify that the snapshot be taken now or when the test starts. The data file will show the Reference (raw pressure) Reading and when it was taken.

- **Now:** the pressure is measured when you finish setting up the pressure parameter, and the value is stored until the test starts. All measurements taken during the test will be relative to the water level at the time you finished the wizard.
- **Start of Test:** the Reference measurement will be taken at time t=0. All measurements taken during the test will be relative to the water level at the moment the test starts.

LIQUID DENSITY

The conversion from PSI units to meters or feet of fluid requires several conversion factors. One of these is the density (ρ) of the aqueous solution being monitored. Pure groundwater at 20°C has a density of 0.998 grams per cubic centimeter (g/cm^3).

Use the values in the table below for density if you do not otherwise know it. However, since these data assume pure water, there is no accommodation for other variables (such as salinity) that can affect your actual water conditions. Alternatively, you could compute the fluid density using the procedure given in the Appendix to this manual.

TIP: *After setting up the pressure channel with the desired display options, select the units you want to see. Use Win-Situ's Options menu, or Pocket-Situ's Setup button.*

Fluid density by temperature

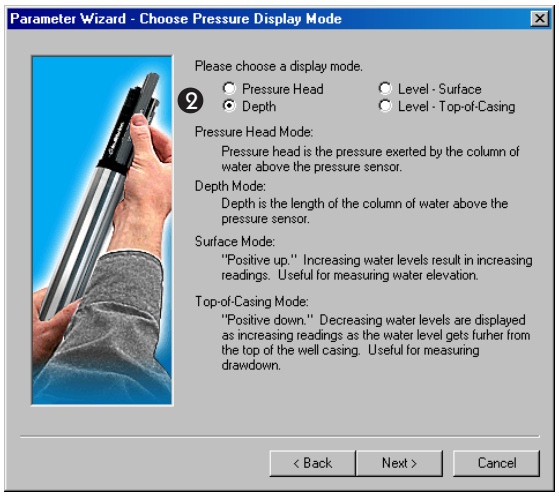
Temp. (°C)	Density (g/cm^3)	Temp. (°C)	Density (g/cm^3)	Temp. (°C)	Density (g/cm^3)
1	0.999900	11	0.999605	21	0.997992
2	0.999941	12	0.999498	22	0.997770
3	0.999965	13	0.999377	23	0.997538
4	0.999973	14	0.999244	24	0.997296
5	0.999965	15	0.999099	25	0.997044
6	0.999941	16	0.998943	26	0.996783
7	0.999902	17	0.998774	27	0.996512
8	0.999849	18	0.998595	28	0.996232
9	0.999781	19	0.998405	29	0.995944
10	0.999700	20	0.998203	30	0.995646

QUICK SUMMARY OF PRESSURE SETUP

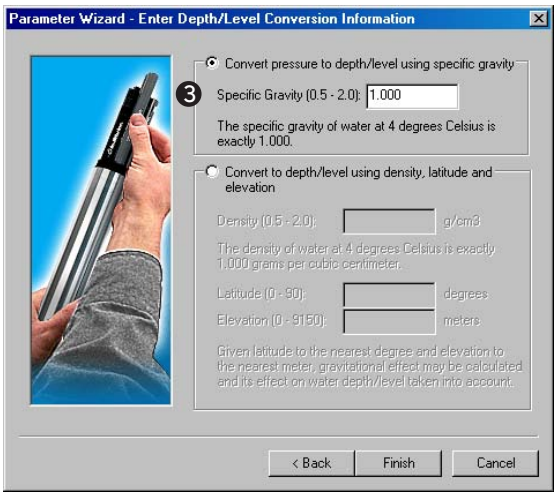
For **DEPTH:**

1 Select Pressure in Parameters list, select Edit

2 **Display Mode:** Select Depth, click Next.



3 Select Depth/Level Conversion: Specific Gravity 1.0. Click Finish.



For **AQUIFER TESTING:**

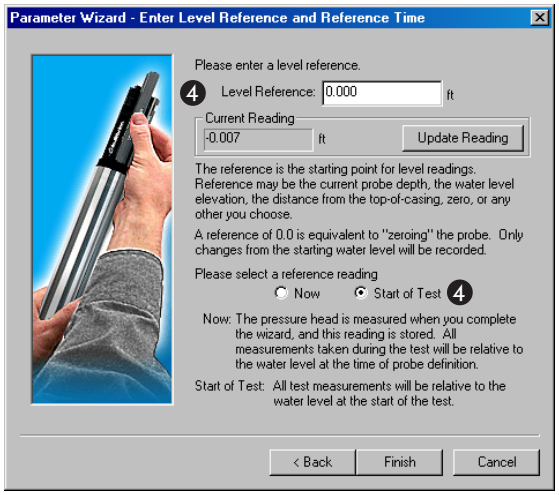
1 Select Pressure in Parameters list, select Edit

Display Mode
Depth/Level Conversion Specific Gravity 1.0

2 **Display Mode:** Select Level - Top of Casing, click Next.

3 Select Depth/Level Conversion: Specific Gravity 1.0. Click Next.

4 Select Level Reference 0 & Reference Reading Start of Test. Click Finish.



For **SURFACE WATER MONITORING** (install probe before setting these):

Display Mode	Level - Surface
Depth/Level Conversion	Specific Gravity 1.0
Level Reference	Current elevation or gauge height of water surface
Reference Reading	Now (with probe installed)

After setting the pressure mode, select the **UNITS** you want:

Win-Situ: Options menu > Preferences, scroll down to **LEVEL/DEPTH**, select unit, click OK

Pocket-Situ: Tap Home at top of screen, tap Setup at bottom of screen, scroll down to **LEVEL/DEPTH**, select unit, click OK

INSTALLATION FOR PRESSURE/LEVEL MEASUREMENT

Position the instrument below the lowest anticipated water level, but not so low that its range might be exceeded at the highest anticipated level. Lower the MP TROLL 9500 gently to the desired depth.

Pressure Sensor Pressure Ratings

Range		Usable Depth	
kPa	PSI	Meters	Feet
103.4	15	11	35
206.8	30	21	69
689.5	100	70	231
2068	300	210	692

If real-time readings are not required, remove the TROLL Com from the cable after programming. Protect the "uphole" end of the cable with the dust cap or optional desiccant. If cable will not be used, attach a Twist-Lock Hanger to the TROLL 9500.

SECURING THE CABLE

The RuggedCable has a handy device called a Kellems® grip near the surface end. You can slide it along the cable to the desired position by compressing it. When you pull on it, it tightens and stops sliding. You may need to pull on both ends of the Kellems grip to properly tighten it and keep it from slipping.

Kellems grip

Use the loop of the Kellems grip to anchor the cable to a convenient stationary object. It works well with In-Situ's "well dock" installation ring. Simply insert the loop into the locking clip on the well dock, and position the assembly on the top of a well. Insure the cable is secured to prevent the instrument moving while data is being logged.

STABILIZATION TIME

Allow the instrument to stabilize to the water conditions for *about an hour* before starting a test. A generous stabilization time is always desirable. Even though the cable is shielded, temperature stabilization, stretching, and unkinking can cause apparent changes in the probe reading. If you expect to monitor water levels to the accuracy of the probe, it's worth allowing the extra time for the probe to stabilize to the test environment.

TWIST-LOCK HANGER INSTALLATIONS

The non-vented Twist-Lock hanger accessory can be used to suspend a pre-programmed MP TROLL 9500 in a well or other site while taking data where barometric pressure changes are not crucial.

The Twist-Lock hanger allows use of inexpensive hanging cable, and requires no direct communication and no cable venting. This setup is ideal for use where barometric compensation of pressure measurements is not required—in vacuum testing, unconfined aquifers, or very deep applications where barometric pressure effects are minimal.

- Because the Twist-Lock Hanger has no communication capabilities, you must program the MP TROLL 9500 before installation
- Logged pressure data will show the effects of changes in barometric pressure. However, post-processing tools may be used to eliminate the effects of barometric pressure changes from the data, if required. See "Correcting Absolute Pressure Readings for Barometric Pressure" below for more information.

Installation Tips for Level/Depth/Pressure Monitoring

- Never let a probe "free fall" down a well. The resulting shock wave when it hits the water surface can damage the pressure sensor strain gauge (the "waterhammer" effect), as well as other sensors.
- It is always wise to check the level of water above the probe, then move it and read again to be sure that the probe is giving a reasonable reading and showing change. It might not be located where you think it is — for example, it could be wedged against the casing with a loop of cable hanging below it. A probe in such a position might become dislodged and move during the test, giving a false change in level. *A secure placement is critical to accurate level measurements.*
- When monitoring pressure with vented cable, do not allow the cable (and its internal vent tube) to kink or bend. If the vent tube is obstructed, water level measurements can be adversely affected. The vent tube can become kinked and damage the internal components without any visible harm to the outside of the cable. The recommended minimum bend radius is 63.4 mm (about 2½ in) or more.
- Do not position the instrument below the level of the pump in a pumping well. The pressure transients generated by the pump will cause false level readings. Large pumps can swallow the probe and cause permanent damage to both the MP TROLL 9500 and the pump.

CORRECTING ABSOLUTE PRESSURE READINGS FOR BAROMETRIC PRESSURE

Pressure measured with an "absolute" or "non-vented" (psia) pressure sensor includes all pressure forces detected by the strain gauge—atmospheric pressure as well as the pressure due to the water column. "Gauged" or "vented" (psig) sensors remove the atmospheric pressure component (pressure due to the atmosphere), so that atmospheric pressure on a water surface is not doubled in the measurements from a sensor under the water surface.

Barometric compensation of absolute pressure measurements, if required, may be accomplished in a couple of ways.

MANUAL BAROMETRIC PRESSURE COMPENSATION

Using the MP TROLL's Barometric Pressure Sensor

If your model of MP TROLL 9500 includes an onboard barometric pressure sensor, and the instrument is attached to vented cable, the barometric pressure sensor output can be used to correct measurements from a submerged absolute (psia) pressure sensor. In this case, set up the pressure channel in "pressure head" mode, and select the same units for both the water pressure channel and the barometric pressure channel. Set up and run a test that includes both pressure channels. Extract (download) the data, and subtract the barometric pressure measurements from the water pressure measurements.

Using a Second Unit and a Spreadsheet

If a barometric pressure sensor is not present, and/or the cable is not vented, barometric compensation of absolute pressure measurements may be accomplished with the use of a separate device—a Baro TROLL or Absolute miniTROLL—installed above the water surface, taking barometric pressure measurements. Set up both devices to use the same units and display mode—the only difference will be if a level reference is used; in that case the barometric reference should be zero, the downhole reference will be the water level. Schedule tests to start at the same time in each unit. Extract (download) the data from both tests, and subtract the barometric pressure measurements from the water pressure measurements (by hand or in a spreadsheet).

TIP: *For additional information on correcting absolute pressure measurements, see Technical Note 13 in the Downloads section of our website at www.in-situ.com.*

AUTOMATIC BAROMETRIC PRESSURE COMPENSATION

A Baro Wizard in Win-Situ and Pocket-Situ allows for automatic barometric pressure compensation of absolute pressure data, either using a fixed user-specified value or by reference to a file of barometric pressure data collected at the same time by a BaroTROLL or other absolute (psia) instrument installed at the surface. The barometrically corrected absolute pressure data may be saved in a new file, if desired.

Collecting Barometric Pressure Data for Reference

Be sure to set the clock in the BaroTROLL (or other absoltue instrument). Add a test. Ideally, this test should start before the test in the Absolute MP TROLL 9500 starts and log data on approximately the same schedule. Run the test. Extract the test (it is not necessary to stop it.)

Collecting PSIA Data

Set the clock in the Absolute MP TROLL 9500. Add a test and run it as usual. Extract this test also.

Using the Baro Wizard

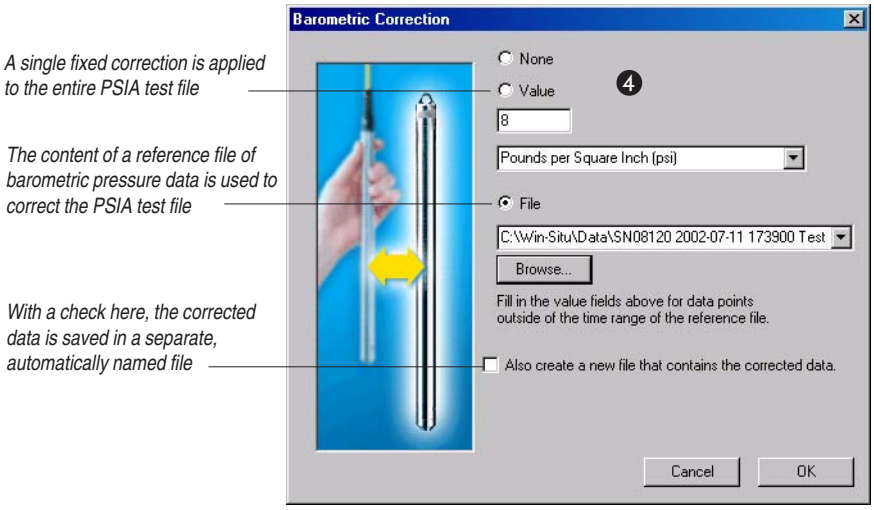
The difference in pressure between a BaroTROLL at the surface and a submerged MP TROLL 9500 with an absolute (psia) pressure sensor can be calculated from extracted test data files. This task is simplified if the BaroTROLL test covers the entire duration of the Absolute instrument's test.

1. Launch Win-Situ 4 or Pocket-Situ 4. Connection to an instrument is not necessary after the tests have been extracted.
2. In the data folder, select a test extracted from an MP TROLL 9500 with an Absolute pressure sensor (PSIA data).
3. On the Tools menu, select Baro Wiz.

4. In the Barometric Correction window, select the type of correction to be performed:
   - None
   - Value: Enter a barometric pressure value to be subtracted from all data points in the test file. Units are selectable, and your entry is checked for validity. For example, in inches of mercury the valid range is 14.3 to 33.5 (covering altitudes from the Alps to the Dead Sea). You may not leave this entry blank, because a fixed value will be needed even with a reference file (next option, see below) in case the time stamps in the two files do not completely overlap.
   - File: Select a test of barometric pressure data collected by a BaroTROLL or other PSIA instrument. This becomes the Reference file from which barometric pressure corrections will be derived. If the time stamps in the files do not overlap completely, the fixed value will be applied.
5. To save the corrected data in a new file that will be automatically named, check the create new file checkbox.
6. Click OK. The correction is performed immediately and the corrected file is displayed.

RECALIBRATION RECOMMENDATIONS

Pressure sensor accuracy can be adversely affected by improper care and handling, lightning strikes and similar surges, exceeding operating temperature and pressure limits, physical damage or abuse, as well as normal drift in the device's electronic components. Aside from damage to the sensor, the need for factory recalibration is dependent upon the amount of drift a customer is willing to tolerate. Factory calibration every 12-18 months is recommended. Contact In-Situ Customer Service for information on the factory maintenance and calibration plan. Calculations of the accuracy drift of the MP TROLL 9500 over time are contained in the Appendix of this manual. Contact In-Situ Customer Service for information on periodic check-ups and recalibration.



8 MONITORING TEMPERATURE

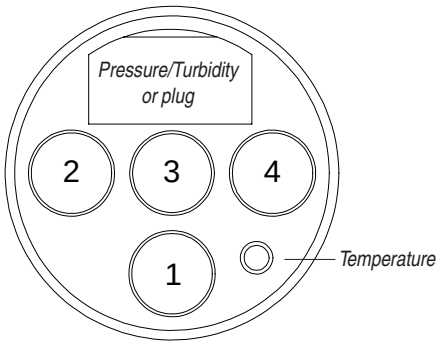
WHY MONITOR TEMPERATURE?

Water temperature plays an important role in water chemistry, which in turn influences the biological activity and growth of aquatic organisms. In general, the higher the water temperature, the greater the biological activity and the rate of chemical reactions. An important example of the effects of temperature on water chemistry is its impact on oxygen. Warm water holds less oxygen than cool water; the maximum amount of oxygen that can be dissolved in the water decreases as water temperature increases.

Artificially high temperatures are often referred to as "thermal pollution," which may result from discharge of municipal or industrial effluents. Thermal pollution can have a significant ecological impact. In running waters, particularly small urban streams, elevated temperatures from road and parking lot runoff can be a serious problem for populations of cool or cold-water fish.

Changes in the growth rates of cold-blooded aquatic organisms and many biochemical reaction rates can often be approximated by the "Q_{10} rule," which predicts that growth rate will double if temperature increases by 10°C (18°F) within their "preferred" range.

End view of sensor block



Knowledge of water temperature is essential to the measurement of dissolved oxygen, conductivity (salinity), pH, and many other water-quality parameters. In limnological studies, water temperature as a function of depth can be an important indicator. Industrial plants often require data on water temperature for process use or heat-transmission calculations.

These are only a few of many reasons for measuring and recording water temperature over the short or long term.

THE TEMPERATURE SENSOR

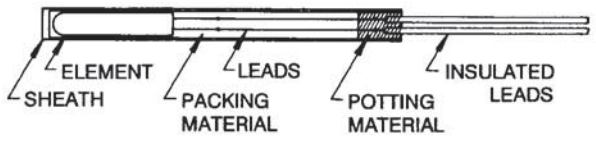
All models of the Multi-Parameter TROLL 9500 include a permanently installed, factory-calibrated sensor for measuring solution temperature.

Do not try to remove the permanently installed temperature sensor.

The MP TROLL 9500 temperature sensor is the Standard Platinum Resistance Thermometer specified by the ITS-90 (International Temperature Scale of 1990). A platinum resistance thermometer (PRT) is a type of resistance temperature detector (RTD).

TIP: *After a drop or shock, if the end of the temperature sensor is slightly bent, it may be carefully bent by hand (no tools, please!) back to its original alignment. Note that a severe shock may affect the accuracy of the temperature sensor.*

Platinum Resistance Thermometer



ROLE OF THE SENSOR IN CALIBRATION

The temperature sensor has a primary function during calibration of temperature-dependent water-quality parameters such as conductivity. When the calibration temperature is known, temperature compensation can be provided during measurement of water-quality parameters. The temperature sensor also provides continuously updated real-time measurements of solution temperature when profiling.

Ensure that the temperature sensor is immersed in at least one-half inch of solution during calibration of all parameters. The fill line on the Cal Cup serves as a guide to the recommended quantity of calibration solution.

For best results, the water-quality sensors should be calibrated at the same temperature that will be encountered in the field.

SOFTWARE FUNCTIONS

Conversion of resistance (measured by the PRT) to temperature is automatic in the software. No user calibration is required.

The temperature channel is automatically included in tests so that solution temperature is available to compensate water-quality data from other channels.

UNITS

Temperature may be displayed in degrees Celsius (°C) or degrees Fahrenheit (°F).

TIP: *To change unit preferences: In Win-Situ, select Preferences on the Options menu. In Pocket-Situ, select the Home site, then tap Setup in the command bar.*

REFERENCES

Eaton, A.D., L.S. Clesceri, E.W. Rice, and A.E. Greenberg, eds., *Standard Methods for the Examination of Water and Wastewater,* 21st edition, Washington, D.C.: American Public Health Association, American Water Works Association, and Water Environment Federation, 2005. Section 2550, Temperature.

EPA, Methods for Chemical Analysis of Water and Wastes, EPA/600/4-79-020, revised March 1983. Method 170.1, Temperature, Thermometric. Approved at 40 CFR Part 136.

Mangum, B.W., and G.T. Furukawa, *Guidelines for Realizing the ITS-90,* NIST Technical Note 1265, U.S. Department of Commerce, 1990.

Water on the Web (WOW). University of Minnesota project initially funded by the National Science Foundation. On the web at wow.nrri.umn.edu.

9 MONITORING BAROMETRIC PRESSURE

WHAT IS BAROMETRIC PRESSURE?

Barometric, or atmospheric, pressure is the force exerted by the gases in the atmosphere everywhere on the surface of the earth. Barometric pressure is greatest at or below sea level, and decreases as altitude above sea level increases.

WHY MONITOR BAROMETRIC PRESSURE?

Barometric pressure influences the measurement of water levels in water bodies that are open to the atmosphere. It also determines the amount of atmospheric gases that can be dissolved in water; more oxygen, for example, can be dissolved in water at higher barometric pressure (lower altitude). Barometric pressure additionally influences other water-quality parameters such as pH.

A logged record of barometric pressure data during a test can be used to correct water level measurements made with an absolute pressure sensor to factor out the effects of barometric pressure fluctuations.

To measure barometric pressure, the probe must be vented to the atmosphere. A submerged Multi-Parameter TROLL on non-vented cable cannot accurately report barometric pressure.

If your MP TROLL 9500 is used with a non-vented backshell and/or non-vented cable, a software correction can substitute for barometric pressure venting. See the procedure in this section.

THE BAROMETRIC PRESSURE SENSOR

Most models of the Multi-Parameter TROLL 9500 include a permanent, factory-calibrated internal barometric pressure sensor. Its primary function is in calibration and measurement of water-quality parameters, such as dissolved oxygen, that are dependent upon barometric pressure. It may also be used to compensate fluid pressure measurements made with an absolute pressure sensor.

The sensor is automatically included in tests so that its value is available to compensate water-quality data from other channels.

UNITS

The following units are available for barometric pressure: Bars, milliBars, inches of mercury (in. Hg or " Hg), millimeters of mercury (mm Hg), cm, pounds per square inch (psi)

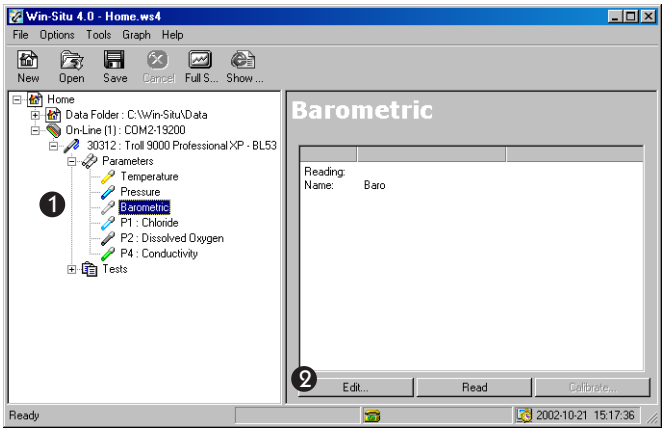
***TIP:** To change unit preferences: In Win-Situ, select Preferences on the Options menu. In Pocket-Situ, select the Home site, then tap Setup in the command bar.*

COLLECTING ACCURATE MEASUREMENTS WITHOUT VENTED CABLE

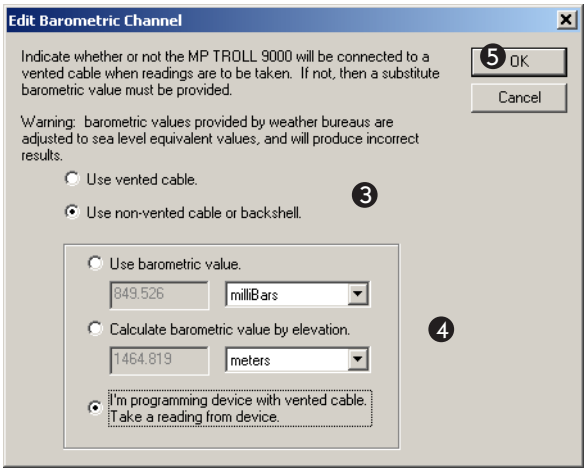
Win-Situ and Pocket-Situ cannot determine whether the MP TROLL 9500 is on vented or non-vented cable. However, you can supply the software with this information, and also enter a fixed barometric pressure value to be used in the absence of cable venting.

Procedure:

1. Select the barometric channel in the Navigation tree.



2. Click or tap **Edit...**. The Edit Barometric Channel screen appears. Several options are presented:



3. Do one of the following:

   - If this MP TROLL 9500 has a barometric pressure sensor and **vented** cable, select "Use vented cable." Go to step 5.
   - If the device is on **non-vented** cable now and will take measurements using **non-vented** cable, select "Use non-vented cable or backshell." Continue to step 4.
   - If the TROLL is on **vented** cable now but will take measurements on **non-vented** cable, select "Use non-vented cable or backshell" and also check the last box so a reading can be taken from the barometric pressure sensor while it is available.

4. Supply a barometric pressure value for the software to use in the absence of vented cable. Choose one of these options:

   - Supply a fixed pressure value in your choice of units (select units by clicking the arrow on the list box). This value will be used each time barometric pressure is required elsewhere in the software—for example, when calibrating dissolved oxygen.
   - Enter your elevation and let the software calculate barometric pressure based on the values in the table on this page. Please note that *this fixed value will not be recalculated if the elevation changes.*

5. Click **OK** to store this information.

Conversions
bars ∗ 29.530 = inches of mercury
psi ∗ 2.036 = inches of mercury
atmosphere ∗ 101325 = Pascals
psi ∗ 6.894757 ∗ 10^3 = Pascals
bars ∗ 14.50337 = psi

PRESSURE VS. ELEVATION

(based on U.S. Standard Atmosphere)

Elevation		Pressure			
ft	m	in. Hg	mm Hg	PSI	Bars
-1,000	-304.8	31.02	787.9	15.25	1.051
- 500	-152.4	30.47	773.8	14.94	1.030
0	0	29.92	760.0	14.70	1.013
500	152.4	29.38	746.4	14.43	0.995
1,000	304.8	28.86	732.9	14.18	0.977
1,500	457.2	28.33	719.7	13.90	0.958
2,000	609.6	27.82	706.6	13.67	0.942
2,500	762	27.31	693.8	13.41	0.924
3,000	914.4	26.81	681.1	13.19	0.909
3,500	1066.8	26.32	668.6	12.92	0.891
4,000	1219.2	25.84	656.3	12.70	0.875
4,500	1371.6	25.36	644.2	12.45	0.858
5,000	1524	24.89	632.3	12.23	0.843
5,500	1676.4	24.43	620.6	12.00	0.827
6,000	1828.9	23.98	609.0	11.77	0.811
6,500	1981.2	23.53	597.6	11.56	0.796
7,000	2133.6	23.09	586.4	11.34	0.781
7,500	2286	22.65	575.3	11.12	0.766
8,000	2438	22.22	564.4	10.90	0.751
8,500	2590.8	21.80	553.7	10.70	0.737
9,000	2743.2	21.38	543.2	10.50	0.723
9,500	2895.6	20.98	532.8	10.30	0.710
10,000	3048	20.58	522.6	10.10	0.696
10,500	3200.4	20.18	512.5	9.91	0.692
11,000	3352.8	19.79	502.6	9.73	0.670
11,500	3505.2	19.40	492.8	9.53	0.657
12,000	3657.6	19.03	483.3	9.35	0.644
12,500	3810	18.65	473.8	9.15	0.631
13,000	3962.4	18.29	464.5	8.97	0.618
13,500	4114.8	17.93	455.4	8.81	0.607
14,000	4267.2	17.57	446.4	8.63	0.595
14,500	4419.6	17.22	437.5	8.46	0.583
15,000	4572	16.88	428.8	8.28	0.571
15,500	4724.4	16.54	420.2	8.13	0.560
16,000	4876.8	16.21	411.8	7.96	0.549
16,500	5029.2	15.89	403.5	7.81	0.538

TIP: *This screen can also be accessed during test setup and dissolved oxygen calibration.*

10 MONITORING WATER QUALITY: OVERVIEW

WHY MONITOR WATER QUALITY?

At a time of increasing demands on the finite natural resources of our planet, public organizations and private individuals alike have become acutely aware of the responsibility to maintain the quality of the earth's air and water supplies.

Recent rapid advances in knowledge and technology have made it possible to deliver accurate, timely, and reliable data on processes we cannot necessarily examine visually. New-generation sensors for in-situ measurement of surface waters and groundwater can be an efficient alternative to time- and labor-intensive programs of field sampling and transportation to a laboratory for analysis, or can supplement such programs. If it is possible to collect, interpret, and respond in a timely fashion to accurate information about water supplies and water quality, we can design better systems for protection of those supplies.

Monitoring water-quality parameters can reveal much about the presence and movement of natural and unnatural components of water—the presence of harmful bacteria, potential pollution sources, depletion of nutrient requirements for aquatic life, salt-water intrusion into fresh water bodies, changes in water level or temperature that can alert observers to the onset of an "event" that can adversely affect the quality of the resource.

Monitoring water quality in surface and groundwater resources may be required by Federal, state, or local regulations. Digital records of monitoring can document compliance with guidelines and standards mandated by regulatory bodies.

Profiling and logging water-quality data can provide timely information on continually changing conditions—profiling to provide instantaneous real-time feedback, logging to track trends and demonstrate compliance.

THE SENSORS

The Multi-Parameter TROLL 9500 takes advantage of new technologies to monitor water-quality parameters in-situ with high accuracy. Each sensor has been manufactured to our rigid specifications and is designed to operate with the entire suite of sensors and with the MP TROLL 9500 electronics. These "smart" sensors retain serial number identification and calibration information, and are detected and identified by the instrument. A sensor may be calibrated in any MP TROLL 9500 and moved to another port that accepts the sensor type, or used in another MP TROLL 9500, without recalibration. The most accurate results will be obtained when a sensor is calibrated and operated in the same MP TROLL 9500.

The water quality sensors available for the Multi-Parameter TROLL 9500 may be classed in two general types:

BASIC SENSOR SET

- pH
- Combination pH/ORP (Oxidation-Reduction Potential)
- Dissolved Oxygen, polarographic (DO)
- Conductivity (and Specific Conductance, Salinity, Total Dissolved Solids, Resistivity)

The pH sensor is a Single ISEs (ion-selective electrode). The Combination pH/ORP sensor is a Multiple ISE.

The Basic sensors can be factory-calibrated and pre-installed in the MP TROLL 9500. They are ready for use right out of the box with a brief Quick Cal. However, for best results, if your software supports it, we recommend that you perform a traditional two-point calibration for pH and DO, and a specific range calibration for conductivity as described in sections 11-13 below. The accuracy that can be achieved from the instrument is proportional to the time and care you put into calibration.

EXTENDED SENSOR SET

The Extended Sensor set includes:

- Ammonium
- Chloride
- Nitrate
- Turbidity (factory-installed)
- RDO® Optical Dissolved Oxygen

INSTALLING SENSORS

The diagram below represents a head-on view of the "sensor block" in the front end of the MP TROLL 9500. There are four sensor ports, plus permanently installed pressure and/or turbidity and temperature sensors. Pressure and turbidity sensors are optional—if your instrument does not include one or both of these sensors, there will be a permanently installed plug in the port.

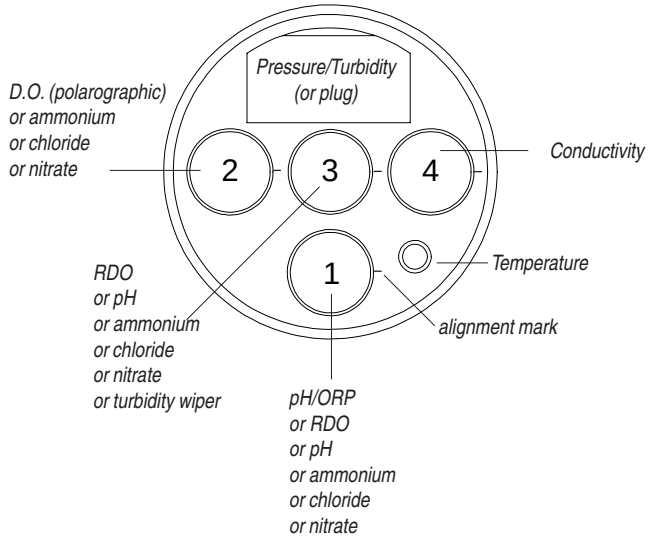
Do not try to remove the pressure or turbidity sensor or permanently installed plug.

Although the sensor design permits any sensor to install into any sensor port without damage to either the sensor or the instrument, for proper functioning please insure that sensors are installed in their intended ports, as shown in the diagram.

To install sensors:

1. Remove the restrictor or Cal Cup from the front end of the MP TROLL 9500. This allows access to the sensor block shown below.

End view of sensor block



Will a sensor work if installed in the wrong port?

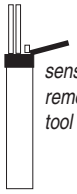
Physically, a sensor may be plugged into any port. However, a sensor that is detected in the wrong port for its type will generate an error message in the software. The message will let you know which port or ports the incorrectly installed sensor should be moved to.

In this case, remove the offending sensor and install it in the correct port. Then "refresh" the device view in the software to update the display.

2. Remove the cap or storage bottle from the sensor. Retain the cap or bottle for future storage and protection of the sensor. If the connector end is covered with a cap, remove it also.

***TIP:** To ensure optimum membrane response for new ion-selective electrodes (pH, ORP, nitrate, ammonium, chloride), soak the sensor in calibration solution for at least 15 minutes and up to several days before calibration.*

3. Remove any moisture or dirt from the area around the port where you will install the sensor, then use the sensor removal tool to remove the plug from the port. Retain the plug for use with fewer than 4 removable sensors installed.

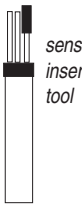


***TIP:** If you are installing a sensor in port 3 (the central port), install it first. This will make it easier to install sensors in other ports.*

4. Remove any moisture or debris from the connector in the bottom of the port with a clean swab or tissue.
5. Check lubrication of the sensor o-rings.

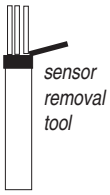
The sensor o-rings require generous lubrication before installation. New sensors will be lubricated at the factory. If the o-rings appear dry, apply a silicone lubricant before installation.

6. Align the mark on the sensor with the alignment mark on the correct port (see diagram), or visually align the sensor connector pins with the port connector pins.
7. Press the sensor firmly into the port until it is securely seated. When properly inserted a small gap (width of the sensor removal tool) remains between the instrument body and the widest part of the sensor, for ease of removal.



REMOVING SENSORS

Sensors may be removed for inspection, cleaning, routine maintenance, and storage. Because the smart sensors retain calibration information, they may be removed and re-installed—even in another MP TROLL 9500— as often as necessary.



Remove a sensor by positioning the yoke of the sensor removal tool at the point where the sensor enters the sensor block. Firmly pry the sensor upward until it pops out.

Sensor O-Rings

Two Viton® o-rings on each sensor provide a watertight seal against water leakage into the instrument body. We recommend that you inspect these o-rings each time you remove or install a sensor. Check carefully for cracks, tears, splitting, shredding, and other damage. If the o-rings are in good condition, apply silicone lubricant before installing the sensor again. Remove excess lubricant with a tissue, and take care to keep grease away from the area around the connector at the bottom of the sensor. Should lubricant get into this area, it can be removed with a clean cotton swab.

If the o-rings become damaged to the extent that no longer provide an effective seal, they should be replaced. Sensor o-rings and lubricant are available from In-Situ Inc. or your distributor.

CALIBRATION OVERVIEW

The MP TROLL 9500 and its control software provide several options for calibration of the water-quality sensors. Select the method that suits the time you have at your disposal and the degree of accuracy you want to achieve when measuring water-quality parameters.

Satisfactory results may be achieved using the Quick Cal procedure. Some sensors can even return nominal results straight out of the box using the factory-supplied default calibration coefficients. However, for best results we recommend a full traditional calibration procedure before the first field use, and periodic checks and recalibrations as necessary thereafter.

The following available options are briefly described in the next two pages:

- Traditional Calibration
- Quick Calibration
- Out-of-Box
- Factory Defaults

TRADITIONAL CALIBRATION

A full traditional calibration, guided by software wizards, can achieve the highest level of accuracy. Some sensors require a single-point calibration, others present a choice of single- or multi-point, requiring more than one calibration standard. A single-point calibration gives good results in the range of values represented by the selected calibration solution. When a wide range of values are expected, a multi-point calibration is recommended.

With the sensor installed in the MP TROLL 9000 and immersed in calibration solution, the sensor is powered at regular intervals and its response is monitored. The difference (deviation) between the minimum and maximum response over a predetermined time period is tracked by the software. When the peaks of the response fall within predetermined limits for the time period, the sensor response is considered sufficiently stable to provide a valid calibration point. The length of time and allowable deviation are specific to each sensor type, and furthermore are specific to the determination of nominal stability or complete stability. The time period of interest is shorter for nominal stability than for complete stability, allowing for a shortening of the calibration soak time while still returning a valid calibration point.

- Available for: All water-quality parameters.
- Requirements: MP TROLL 9500, sensors (installed), Cal Cup, and one or more calibration solutions for each parameter to be calibrated. Suitable calibration solutions are supplied in In-Situ's individual calibration kits.
- Where to find the method in this manual: Sections 11-19.

What is the difference between NOMINAL and STABLE?

To meet the criteria for a valid calibration point, the change (deviation) in sensor response is monitored over time. The software is looking for the calibration solution temperature and the sensor readings to settle over a specific time period. The criteria for STABLE are designed to meet the published specifications. The NOMINAL criteria are designed to shorten the calibration time when an approximate calibration is acceptable. When the deviation falls within the limits of the "loosened" specifications, NOMINAL is displayed in the Status area, and the Accept button becomes available to store the current calibration point.

Accepting a NOMINAL value may save considerable time. In some cases, especially if the sensors have been soaking in the solution for several minutes prior to calibration, the accuracy achieved by accepting a nominal value may be very similar to that obtained by waiting for complete stability.

QUICK CALIBRATION

A "Quick Cal" calibrates the Basic sensors simultaneously to achieve adequate performance with minimal labor using a single "universal" calibration solution.

- Available for: pH, ORP, polarographic Dissolved Oxygen, and Conductivity.
- Requirements: MP TROLL 9500, sensors (installed), Cal Cup, and Quick Cal solution.
- Where to find the method in this manual: Section 3, Getting Started.

OUT OF THE BOX

Some sensors may be installed and used right out of the box using factory-supplied default calibration coefficients.

- Available for: pH, ORP, and Conductivity.
- Requirements: MP TROLL 9500, sensors (installed).
- Where to find the method in this manual: No method required, plug-and-play.

DEFAULT COEFFICIENTS

This option resets the sensor's factory defaults and is best when the sensor is new.

- Available for: pH, ORP, and Turbidity.
- Where to find the method in this manual: See pH calibration in Section 11, ORP calibration in Section 14, Turbidity calibration in Section 18.

The cell constant for a conductivity sensor may be entered "by hand," without performing a complete calibration, if desired. See the procedure in Section 12 below.

TIP: *When using Pocket-Situ to perform calibrations, do not let the PDA time out during the procedure. To locate this setting in most PDAs, display the Start menu, select Settings, System tab, Power.*

PREPARING TO CALIBRATE

CALIBRATION KITS

Kits of calibration solutions for various parameters and ranges are available from In-Situ Inc. Our calibration solutions are certified to N.I.S.T. standards, packaged in quarts, each providing sufficient fluid for at least 6 calibrations. Kits include deionized water if that substance is recommended for rinsing a particular sensor during calibration.

The Quick Cal kit provides a convenient "universal" calibration solution, designed to calibrate multiple parameters simultaneously.

THE CALIBRATION CUP

The clear acrylic Cal Cup shipped with your MP TROLL 9500 is used to hold solution during sensor calibration. When fitted with a small moist sponge, it also provides a convenient way to protect and hydrate the sensors of the MP TROLL 9500 between uses.

The base of the Cal Cup is removable so that the stirrer may be attached for calibrations where continuous agitation of the solution is recommended. A small hole in the threads of the base near the o-ring permits venting during 100% dissolved oxygen calibration with the Cal Cup and probe inverted.

The Cal Cup's fill lines indicate the recommended amount of solution for most calibrations, and ensures the temperature sensor is immersed.

- With a full complement of sensors installed, use the lower line as a guide.
- With only 1 or 2 removable sensors installed, fill to the upper line.

The temperature sensor should always be immersed in at least one-half inch of fluid.

When attaching the Cal Cup to the front end of the MP TROLL 9500, align carefully and thread the Cal Cup onto the body until seated against the o-ring, then back off slightly to avoid overtightening.

When attaching the Cal Cup to the instrument body, be careful not to overtighten.

EFFECT OF TEMPERATURE ON CALIBRATION

The most successful calibrations reproduce field conditions as nearly as possible, especially temperature. It is best to calibrate at the expected field temperature.

RINSING

As a general guideline, we recommend you rinse the Cal Cup, the front end of the MP TROLL 9500, and the installed sensors prior to beginning calibration. This will remove trace contaminants or solutions used in previous calibrations, and prepare the instrument for a clean calibration.

A good way to do this is to fill the Cal Cup with water, attach to the instrument, and shake vigorously. This may need to be done a couple of times.

Rinse first in tap water, followed by a rinse with distilled or deionized water.

Shake or wipe with a clean lint-free tissue to dry. It is not necessary to dry thoroughly.

Some calibration procedures also recommend a rinse in the selected calibration solution. In this case, drying is not necessary.

STIRRING

When to Stir?

The stirrer accessory should be used during a calibration procedure if it will also be used during field use—for example, if the instrument will be in stagnant or very slowly moving water. The more closely calibration conditions reflect field conditions, the more successful the calibration. This is especially important when calibrating the ISE sensors (ammonium, chloride, and nitrate).

ISE sensors in close proximity to each other can sometimes create interferences. Constant stirring can enhance the performance of the ISE sensors.

Attaching the Stirrer for Calibration

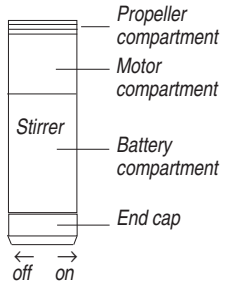
To use the battery-powered stirrer for calibration, attach it to the MP TROLL 9500 and Cal Cup as follows. See illustration C on the following page.

1. Remove the restrictor (nose cone attached) from the MP TROLL 9500 and set it aside.
2. Remove the black end cap from the Cal Cup.
3. Screw the top of the stirrer (propeller end) to the bottom of the Cal Cup (the end from which you just removed the end cap).
4. Fill Cal Cup to fill line with solution.
5. Attach Cal Cup/stirrer assembly to front end of MP TROLL 9500.

Starting the Stirrer

The stirrer is powered by two alkaline D-cells (installed). To start the motor, tighten the end cap.

The magnetic stir bar in the propeller compartment will start to spin. The stir bar is protected by a guard plate that may be removed for cleaning if necessary.



TIP: *Should the stir bar not start spinning, try giving it a gentle nudge by sliding a narrow tool such as a screwdriver or key between the protective bars of the guard plate.*

To turn the stirrer off, back off the end cap until the stir bar stops spinning.

CALIBRATION PROCEDURES

Refer to the following sections for specific calibration procedures and guidelines:

Quick Cal	Section 3
pH	Section 11
Conductivity	Section 12
Dissolved Oxygen (polarographic)	Section 13, first half
Dissolved Oxygen (optical)	Section 13, second half
ORP	Section 14
Ammonium	Section 15
Chloride	Section 16
Nitrate	Section 17
Turbidity	Section 18

AFTER CALIBRATION

When you finish calibrating with any method, the following happens:

- The newly calculated calibration coefficients are written to the "smart sensor" memory.
- You have the option of viewing the calibration report. The report may be viewed immediately after calibration, or at any time. See Calibration History, below.
- The sensors are ready to take measurements.

MP TROLL 9500
A. with restrictor and nose cone
B. with Cal Cup in place of restrictor and nose cone
C. with Cal Cup and stirrer, for stirring calibrations
D. with Restrictor and stirrer, for monitoring water quality in stagnant water

SENSOR STORAGE

It is best to calibrate just before field use. However, should you need to store calibrated sensors, there are a couple of options:

- If the instrument will be used in a day or so, leave the sensors installed. Remove the Cal Cup and rinse it and the sensors. Moisten a sponge and place it in the bottom, or add a little water (deionized, distilled, or tap) to the Cal Cup—just enough to create a moist environment. Return the probe to the Cal Cup for transport to the field site.

TIP: *Deionized water is preferred over tap water, but it is not essential; especially if the local tap water is of good quality.*

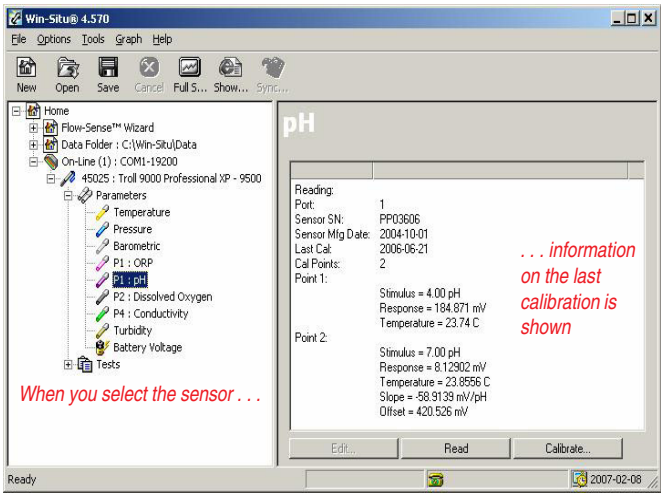
To seal the Cal Cup against leakage, seat it lightly against the o-ring on the instrument body. It is best not to overtighten.

- For longer storage, remove the sensors from the MP TROLL 9500. Store the conductivity sensor dry. Store the DO, pH, and pH/ORP sensors in their storage bottles (located in the sensor kits): DO in clean water, pH and pH/ORP in the solution they were shipped in, or with a moist sponge in the sensor storage bottle to avoid depleting the reference solution.

CALIBRATION HISTORY

Each time a sensor is calibrated, the information is written to the sensor, where it is stored until the next calibration. Details on the most recent calibration are displayed by the software when a parameter is selected in the Navigation tree.

The software also creates a calibration report in html format each time a sensor is calibrated. A separate report is created for every calibration of every parameter—even for a calibration that was cancelled. You have the option to view the report immediately after calibration. Reports are stored for later retrieval and reference in a folder named “Calibration Reports” in the folder where Win-Situ 4 or Pocket-Situ 4 is installed. Reports include a detailed record of date and time, parameter, calibration type, number of calibration points, stimulus and response, and calculated coefficients. An index in html format is also created and updated each time a calibration is performed.



pH calibration information for a combination pH/ORP sensor in port 1

The calibration reports are accessible from the Tools Menu and the Show Calibration Report button on the toolbar

. They may also be accessed like other files through Windows Explorer (desktop PC) or File Explorer (PDA); they are not displayed in the Data Folder. They may be viewed or printed to provide a complete calibration history.

***TIP:** Here's how to find the calibration report indexes:*

Desktop or laptop PC—Calibration Reports subfolder in the folder where Win-Situ 4 is installed

PDA—Calibration Reports subfolder in the folder where Pocket-Situ 4 is installed

Example of a calibration report index

Folders:

Folder
SN32072
SN45025

Click a folder to see its listings

Click a tile to open it

SN32072

Files:

File Name
SN32072 2006-04-17 171530 TURB.html
SN32072 2006-06-18 102309 DO.html
SN32072 2006-08-14 134200 QuickCal.html
SN32072 2006-11-25 121530 PH.html
SN32072 2007-01-11 154322 Cond.html

MP TROLL 9500 serial number | *Cal Date* | *Cal Time (hhmmss)* | *Parameter*

HOW OFTEN TO CALIBRATE

No sensor will remain in calibration forever. The calibration frequency is almost completely determined by the chemical properties of the fluid being monitored, and the accuracy you wish to achieve from the instrument. For example, when used in relatively clean water, in a normal pH range, at a relatively stable temperature, some sensors could remain in calibration for a couple of weeks or longer. On the other hand, in surface water with a high nutrient content and wide temperature fluctuations, the sensors may need to be cleaned and recalibrated every few days. Your own measurement results are the best guide to the need to recalibrate.

When a sensor or instrument is new, we recommend checking the readings often (say, once a day) to get an idea of the stability of the sensor.

Changes in flow also affect readings. Constant flow will increase the accuracy. This can be achieved with the stirring accessory.

The table below may be used as a very general guideline to how long sensors may be expected to remain in calibration under optimum conditions:

pH, ORP	1-2 months
Conductivity	2-3 months
D.O. (polarographic)	2-4 weeks
D.O. (optical, RDO)	up to a year if foil is not damaged
ISEs	1 day

***TIP:** For additional information on calibration schedules, see the Technical Note on Instrument Calibration in the Downloads section at www.in-situ.com.*

HOW TO CHECK IF A SENSOR IS STILL IN CALIBRATION

Immerse the sensor in a calibration standard of known value and at the same temperature as the original calibration. Compare the sensor reading to the solution value. Some drift is to be expected, but generally the readings should fall within the sensor's accuracy specification. If readings fall outside the accuracy specification by an amount that is not acceptable for your current application, recalibration is recommended. You will quickly learn by experience how often you need to recalibrate a given sensor based on usage.

***TIP:** Quick Cal solution may be used for a quick check of pH, ORP, and conductivity. Refer to the values printed on the label.*

WHEN TO REPLACE A SENSOR

After a certain amount of use even a complete recalibration will not be able to accurately calculate calibration coefficients. The slope will gradually become lower and lower. At this point the sensor should be replaced. Specific slope guidelines for individual sensors are given in the individual parameter sections below.

USING A STIRRER

In-Situ's stirrer accessory provides continuous sample circulation or agitation, which can improve the performance of water-quality sensors in a number of applications.

Dissolved oxygen (DO) measurements drop in very stagnant water due to depletion of oxygen next to the membrane. A slight perturbation to the system will cause the DO measurements to return to normal. Stirring is recommended if the instrument is anchored to a fixed structure in stagnant conditions—for example, attached to a pier in a calm lake that has no underwater currents. If the wind is blowing and waves are slightly moving the cable, then stirring is probably not necessary.

ISE sensors in close proximity to each other can sometimes create interferences. Constant stirring can enhance the performance of the ISE sensors.

Sample agitation can also help to improve sensor response time when water-quality conditions are subject to change (e.g., in a moving contaminant plume) and can speed up temperature stabilization.

Attaching the Stirrer for Field Use

The stirrer accessory is easily installed on the MP TROLL 9000. See illustration D earlier in this section.

1. Remove the nose cone from the MP TROLL 9500. Leave the restrictor attached to the instrument.
2. Screw the top of the stirrer (propeller end) to the stainless steel restrictor in place of the nose cone.
3. Start the stirrer; see Starting the Stirrer earlier in this section.

The instrument is ready for use in stagnant water.

How can I find the serial number of a water quality sensor—pH for example?

The software can display the sensor serial number. Do this:

1 Select pH in the Navigation tree

2 Look at the information displayed The serial number is displayed in the Information pane on the right side of the screen (or at the bottom on a PDA)

REFERENCES

Eaton, A.D., L.S. Clesceri, E.W. Rice, and A.E. Greenberg, eds., *Standard Methods for the Examination of Water and Wastewater,* 21st edition, Washington, D.C.: American Public Health Association, American Water Works Association, and Water Environment Federation, 2005.

A Fish Farmer's Guide to Understanding Water Quality. LaDon Swann, Dept. of Animal Sciences, Illinois-Indiana Sea Grant Program, Purdue University. On the web at AquaNIC (Aquaculture Network Information Center), aquanic.org.

Rundle, Chris C., A Beginners Guide to Ion-Selective Electrode Measurements. Nico2000 Ltd., London, UK. On the web at www.nico2000.net

Water on the Web (WOW). University of Minnesota project initially funded by the National Science Foundation. On the web at wow.nrri.umn.edu

Water Quality Sensor Pressure Ratings

Sensor	Pressure Rating PSI	Usable Depth Meters	Usable Depth Feet
pH	300	210	692
pH/ORP	300	210	692
Conductivity	350	246	807
D.O. polarographic*	350	246	807
Turbidity	350	246	807
Wiper	350	246	807
Chloride	100	70	231
Ammonium	20	14	46
Nitrate	20	14	46
RDO	*exceeds rating of the TROLL 9500*		

** Submersion and retrieval at up to 4 feet per second.*

11 pH

WHAT IS pH?

The term pH is derived from "p" meaning power and "H" for the element hydrogen and literally means "power of hydrogen." pH is defined as the negative logarithm of the hydrogen ion activity (or concentration in moles/liter):

$$pH = - \log [H^+] \quad \text{or} \quad [H^+] = 10^{-pH}$$

Water (H_2O) dissociates into hydrogen ions (H^+) and hydroxide ions (OH^-) in aqueous solution. At 25°C there are 1.0 x 10^{-7} moles/L of hydrogen ions and 1.0 x 10^{-7} moles/L of hydroxide ions in pure water. Thus the water is neutral (pH = 7) because there are equal amounts of each ion. Addition of a substance with hydrogen or hydroxide ions will shift the balance and cause the water to become either acidic or basic.

The pH scale ranges from 0 (most acidic) to 14 (most basic or least acidic). A change of 1 pH unit corresponds to a tenfold change in hydrogen ion concentration.

WHY MEASURE pH?

A pH value indicates the amount of hydrogen ion that is present in an aqueous environment. The hydrogen ion concentration gives an indication of the acidity of a substance. pH is an important measurement in natural waters because most chemical and biochemical processes are pH dependent. The physiological chemistry of most living organisms can tolerate only small changes in pH and still provide the chemical reactions that sustain life. The solubility of many chemicals is pH dependent. Thus, pH determines their availability to living organisms.

Typical pH values

Fluid	pH units
Acid rain	< 5
Distilled water	5.6
Most natural waters	8
Safe for freshwater fish	6-9
Properly chlorinated swimming pool	7.2 - 7.6

Natural waters usually have pH values in the range of 4 to 9. Most natural waters are slightly basic (~ pH 8) because of the presence of carbonates (CO_3^{2-}) and bicarbonates (HCO_3^-). Extremely fresh water can even be slightly acidic (~ pH 6), depending on the concentration of dissolved carbon dioxide (CO_2). The carbon dioxide combines with water to form a small amount of carbonic acid (H_2CO_3) and this process lowers the pH. Nitrogen oxides (NO_x) and sulfur dioxides (SO_2) from automobile exhaust and the burning of coal combine with water in the atmosphere to form nitric (HNO_3) and sulfuric acid (H_2SO_4). This falls to the ground as acid rain and accumulates in surface water. Runoff from mining spoils and the decomposition of plant materials can also cause acidic surface water.

pH values below 5 in natural waters are generally considered to be too acidic. Freshwater fish seem to do well in the pH range of 6 to 9. Acidic drinking water is a concern because of its corrosive characteristics to plumbing and appliances. pH also affects the ammonia/ammonium (NH_3/NH_4^+) equilibrium in water. Even a small amount of ammonia is detrimental to fish while a moderate amount of ammonium is tolerated. At a pH of 6.5 almost all ammonia is in the form of ammonium. However, as the pH becomes slightly basic, ammonium is changed into harmful ammonia. The lethal dose of ammonia for trout is only 0.2 mg/L.

THE pH SENSOR

pH electrodes use a potentiometric method to measure the pH of a solution. The pH sensor consists of a pH-sensitive glass whose voltage is proportional to the hydrogen ion concentration. A second sensor (electrode) serves as a reference, which supplies a constant stable output. Electrical contact is made with the solution using a saturated potassium chloride (KCl) solution. The electrode behavior is described by the Nernst equation:

$$E_m = E_o + (2.3\ RT/nF) \log [H^+]$$

where

E_m is the potential from the pH electrode,

E_o is related to the potential of the reference electrode,

R is the Gas Law constant,

F is Faraday's constant,

T is the temperature in Kelvin,

n is the ionic charge (+1 for Hydrogen), and

$[H^+]$ is the hydrogen ion concentration in moles/L.

The MP TROLL 9500 reads the signal from the pH electrode, the reference electrode, and the temperature and then calculates the pH using the Nernst equation.

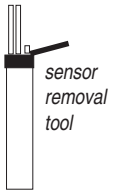
SENSOR INSTALLATION

The MP TROLL 9500 may be shipped with a pH or combination pH/ORP sensor installed. If installation is necessary, unpack and install the sensor in the MP TROLL 9500 as follows.

A combination pH/ORP sensor will work properly only in port 1. A pH sensor may be installed in port 1 or 3.

***TIP:** To ensure optimum response for a new or previously stored sensor, rinse off the soaking solution, then soak the sensor in clean water for at least 15 minutes before calibrating.*

1. Remove the restrictor or Cal Cup from the front end of the MP TROLL 9500. This allows access to the sensor block shown below.
2. Remove the sensor hydration bottle and set aside for future use.
3. Rinse the sensor in clean water to remove the soaking solution. Soak the sensor in clean water for at least 15 minutes before calibrating.
4. Remove any moisture or dirt from the area around the port where you will install the sensor, then use the sensor removal tool to remove the plug from the port. Retain the plug for future use.



5. Remove any moisture or dirt from the port connector with a clean swab or tissue.
6. Remove the cap from the sensor connector. Check lubrication of the o-rings. If they appear dry, apply a silicone lubricant before installation.
7. Visually align the sensor connector pins with the port connector pins.
8. Press the sensor into the port until you feel it dock with the port connector. When properly inserted a small gap (the width of the sensor removal tool) remains between the instrument body and the widest part of the sensor, for ease of removal.

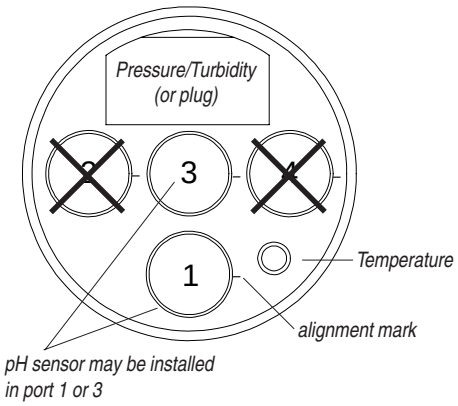
CALIBRATION

OVERVIEW

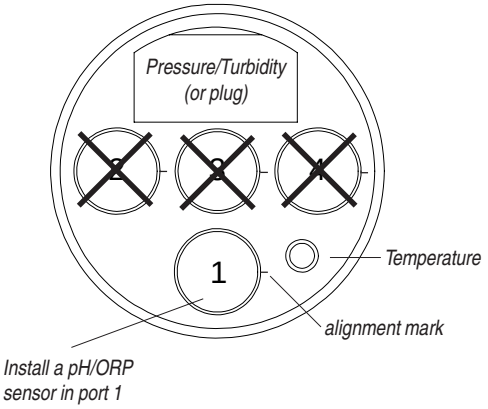
Several options are available for pH calibration.

- **Quick Cal:** Calibrates all basic sensors (pH, ORP, polarographic D.O., conductivity) at the same time with one convenient solution. A one-point calibration in pH 7; default slope, calculated offset.
- **Traditional calibration–1 point:** requires a single solution; results in calculation of sensor offset for a single pH value (pH 4, 7, or 10). Select a calibration solution for the region of the pH range you expect to measure. A one-point calibration may be used with good results when the sensor is new.
- **Traditional calibration–2 point:** requires two solutions; results in calculation of sensor slope and offset for one pH range (pH 4-7 *or* pH 7-10). Choose solutions that bracket the expected pH range:

pH Sensor Positions



pH/ORP Sensor Position



- 4.0 and 7.0 pH buffer solutions for neutral to acidic conditions
- 7.0 and 10.0 pH buffer solutions for neutral to basic conditions

- **Traditional calibration–3 point:** requires three solutions; results in calculation of slope and offset for 2 ranges (pH 4-7 *and* pH 7-10). The correct slope for the pH values being monitored will automatically be applied. A 3-point calibration is useful when the pH range of the environmental fluid is completely unknown.
- **Default Coefficients:** Resets the sensor's factory defaults. No solutions are required.

Nominal vs. Stable

To shorten the calibration time, you have the option to accept the calibration when "Nominal" stability conditions are achieved. If the early value is accepted, the calibration point will be designated "USER SET" in the calibration report. If the calibration report indicates that calibration was performed through to stability then the instrument will operate as intended by In-Situ's quality standards.

CALIBRATION SOLUTIONS

Calibration solutions certified to N.I.S.T. standards are supplied in the In-Situ pH Calibration Kit: pH 4, pH 7, pH 10 buffer, and deionized water. Catalog No. 0032080. Solutions are also available separately.

TIP: *Most solutions are usable beyond their stated expiration date, depending on storage conditions; however, the results cannot be guaranteed.*

Primary standard buffer salts are available from the National Bureau of Standards, and may be used in situations where extreme accuracy is required. Commercially available pH buffers may be used.

RECOMMENDED CALIBRATION FREQUENCY

Calibration frequency will depend on the nature of the sample and the degree of accuracy required. In clean water samples, the pH sensor should retain its accuracy for 2-6 weeks before requiring recalibration. Recalibrate the sensor—

- after replacing the reference junction and/or the filling solution,
- during routine, scheduled maintenance,
- every 2-6 weeks in the absence of other indications.

RECOMMENDED CALIBRATION ORDER FOR PH AND ORP

The pH/ORP sensor requires separate calibrations for pH and ORP. A suggested calibration scenario is as follows:

A. First, Quick-Cal ORP (plus, optionally, other installed Basic sensors). For the procedure, see Section 3, Getting Started.

B. Then, perform a 2- or 3-point Traditional pH calibration as described here.

pH QUICK CAL

The procedure to Quick Cal the pH sensor (a 1-point calibration at pH 7), along with other sensors in the Basic Sensor Set, may be found in Section 3, Getting Started.

To perform a more accurate traditional calibration, follow the procedure below.

TIP: *The pH calibration procedure is the same for pH sensors and pH/ORP sensors.*

TRADITIONAL pH CALIBRATION PROCEDURE

1. With a pH or pH/ORP sensor installed and plugs or sensors in the other ports, rinse the front end of the MP TROLL 9500 in tap water, then again in deionized water. Shake to dry.

   For the most accurate results, follow this with a rinse in a portion of the selected calibration solution.

2. Insure the black PVC base is attached to the Cal Cup, and fill the Cal Cup to the fill line with the selected calibration solution.

   - Begin with the lowest buffer value when performing a multi-point calibration.
   - With a full complement of sensors installed, use the lower line as a guide.
   - With 1 or 2 removable sensors installed, fill to the upper line.

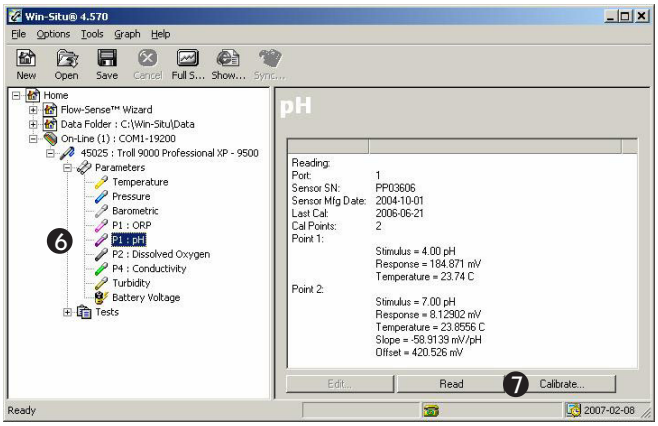
❸

3. Insert the front end of the MP TROLL 9500 into the open end of the Cal Cup. Thread the Cal Cup onto the body until seated against the o-ring, then back off slightly to avoid overtightening.
4. Connect the MP TROLL 9500 to a PC and establish a connection in Win-Situ 4 or Pocket-Situ 4. Win-Situ screens are illustrated here. The Pocket-Situ interface is similar, with the Navigation tree at the top of the screen and the Information pane below it.

5. Select the MP TROLL 9500 in the Navigation tree.

   The software will automatically detect and display the installed sensors. If one or more sensors is installed in the wrong port, an error message will be displayed. Simply remove the sensor and install it in the correct position, then “refresh” the device before continuing.

6. Click to select pH in the Parameters list. The sensor serial number (SN) and recent calibration information is displayed.

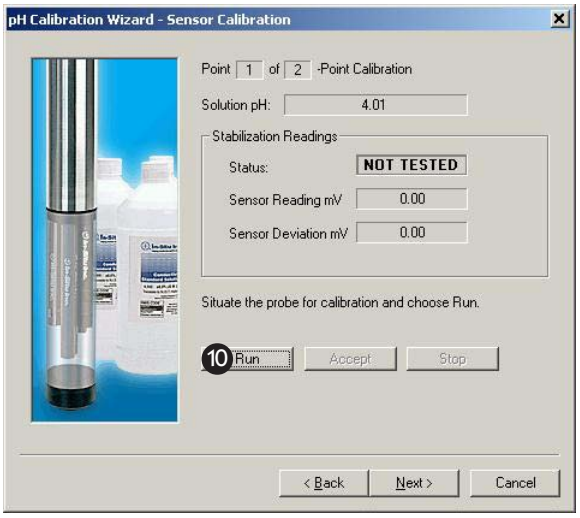


7. Select **Calibrate** to launch the pH Calibration Wizard. A screen like this is displayed.

8. Select the number of calibration points for this calibration, and the pH value of the calibration solution for each point. Cal point 1 is the solution the sensor is soaking in now.

9. Select **Next** to continue.

10. In the next screen, select **Run** to begin the stabilization.



The display will continuously update as readings are taken and compared against the stabilization criteria.

11. If doing a a one-point calibration, go to step 14.

    For a multi-point calibration, the Wizard returns to the screen shown at step 10 and waits for you to situate the probe in the next calibration solution and click Run.

Indicators during Calibration

- **Status:**

  NOT TESTED is displayed until you begin the calibration by selecting Run.

  UNSTABLE indicates the sensor response does not meet the criteria for a valid calibration point.

  NOMINAL indicates the sensor deviation meets early stabilization criteria.

  The **Accept** button becomes available when nominal stability is achieved. You may accept the early value, or wait for complete stability. If you accept the early value, the calibration point will be designated “USER SET” in the calibration report. (For more on calibration reports, see “Calibration History” in Section 10.)

  STABLE is displayed when the readings have stabilized sufficiently to take a valid calibration point. The calibration proceeds automatically to the next screen.

- **Sensor Reading**: The current sensor response in milliVolts.

- **Sensor Deviation:** Change in sensor response between the last two readings. This enables you to follow the progress of the stabilization, but deviation from the previous reading is not necessarily the best indicator of stability as the software is looking at longer-term trends.

12. Remove the Cal Cup, discard the first solution, rinse the Cal Cup and the front end of the instrument, refill the Cal Cup with the second solution, and attach it to the instrument.

    TIP: *The calibration solution may be flushed down the drain with running water, or saved in a separate container and used to rinse the next time you calibrate with the same solution.*

13. Select **Run** to begin the stabilization for the second calibration point. Status indicators and controls are the same as for the first calibration point (step 10).

    For a 3-point calibration, repeat steps 12 and 13.

14. The final screen shows the sensor slope and offset calculated during calibration. For a 3-point calibration, 2 sets of coefficients will be shown.

    "Pivot pH" is the point at which the slope characteristics change with a 3-point (2-range) calibration. The correct slope for the pH values being monitored will automatically be applied.

15. Select **Finish** to program the sensor with the newly calculated calibration coefficients.

    TIP: *You can look at the calibration report right after calibrating, or at any time. See "Calibration History" in Section 10 for details.*

Options for storing the sensor:

- If the instrument will be used in a day or so, leave the sensors installed. Remove the Cal Cup and rinse it and the sensors. Add 50-100 mL of tap water to the Cal Cup. Return the probe to the Cal Cup for transport to the field site.
- For longer storage, see Sensor Care and Handling, below.

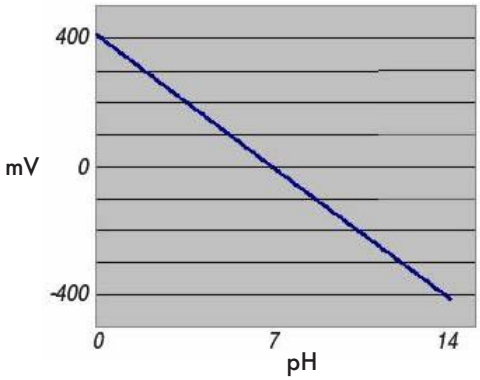
RESETTING DEFAULT COEFFICIENTS

The sensor's calibration may be reset back to factory defaults at any time. As the sensor ages, the coefficients calculated during calibration will deviate more and more from the nominal values, which are derived from new sensors. Default coefficients will give reasonable results when the sensor is relatively new.

1. With a pH or combination pH/ORP sensor installed, establish a connection to the instrument in Win-Situ 4 or Pocket-Situ 4.
2. Select pH in the Parameters list and click **Calibrate**.
3. In the first screen, select Use Nominal Coefficients, then **Next**.
4. In the final screen, click **Finish** to send the values to the sensor.

SENSOR SLOPE AND OFFSET

The pH calibration curve pivots around pH 7 (0 mV response). The offset calculated by the software when calibrating at pH 7 will typically be between 390-450 mV. If the offset falls much outside these limits, replace the filling solution or the junction (see the following page).



The slope should fall between -54 mV/pH and -62 mV/pH. A calculated slope greater than -50 mV/pH or less than -66 mV/pH indicates that the sensor requires maintenance (see the following page).

UNITS AND CALCULATED MEASUREMENTS

Readings from pH channel are displayed in pH units. No calculated measurements are available.

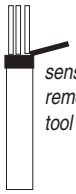
USAGE RECOMMENDATIONS AND CAUTIONS

- Temperature compensation is provided in the software to account for measurements taken at temperatures different from the calibration temperature. For most accurate results, try to calibrate at the same temperature as the expected sample temperature.
- A small error in pH will occur in basic solutions (>pH 10) that contain high levels of sodium salts (>0.01M) due to sodium interference. Contact In-Situ for more information.

- pH readings in pure water samples (<100µS/cm conductivity—also known as "low ionic strength" samples) require up to 20 minutes after calibration to stabilize and begin producing accurate results. You may wish to condition the sensor after calibration in a low conductivity solution.

SENSOR CARE AND HANDLING

SENSOR REMOVAL


sensor removal tool

Position the yoke of the sensor removal tool at the point where the sensor enters the sensor block and pop the sensor out.

MAINTENANCE/INSPECTION/CLEANING

If a film develops on the glass electrode, or if the sensing glass or junction should become dehydrated, the sensor response may be sluggish or erratic, or the sensor may fail to calibrate. In these cases, rinse the sensor in 90% isopropyl alcohol, then soak it in storage solution (Catalog No. 0065370) for at least an hour, or overnight if needed. If this does not restore the response, try soaking in 0.1 M HCl solution for 5-10 minutes, followed by a thorough rinse in clean water. If the response has still not improved, replace the filling solution, or possibly the junction.

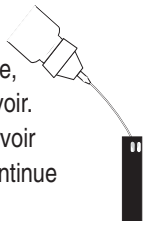
Note: The following maintenance instructions apply to In-Situ's newest pH sensor (cat. no. 0059510). Older sensors (cat. no. 0032000, now discontinued) are not user-serviceable.

REPLACING THE FILLING SOLUTION

Replace the filling solution every five to six months, or when:

- The sensor fails to calibrate with reasonable slope and offset
- Readings drift
- Readings during calibration at pH 7 are outside the range 0±20 mV

1. Unscrew the reference junction as shown.
2. Holding the sensor at an angle, shake out the filling solution.
3. Protect the connector end of the sensor with the soft cap it shipped with, or wrap the sensor in a paper towel to prevent solution from entering the electrical connector.
4. Using the dispenser cap on the filling solution bottle, insert the tube into the **bottom** of the empty reservoir. Squeeze a steady stream of solution into the reservoir until it overflows and no bubbles are observed. Continue to add solution while withdrawing the tube.



5. Screw in the reference junction, and hand-tighten until snug. Some filling solution will overflow. Wipe the excess off the sensor body.
7. Soak the sensor in tap water for at least 15 minutes.
8. Recalibrate the sensor.

If necessary, thoroughly clean the electrical connector to remove filling solution: Using a disposable pipette, fill the connector with isopropyl alcohol (70% to 100%). Shake to dry. Repeat 3 times. Dry overnight. When thoroughly dry, recalibrate.

REPLACING THE JUNCTION

Replace the junction when the sensor fails to calibrate, even after replacing the filling solution.

1. Unscrew the reference junction and discard.

2. Replace the solution and screw in a new junction as above.
3. Soak for 15 minutes in tap water, then recalibrate the sensor.

***TIP:** Keep the junction damp at all times to avoid a lengthy rewetting process.*

STORAGE

Short-Term Storage (several days)

Store in the Cal Cup in tap water.

Long-Term Storage (several weeks)

Remove the sensor and store it in the electrode storage bottle with 10-20 mL of storage solution (Catalog No. 0065370). Tighten the cap to prevent drying. Prior to use, condition the sensor by rinsing with deionized or tap water and soaking for 15 minutes.

REFERENCES

Eaton, A.D., L.S. Clesceri, E.W. Rice, and A.E. Greenberg, eds., *Standard Methods for the Examination of Water and Wastewater,* 21st edition, Washington, D.C.: American Public Health Association, American Water Works Association, and Water Environment Federation, 2005. Section 4500 H^+, pH Value.

EPA, Methods for Chemical Analysis of Water and Wastes, EPA/600/4-79-020, revised March 1983. Method 150.1, pH, Electrometric; Method 150.2, pH, Electrometric (Continuous Monitoring). Both approved at 40 CFR Parts 136 and 141.

12 CONDUCTIVITY

WHAT IS CONDUCTIVITY?

Electrical conductivity measures the ability of a material to carry an electric current. Lakes, rivers, oceans, and underground aquifers are typically good conductors because they contain dissolved salts and minerals. These salts and minerals dissociate in the presence of water to form negatively and positively charged particles called anions and cations. Anions and cations provide a pathway for the transportation of electrical charges throughout the aqueous medium. For the most part, the higher the concentration of dissolved salts and minerals in water, the better the conductor and the higher the electrical conductivity. Deionized/distilled water is a poor conductor because almost all anions and cations are removed during the deionization/distillation process.

WHY MEASURE CONDUCTIVITY?

Changes in the conductivity of a body of water are often used to indicate an environmental event. For example, a drastic increase in the electrical conductivity of an underground fresh water aquifer located near the ocean could indicate the beginning of salt water intrusion. On the other hand, an increase in the electrical conductivity of a small lake that is completely surrounded by farmland may simply be the result of runoff from a recent rain.

HOW IS CONDUCTIVITY MEASURED?

Conductance is the reciprocal of the resistance, in ohms, measured between two opposing electrodes of a 1 cm cube at a specific temperature. The unit 1/ohm or mho was given the name of Siemens (S) for conductance. It is not practical to require all conductance cells to have the dimensions of an exact cube. To enable the comparison of data from experiments with different conductance cells, the conductance is multiplied by the cell constant to give *conductivity* in Siemens per centimeter (S/cm). Cell constants are determined for each sensor using a standard solution of known conductivity. The cell constant depends on the electrode area and the amount of separation or distance between the electrodes.

Typical Conductivity values

Ultra-pure distilled water	0.05 µS/cm
Distilled water	1.0 µS/cm
Drinking water	50 to 300 µS/cm
Surface water	100 to 10,000 µS/cm
Sea water	40,000 to 55,000 µS/cm
Great Salt Lake	158,000 µS/cm

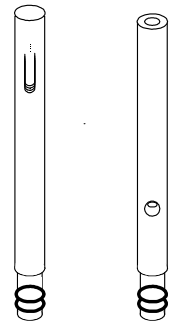
Early conductivity measurements were performed using cells with two electrodes. This method required using three conductivity cells with different cell constants in order to span the range of 1 to 100,000 microSiemens per centimeter (µS/cm). Another inconvenience occurred when deposits formed on the electrodes, thus reducing the measured conductivity of the sample.

The modern four-electrode conductivity cell offers many advantages over the two-electrode method. It contains two drive electrodes and two sensing electrodes. The sensing electrodes are positioned in a low current area so that electrode fouling is minimized. An alternating current is used to drive the cell. This reduces errors caused by polarization resulting from the application of a direct current.

THE CONDUCTIVITY SENSORS

Two conductivity sensors are available, optimized for performance in different areas of the conductivity range. Chemically resistant electrodes are used for lower reactivity in high conducting samples (carbon electrodes in the low-range sensor, passivated stainless steel electrodes in the high-range sensor).

The conductivity sensors are shorter than the other water quality sensors in order to distance the conductivity cell from the KCl reference solutions in other sensors.



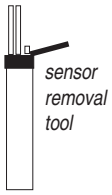
Type	Operating Range	Cell Constant Range
Low	3 to 50,000 µS/cm	0.33 – 0.39 cm^{-1}
High	70 to 200,000 µS/cm	4.4 – 5.8 cm^{-1}

SENSOR INSTALLATION

The MP TROLL 9500 may be shipped with a conductivity sensor already installed in port 4, as shown on the drawing below. If installation is necessary, unpack and install the conductivity sensor in port 4 as follows.

*The conductivity sensor will function properly only when installed in **port 4**.*

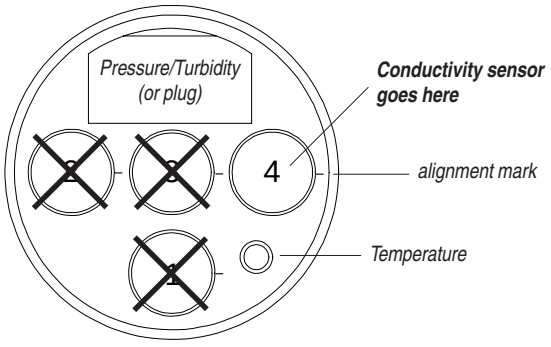
1. Remove the restrictor from the front end of the MP TROLL 9500. This allows access to the sensor block shown in the drawing below.
2. If there is a cap on the connector end of the sensor, remove it and set it aside for future use.
3. Remove any moisture or dirt from the area around port 4, then use the sensor removal tool to remove the plug from the port. Retain the plug for future use.



4. Remove any moisture or dirt from the port connector with a clean swab or tissue.
5. Check lubrication of the sensor o-rings.

TIP: The sensor o-rings require generous lubrication before installation. New sensors will be lubricated at the factory. If the o-rings appear dry, apply a silicone lubricant before installation.

6. Align the mark on the side of the sensor with the mark on the port.
7. Firmly press the sensor into the port until you feel it dock with the connector at the bottom of the port. When properly inserted a small gap (width of the sensor removal tool) remains between the widest part of the sensor and the instrument body, for ease of removal.



CALIBRATION

OVERVIEW

The conductivity calibration calculates the cell constant for the conductivity sensor. A one-point calibration is sufficient. Best results will be obtained if you calibrate with the solution for the range you expect to measure, and at the temperature you expect during field use.

Nominal vs. Stable

To shorten the calibration time, you have the option to accept the calibration when "Nominal" stability conditions are achieved. If the early value is accepted, the calibration point will be designated "USER SET" in the calibration report. If the calibration report indicates that calibration was performed through to stability then the instrument will operate as intended by In-Situ's quality standards.

CALIBRATION SOLUTIONS (PRIMARY STANDARDS)

Potassium chloride (KCl) calibration solutions certified to N.I.S.T. standards are supplied in the In-Situ Conductivity Calibration Kits. The value on the bottle indicates the solution's specific conductance (conductivity at 25°C). Select an appropriate solution for your application from the following:

Fresh water	147 µS/cm solution
Fresh to brackish water	1,413 µS/cm solution
Brackish water	12,890 µS/cm solution
Sea water	58,670 µS/cm solution

The standard conductivity calibration kit includes a quart each of 147 µS/cm, 1,413 µS/cm, 12,890 µS/cm and deionized water. Catalog No. 0032090. Solutions are available separately, and specialized kits are available for fresh and salt water applications.

***TIP:** Most solutions are usable beyond their stated expiration date, depending on storage conditions; however, the results cannot be guaranteed. The 147 µS/cm solution should be refrigerated.*

Calibrating with Other Solutions

A custom solution may be used if its specific conductance value (in µS/cm) at 25°C is known. Calibration to secondary standards may also be performed. This involves a manual calculation of the cell constant. See the procedure later in this section.

RECOMMENDED CALIBRATION FREQUENCY

Your own experience is the best guide to how often the conductivity sensor will benefit from recalibration. Refer to the general guidelines under "How Often to Calibrate" in Section 10, and to the tech note on "Instrument Calibration."

CONDUCTIVITY QUICK CAL

The procedure to Quick Cal the conductivity sensor (a 1-point calibration at approximately 8,000 µS/cm), along with other sensors in the Basic Sensor Set, may be found in Section 3, Getting Started. To perform a more accurate calibration for a specific conductivity range, follow the procedure below.

TRADITIONAL CONDUCTIVITY CALIBRATION PROCEDURE

1. With a conductivity sensor installed and plugs or sensors in the other sensor ports, rinse the front end of the MP TROLL 9500.

   To calibrate using a medium- to high-range solution, rinse in tap water and shake to dry.

   To calibrate using a low-range solution, it is important to rinse well; we recommend a rinse with tap water, then with deionized water, followed by a rinse with the solution to be used for calibration.

   TIP: *For highest accuracy, conductivity sensors should be wetted for 15-30 minutes immediately prior to calibration. This immersion can be in either clean water or the conductivity calibration solution.*

2. Insure the black PVC base is attached to the Cal Cup, and fill the Cal Cup with the selected calibration solution.

   - Low-range sensor: Fill to the lower or upper line depending on the number of sensors installed (fewer sensors require more solution).
   - High-range sensor: Fill to or above the upper line, depending on the sensor load. You need enough solution to immerse the sensor's side ports.

3. Insert the front end of the MP TROLL 9500 into the open end of the Cal Cup. Thread the Cal Cup onto the body until seated against the o-ring, then back off slightly to avoid overtightening.

   - Low-range sensor: the open area of the sensor should be completely immersed.
   - High-range sensor: the side openings should be completely immersed.
   - The temperature sensor should be immersed in about an inch of liquid.
   - If any air bubbles are visible on the sensor, tap the sides or bottom of the Cal Cup to dislodge them. Or invert the Cal Cup a couple of times.

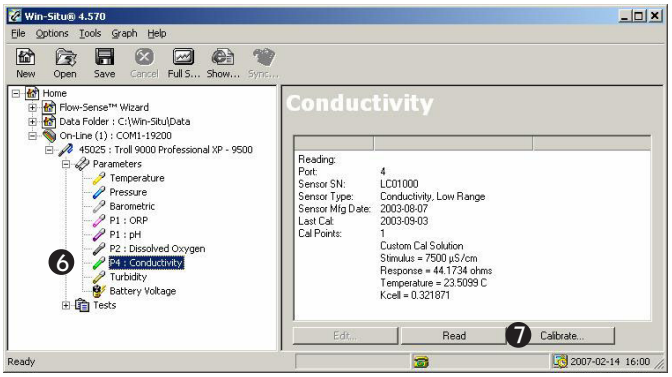
❸

4. Connect the MP TROLL 9500 to a PC and establish a connection in Win-Situ 4 or Pocket-Situ 4. Win-Situ screens are illustrated here. The Pocket-Situ interface is similar, with the Navigation tree at the top of the screen and the Information pane below it.

5. Select the MP TROLL 9500 in the Navigation tree.

   The software will detect and display the installed sensors. If any sensor is installed in the wrong port, an error message will be displayed. Simply remove the sensor and install it in the correct position, then "refresh" the device before continuing.

6. Select conductivity in the Parameters list. The sensor serial number (SN), type, and recent calibration information is shown.



7. Select **Calibrate**.

   The Conductivity Calibration Wizard starts. Available calibration ranges will depend on the sensor installed (high or low range)

8. Select the calibration solution the sensor is soaking in.

   For a custom solution, select **Other** and enter the Specific Conductance of the solution (conductivity corrected to 25°C) in µS/cm.

9. Select **Next** to continue.

10. In the next screen, select **Run** to begin the stabilization.

The display will continuously update as readings are taken and compared against the stabilization criteria.

- Status indicators:

  NOT TESTED is displayed until you begin the calibration by selecting Run.

  UNSTABLE indicates the sensor response does not meet the criteria for a valid calibration point.

  NOMINAL indicates the sensor deviation meets early stabilization criteria.

  The **Accept** button becomes available when nominal stability is achieved. You may accept the early value, or wait for complete stability. If you accept the early value, the calibration point will be designated "USER SET" in the calibration report. (For more on calibration reports, see "Calibration History" in Section 10.)

  STABLE is displayed when the readings have stabilized sufficiently to take a valid calibration point. The calibration proceeds automatically to the next screen.

- Temperature at the time of calibration is displayed for your information.
- Sensor Reading: The current sensor response in ohms.
- Sensor Deviation: Change in sensor response between the last two readings. This enables you to follow the progress of the stabilization, but deviation from the previous reading is not necessarily the best indicator of stability as the software is looking at longer-term trends.

11. The final screen shows the new cell constant (Kcell) calculated for the selected range during the calibration process.

Typical cell constants:

Low-range sensor	0.33 – 0.39
High-range sensor	4.4 – 5.8

The displayed cell constant may be edited.

12. Select **Finish** to program the sensor with the displayed cell constant.

TIP: *You can look at the calibration report right after calibrating, or at any time. See "Calibration History" in Section 10 for details.*

The conductivity sensor is now calibrated and ready to use in the range for which it was calibrated.

TIP: *The calibration solution may be flushed down the drain with running water, or saved in a separate container and used to rinse the sensors the next time you calibrate with the same solution.*

Options for storing sensors:

- If the instrument will be used in a day or so, leave all the sensors installed in the MP TROLL 9500. The conductivity sensor does not require any special storage conditions, but other sensors do. Refer to the relevant sections of this manual for storage recommendations for other installed sensors.
- Remove the conductivity sensor from the MP TROLL 9500, rinse it, and store it dry.

USING A CONDUCTIVITY METER AS A SECONDARY STANDARD

If a conductivity meter is available for comparison, the cell constant (Kcell) for the conductivity sensor can be calculated by hand and entered manually into the software.

1. Note the current cell constant. Immerse the MP TROLL with conductivity sensor in a solution. Take and record the reading.
2. Take and record a reading in the same solution with a conductivity meter.
3. Solve the following for X:

$$\frac{\text{Current Kcell}}{\text{Reading with this Kcell}} = \frac{X}{\text{Conductivity meter reading}}$$

4. This is the new cell constant. Enter this value in the software as described below.

ENTERING A CELL CONSTANT MANUALLY

A cell constant may be entered "manually" without running a complete calibration.

1. With a conductivity sensor installed, establish a connection to the instrument in Win-Situ 4 or Pocket-Situ 4.
2. Select Conductivity in the Parameters list and click **Calibrate**.
3. Select Other, and key in any reasonable value. Press **Next** twice to get to the final screen.
4. In the final screen, key in the desired cell constant.
5. Click **Finish** to send the new value to the sensor.

UNITS AND CALCULATED MEASUREMENTS

Basic Unit: AC

Absolute (or "actual") conductivity, without temperature compensation, is the basic unit for the conductivity sensor. Measurements may be displayed in:

microSiemens per centimeter (µS/cm AC)
milliSiemens per centimeter (mS/cm AC)

The following units are also available for displaying derived measurements calculated from the conductivity channel output:

TIP: *To change unit preferences: In Win-Situ, select Preferences on the Options menu. In Pocket-Situ, select the Home site, then tap Setup in the command bar.*

TIP: *Since the specific ionic composition of all analytes cannot be known, the conversions provided in the software are reasonably good estimates of Specific Conductance and Total Dissolved Solids. The resulting derived values should be treated with caution.*

Specific Conductance (SC)

Specific Conductance is conductivity corrected to 25°C. The software estimates what the conductivity would be at 25°C to enable comparison between measurements made at different temperatures.

The conversion requires a temperature coefficient for the solution being measured. By convention, the temperature coefficient for potassium chloride (KCl) calibration standards is used. Specific conductance is calculated from:

$$SC = \frac{AC}{[1 + 0.0191 * (Temp. - 25.0)]}$$

where

AC is the actual conductivity in µS/cm
0.0191 is a nominal temperature coefficient for KCl solutions
Temp. is the solution temperature in degrees C.

The correction factor of 0.0191 (1.91% / °C) for KCl solutions is a reasonable approximation for samples containing sodium and chloride salts (i.e., seawater). For comparison, the table below lists correction factors for other solution types.

Solution	Correction factor (%/°C)
5% H_2SO_4	0.96
10% HCl	1.32
5% NaOH	1.7
Dilute NH_3	1.88
KCl salt (default)	1.91
NaCl salt	2.12
98% H_2SO_4	2.84
Ultrapure water	4.55
Sugar solution	5.64

Units: microSiemens per centimeter (µS/cm SC)

Total Dissolved Solids (TDS)

A factor of 0.65 x specific conductance is used to estimate Total Dissolved Solids (TDS). This was chosen for general applicability. Remember that ions in solution will vary, and this general conversion factor will not fit all situations exactly. Units: mg/L

Resistivity

The reciprocal of conductance is resistance. Resistivity is the resistance times the cell constant. Resistivity is useful when monitoring pure water. Units: Kohms cm

Salinity

Calculated from conductivity and temperature using the Practical Salinity Scale adjusted for low salinities. Units: PSU (Practical Salinity Units)

The original Practical Salinity Scale (1978) was considered valid for a range of 2-42 PSU; "standard seawater" is defined as having a value of exactly 35. In 1986, there was an adjustment to the scale for better accuracy with low salinities. That adjusted scale is considered valid for a range of 0-40 PSU. Above 2 PSU there is no significant difference between the two scales. "Fresh" water would typically have values below 1, and typically very close to 0.

USAGE RECOMMENDATIONS AND CAUTIONS

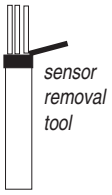
CONDUCTIVITY AND TEMPERATURE

Conductivity is a function of temperature. According to the EPA, temperature variations and corrections represent the largest source of potential error in conductivity measurements. A 0.1°C change in temperature can cause a 0.2% change in conductivity.

Specific conductance is the conductivity of a substance at 25°C, and measurements are usually standardized to 25°C when it is necessary to compare data. When the temperature of a sample and its conductivity at that temperature are known, the software can extrapolate the conductivity to 25°C.

SENSOR CARE AND HANDLING

SENSOR REMOVAL



Position the yoke of the sensor removal tool at the point where the sensor enters the sensor block and pry the sensor upward.

MAINTENANCE/INSPECTION/CLEANING

Check the sensor for fouling of the electrodes. If necessary, flush the sensor with water, or swish in a mild detergent solution and rinse with tap water. A swab or soft-bristle brush may be gently used to clean the electrodes. Remember that the electrodes are made of graphite, which is soft and easily damaged.

STORAGE

Store the sensor dry.

REFERENCES

Eaton, A.D., L.S. Clesceri, E.W. Rice, and A.E. Greenberg, eds., *Standard Methods for the Examination of Water and Wastewater,* 21st edition, Washington, D.C.: American Public Health Association, American Water Works Association, and Water Environment Federation, 2005. Section 2510, Conductivity. Section 2520 B, Salinity - Electrical Conductivity Method.

EPA, Methods for Chemical Analysis of Water and Wastes, EPA/600/4-79-020, revised March 1983. Method 120.1, Conductance, Specific Conductance. Approved at 40 CFR Part 136.

The International Association for Physical Science of the Ocean (IAPSO) Standard Seawater manufactured by Ocean Scientific International is available in North America from Guildline Instruments Inc. in Lake Mary, Florida.

13 DISSOLVED OXYGEN

WHAT IS DISSOLVED OXYGEN?

The amount of dissolved oxygen (D.O.) in both natural water and wastewater is a function of several parameters. D.O. is highly dependent on temperature and atmospheric pressure. An increase in temperature causes a decrease in the amount of oxygen that can dissolve in water. On the other hand, higher atmospheric pressures result in higher D.O. values. Salinity is also a factor. Oxygen solubility is greater in freshwater than in saltwater. There are also chemical and biochemical processes that affect D.O.

Most of the dissolved oxygen in water comes from the atmosphere, but oxygen from the photosynthesis of aquatic plants is also a key source. D.O. levels in lakes and other surface water will actually follow a cyclic or diurnal pattern over the course of a day, rising and falling as light intensity changes from dawn to dusk.

WHY MEASURE DISSOLVED OXYGEN?

Most aquatic life requires an average D.O. value greater than 5.0 milligrams dissolved oxygen per liter of water (mg/L) in order to survive. Although the amount of dissolved oxygen in a body of water fluctuates due to natural processes, large deviations from the norm are usually a result of human activity. Changes in D.O. levels are usually the result of a buildup in organic waste. Organic waste can enter surface water from sewage treatment facilities, runoff from agricultural feed lots or domestic areas and from industrial discharge. Organic wastes often contain nitrates and phosphates. Nitrates and phosphates are nutrients for aquatic plants and algae, stimulating overproduction when present in excessive levels. Accelerated growth of blooms increase the number of photosynthesizing plants, which temporarily increases the amount of dissolved oxygen. However submerged aquatic vegetation eventually experience a reduction in sunlight due to increased coverage on the surface. This decrease in sunlight leads to a reduction in photosynthesis and eventual death. Bacterial processes take over and consume even more dissolved oxygen. Fish and other aquatic species die due to lack of dissolved oxygen. This tragic process is known as eutrophication.

Typical D.O. values

100% DO, 0°C, 1 atm, 0 ppm Chlorine*	14.6 mg/L
100% DO, 20°C, 1 atm, 0 ppm Chlorine	9.09 mg/L
100% DO, 0°C, 0.75 atm, 0 ppm Chlorine	6.77 mg/L
100% DO, 20°C, 1 atm, 20 ppm Chlorine	7.35 mg/L
Safe level for most aquatic life	> 5.0 mg/L

** representative of solute concentration*

POLAROGRAPHIC MEASUREMENT OF DISSOLVED OXYGEN

THE POLAROGRAPHIC DISSOLVED OXYGEN SENSOR

THEORY OF OPERATION

The sensor is a Clark-type polarographic sensor consisting of two metallic electrodes in contact with an electrolyte and separated from the measurement water by a polymeric membrane. Dissolved oxygen and other gases diffuse through the membrane into the electrolyte. An electric potential is applied to the electrodes, which causes an electrochemical reaction. Oxygen is reduced at the cathode:

$$O_2 + 2H_2O + 4e^- \Rightarrow 4(OH)^-$$

while silver is oxidized at the anode:

$$4Ag + 4Cl^- \Rightarrow 4AgCl + 4e^-$$

The resulting current is proportional to the oxygen crossing the membrane. The electric potential is carefully selected so that only the dissolved oxygen is reduced.

The concentration of dissolved oxygen is usually reported in milligrams of oxygen per liter of water (mg/L), but the sensor actually measures the partial pressure of dissolved oxygen. Other gases such as nitrogen, carbon dioxide, and water vapor are also dissolved in the water. The partial pressure of the oxygen is the fraction of the oxygen multiplied by the total pressure of all the gases. This value is also a function of water temperature and water salinity. The maximum amount of oxygen that can be dissolved in water at a given atmospheric pressure, water temperature, and salinity (100% D.O.) can be calculated from first principles. D.O. measurements taken in the field are then compared to the 100% D.O. value. D.O. measurements of surface water are typically less than the 100% D.O. value due to the presence of biological and chemical processes that consume oxygen. Field measurements are corrected for changes in temperature, air pressure, and salinity.

During the electrochemical process dissolved oxygen is consumed while silver chloride (AgCl) is deposited on the anode. In time, both processes will adversely affect the stability and accuracy of the D.O. measurements. Depletion of oxygen near the membrane will cause readings to decrease when measuring D.O. in stagnant water. The use of a stirrer, or similar mechanism to increase water movement, alleviates this problem.

SENSOR CONDITIONING

As soon as the software "recognizes" and displays the D.O. sensor in port 2, powering of the D.O. channel begins. A low-level current is applied continuously to the D.O. circuitry, resulting in continuous polarization. This is similar to laboratory instruments for measuring dissolved oxygen, which are always "on." A certain amount of conditioning or "warm-up" time is necessary for the sensor to return accurate readings during calibration and use.

Before calibrating a new D.O. sensor, or a sensor with a new membrane, we recommend that you allow a minimum of two hours for conditioning. For stable long-term performance and faster stability during calibration, we recommend 10 hours of conditioning. If the D.O. sensor is installed when you receive the instrument, it will be conditioned and ready to calibrate. If you remove the sensor, be sure to allow for another period of conditioning before you calibrate.

TIP: *Testing has shown that 10 hours of conditioning yields very stable long-term performance.*

SENSOR INSTALLATION

The MP TROLL 9500 may be shipped with a polarographic D.O. sensor installed in port 2. When the sensor is shipped in the instrument, it is pre-conditioned and ready for calibration.

If installation is necessary, unpack, fill, install, and condition a polarographic D.O. sensor as follows.

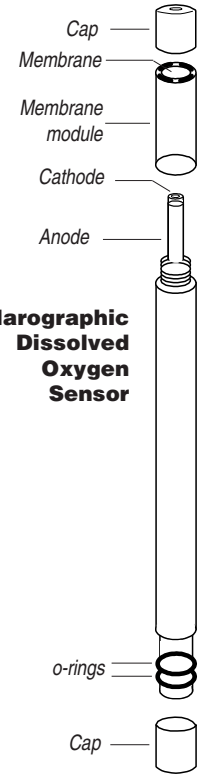
FILL THE MEMBRANE MODULE

New sensors are shipped with a dry membrane module loosely attached.

1. Remove the soft protective caps from the membrane end and the connector end of the sensor.
2. Remove the membrane module from the sensor body and fill with electrolyte as follows: Holding the membrane module open-end up, position the electrolyte dispenser against the side of the module without touching the membrane. Fill slowly.

TIP: *To eliminate air bubbles, tap the side of the module briskly with your fingernail.*

3. Insert the sensor into the open end of the membrane module. To minimize air, some of the electrolyte should overflow from the open end as the sensor is inserted.



Polarographic Dissolved Oxygen Sensor

4. Thread the membrane module to the D.O. sensor.

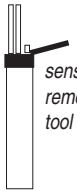
   Be sure the membrane does not leak. You should not see any drops on the surface. There should be no visible air bubbles.

5. Install and condition the sensor as described below. Then you're ready to calibrate.

INSTALL THE SENSOR IN THE MP TROLL 9500

*The polarographic D.O. sensor will function properly only when installed in **port 2**.*

1. Remove the restrictor or Cal Cup from the front end of the MP TROLL 9500. This allows access to the sensor block shown in the drawing below.
2. Remove any moisture or dirt from the area around port 2, then use the sensor removal tool to remove the plug or sensor from port 2. Retain the plug for future use.


sensor removal tool

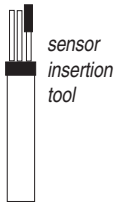
3. Remove any moisture or dirt from the port connector with a clean swab or tissue.
4. Check lubrication of the sensor o-rings.

   TIP: The sensor o-rings require generous lubrication before installation. New sensors will be lubricated at the factory. If the o-rings appear dry, apply a silicone lubricant before installation.

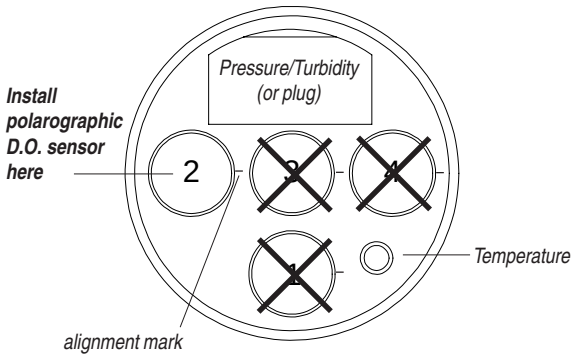
5. Handling the sensor by the sides, not the tip, align the mark on the side of the sensor with the mark on the port.

   Avoid touching the membrane at the tip of the sensor. Contaminants on the membrane can change its properties and affect measurements.

6. Use the sensor insertion tool to press the sensor into the port until you feel it dock with the connector at the bottom. When properly inserted a small gap (width of the sensor removal tool) remains between the widest part of the sensor and the instrument body, for ease of removal.


sensor insertion tool

7. Turn the sensor "on" and condition it, as described next.



CONDITION A NEWLY INSTALLED SENSOR

Condition a new sensor, or one with a new membrane, as follows:

1. Fill and install the sensor as described above.
2. Connect the MP TROLL 9500 to a PC and establish a connection in Win-Situ 4 or Pocket-Situ 4.
3. Select the MP TROLL 9500 in the Navigation tree. All installed sensors will be displayed.

   Powering of the D.O. sensor begins as soon as the software recognizes the D.O. sensor and displays it in the Navigation tree. This starts the conditioning process.

   ***TIP:** If you plan to calibrate 100% D.O. in air, condition the sensor in a moist environment at ambient pressure—the loosely attached Cal Cup with a small amount of clean water is ideal.*

   If you will be calibrating 100% D.O. in water, condition the sensor dry.

We recommend that you allow the sensor to condition for 2-10 hours before calibrating. Testing has shown that 10 hours of conditioning yields very stable long-term performance.

***TIP:** It is not necessary to maintain the computer connection; conditioning continues as long as the sensor is installed.*

CALIBRATION

OVERVIEW

Several options are available for calibrating a polarographic sensor.

- **Quick Cal:** Calibrates all Basic sensors (pH, ORP, polarographic D.O., conductivity) at the same time with one convenient solution. This is a 1-point 100% D.O. calibration in air at ambient pressure.
- **Traditional calibration–1 point:** 100% D.O. may be calibrated either in air (saturated with water) at ambient pressure, or in water (saturated with air—for example, using a bubbler). The water method is generally more accurate, as it better represents actual field D.O. measurement conditions.
- **Traditional calibration–2 point:** 100% D.O. may be calibrated either in air or in water. 0% D.O. is calibrated in an oxygen-

depleted solution such as sodium sulfite or nitrogen-saturated water. A 2-point calibration is recommended

- when you expect to measure very low D.O. values (< 5 mg/L),
- when required by Standard Operating Procedures.

Nominal vs. Stable

To shorten the calibration time, you have the option to accept the calibration when "Nominal" stability is achieved. If the early value is accepted, the calibration point will be designated "USER SET" in the calibration report. If the calibration report indicates that calibration was performed through to stability then the instrument will operate as intended by In-Situ's quality standards.

CALIBRATION SOLUTIONS & EQUIPMENT

100% D.O. calibrations may be performed in water saturated with air, or in air saturated with water. Deionized water is available from In-Situ Inc., but any clean water may be used. In-Situ's bubbler calibration kit is designed for an efficient water calibration.

An oxygen-depleted solution is used to calibrate the 0% D.O. Sodium sulfite is available from In-Situ Inc. For a cleaner calibration, nitrogen-saturated water may be used.

RECOMMENDED CALIBRATION FREQUENCY

Your own experience is the best guide to how often the polarographic D.O. sensor will benefit from recalibration under conditions of normal usage. Refer to the general guidelines under "How Often to Calibrate" in Section 10, and the tech note on "Instrument Calibration."

Until a new polarographic sensor has been thoroughly conditioned, it may require more frequent calibration. In the absence of other indications, a calibration should be performed every 2-4 weeks.

In addition, the polarographic D.O. sensor should be conditioned for 2-4 hours and recalibrated in the following circumstances:

- after cleaning the sensor,
- after replacing the membrane module,
- when taking measurements at an elevation different from that at which the sensor was last calibrated.

Q: I did a Quick Cal. Why should I recalibrate D.O.?

A: *The D.O. Quick Cal, especially if done through to stability, can provide accurate measurement results. However, some procedures require a look-up table for the stimulus at a given temperature and pressure. This can be done in the traditional D.O. calibration. Also, better measurement results will be obtained when the 100% calibration is done in water saturated with air. This procedure is not provided for in Quick Cal. In addition, the traditional calibration provides for a 0% (0 ppm, 0 mg/L) calibration, which is recommended when measuring very low D.O. values.*

DISSOLVED OXYGEN CALIBRATION TIPS

The following discussion may help you to obtain the best results from the polarographic D.O. calibration.

- **Air or Water?** The software provides two options for conducting a 100% D.O. calibration:
  - **in air** (saturated with water). This is the condition during a Quick Cal in the inverted Cal Cup with the sensor membrane exposed to air, temperature sensor submerged, and Cal Cup vented to the atmosphere.
  - **in water** (saturated with air). In-Situ's bubbler calibration kit provides everything needed to create a vigorous bubbling action to insure air-saturated water. The Cal Cup is not used.

  Since dissolved oxygen measurements are typically made in water, calibrating in water will often yield better results. When calibrated in air, the membrane's behavior in water must be estimated.
- The D.O. calibration procedure is very sensitive to changes in temperature. Ideally, it should be done in an area protected from direct sunlight and away from ventilation ducts.
- The nature of the sensor membrane influences the response. Be sure to note the membrane thickness before starting the calibration. (If no thickness is indicated, the membrane is 1-mil Teflon.) Membrane thickness is more important with a 100% calibration in air.

DISSOLVED OXYGEN QUICK CAL

The procedure to Quick Cal the polarographic D.O. sensor, along with other Basic sensors, is in Section 3, Getting Started. This is a single-point 100% calibration in air (saturated with water).

The following traditional calibration is recommended for use when

- the user is required to enter a specific stimulus at the calibration temperature and pressure,
- calibration in water is preferred,
- a 0% calibration point is needed.

TRADITIONAL DISSOLVED OXYGEN CALIBRATION PROCEDURE

You may select a 1-point or a 2-point calibration. The first point (100% saturation) may be taken in air or in water.

Prepare the MP TROLL 9500 for water or air calibration as described on the following page.

Preparation for 100% D.O. Calibration in Water

The bubbler cal kit for the Polarographic D.O. sensor comes with (1) Battery-powered air pump and 2 alkaline D-cells, (2) Bubbler cup with aquarium stone, tubing, check valve and pinch valve, (3) Grey PVC adapter to support the TROLL 9500 in the top of the bubbler cup.

1. Install the batteries in the portable air pump as shown in the diagram on the inside of the lid.
2. Fill the bubbler container almost to the top with clean water. The optimum amount depends on the volume of the sensors installed in the MP TROLL 9500.

TIP: *Tap water is fine, unless it is high in salinity. It is easier to achieve 100% oxygen saturation in low-salinity water. Distilled water is readily available and works well.*

3. About 10 minutes before calibration, turn on the bubbler. Regulate bubbling with the pinch valve. For best results, run at the full flow rate to achieve saturation; after 10 minutes you can use the control valve to match the water turbulence conditions expected in the field.
4. Before beginning the calibration procedure, note the membrane thickness stamped on the membrane module.
5. With the D.O. sensor installed and plugs or sensors in the other sensor ports, rinse the front end of the MP TROLL 9500 thoroughly in clean water to remove contaminants and traces of fluids used for earlier calibrations.
6. When ready to calibrate, place the adapter securely in the top of the bubbler housing and insert the front (sensor) end of the MP TROLL 9500 into the adapter.

   - Insure the D.O. sensor is not in the aeration path. Rotate as necessary to prevent air bubbles from collecting on the membrane surface.
   - Insure the temperature sensor is submerged at least 0.5" (12 mm) in the aerated water.

Allow a few minutes for the temperature to stabilize, especially if you plan to enter a temperature dependent value from a look-up table.

Preparation for 100% D.O. Calibration in Air

TIP: *Before beginning the calibration procedure, check the side of the membrane module for the membrane thickness.*

1. With the D.O. sensor installed and plugs or sensors in the other sensor ports, rinse the front end of the MP TROLL 9500 thoroughly in clean water to remove contaminants and traces of fluids used for earlier calibrations.
2. Dry the D.O. sensor membrane by shaking the probe and/or gently wiping with a soft swab or the corner of a tissue.
3. Rinse the empty Cal Cup and attach it to the MP TROLL 9500. Thread the Cal Cup onto the body until it is seated against the o-ring, then back off slightly to avoid overtightening.
4. Invert the TROLL with Cal Cup attached and remove the black end cap from the Cal Cup.
5. Gently fill the Cal Cup with clean water until the temperature sensor is completely covered and the membrane at the tip of the D.O. sensor is in air. If any water splashes onto the membrane, ***gently*** blot the center of the membrane with a clean cotton swab or the corner of a soft lint-free tissue.

6. Loosely attach the end cap to the Cal Cup. For proper venting, a small hole in the threads of the cap should be at least partly visible to achieve ambient pressure conditions.

   You may wish to use a clamp or other support to maintain the TROLL 9500 in this inverted position.

Allow a few minutes for the temperature to stabilize, especially if you plan to enter a temperature dependent value from a look-up table.

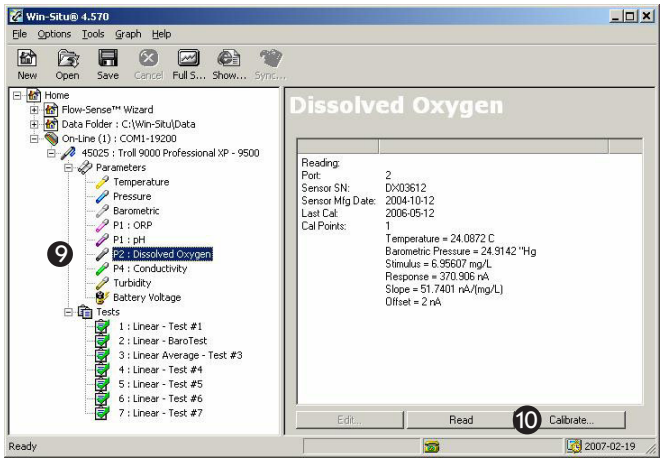
7. If not already connected, connect the MP TROLL 9500 to a PC, launch the software, and "find" the device. Win-Situ screens are illustrated here. The Pocket-Situ interface is similar, with the Navigation tree at the top and the Information pane below it.

8. Select the MP TROLL 9500 in the Navigation tree.

   The software will automatically detect and display the installed sensors.

9. Select Dissolved Oxygen in the Parameters list.

   The sensor serial number (SN) and recent calibration information is displayed, as shown in the screen below.



10. Select **Calibrate**.

After dealing with barometric pressure the D.O. Calibration Wizard displays a screen like the one below:

12. Select the number of calibration points.

    1 point—100% D.O.
    2 points—100% and 0% D.O.

13. Select the membrane type (stamped on membrane module, if not, it's 1-mil Teflon). If calibrating in water, the membrane thickness is not crucial. When calibrating in air, be sure the correct membrane type is selected.

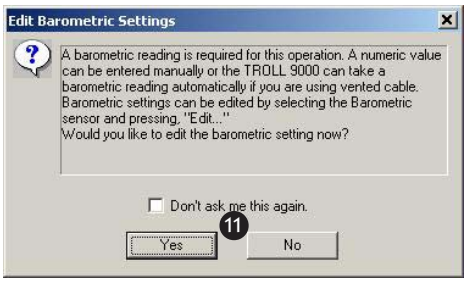
14. Select Air or Water as the medium for the first calibration point.

15. Select the stimulus at saturation:

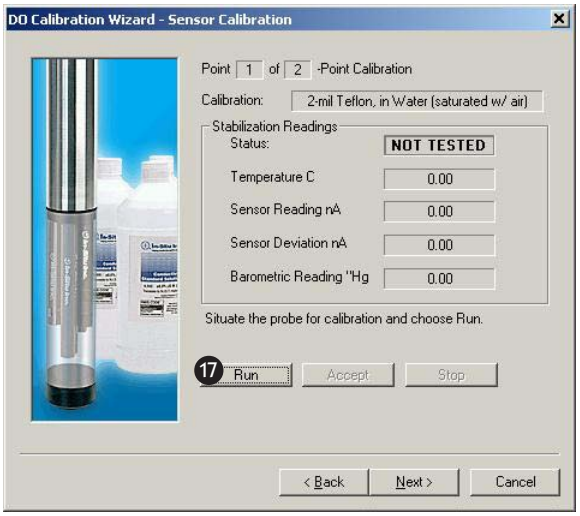
    - Default—This value is calculated by the software at the current temperature and barometric pressure.
    - User Set—Enter a value from a look-up table if required.

11. Before the DO Calibration Wizard starts, you will be asked how you want to handle barometric pressure. Cable venting is essential to obtain accurate measurement, and the software cannot tell if this cable is vented, so please take a moment to supply this information. Do one of the following:

    - If the TROLL 9500 is on **vented** cable now and will take measurements using **vented** cable, click No — and you may want to check the "Don't ask me this again" box.
    - If the device is on **vented** cable now but will take measurements using **non-vented** cable, click Yes. In the Edit Barometric Channel screen, check the box indicating non-vented cable for measurements but vented cable for calibration/programming.
    - If the device is on **non-vented** cable now and will take measurements on **non-vented** cable, click Yes. In the Edit Barometric Channel screen, check the box indicating non-vented cable for measurements and enter a barometric pressure value. For help in supplying information if the cable is not vented, see Section 9, Monitoring Barometric Pressure.



16. Click **Next** to continue. A screen like this will be displayed:



17. Select **Run** to begin stabilization for the first calibration point.

    The display will continuously update as readings are taken and compared against the stabilization criteria.

- Status indicators:

  NOT TESTED is displayed until you begin the calibration by selecting Run.

  UNSTABLE indicates the sensor response does not meet the criteria for a valid calibration point.

  NOMINAL indicates the sensor deviation meets early stabilization criteria.

  The **Accept** button becomes available when nominal stability is achieved. You may accept the early value, or wait for complete stability. If you accept the early value, the status will be designated "USER SET" in the calibration report. (For more on calibration reports, see "Calibration History" in Section 10.)

  STABLE is displayed when the readings have stabilized sufficiently to take a valid calibration point. The calibration proceeds automatically to the next screen.

- Sensor Reading: The current sensor response in nanoAmps.

- Sensor Deviation: Change in response between the last 2 readings. This enables you to follow the progress of the stabilization, but the deviation from the previous reading is not necessarily the best indicator of stability as the software is looking at longer-term trends.

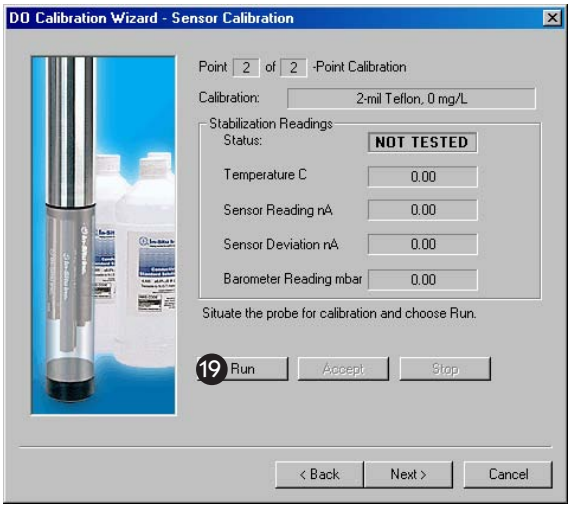
- Current temperature and barometric pressure are shown; these values are used to calculate the stimulus.

***TIP:** If the calibration stimulus was entered from a look-up table at step 15 and the temperature is not as expected, you may select Stop, then Back to retrieve the Setup page and re-enter the User Set stimulus.*

18. When readings have stabilized (or you click to **Accept** the Nominal result), the calibration will advance automatically.

    If doing a 1-point calibration, go to step 20.

    For a 2-point calibration, the Wizard displays a screen similar to the one shown below and waits for you to situate the sensor in oxygen-depleted medium—either the Cal Cup filled with sodium sulfite solution, or a nitrogen-saturated water bath.This time, the D.O. sensor membrane should be completely immersed in solution, as well as the temperature sensor.

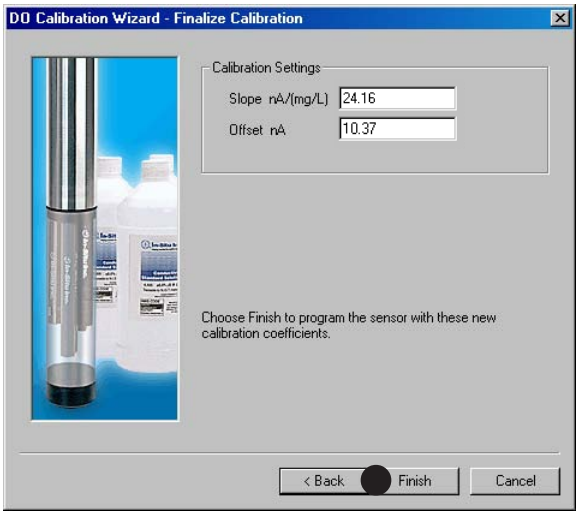


    Allow about 15 minutes for the sensor to stabilize in the medium.

19. Select **Run** to begin the stabilization for the 0% calibration point. Controls and status indicators are the same as for the first calibration point (step 17).

In true 0% conditions, the sensor reading will be 10 nA or less. If the sensor needs maintenance or there is oxygen in the medium, readings will be higher than 10 nA and complete stability will never be reached. If an accurate 0% calibration is important to your application, do not accept Nominal. Cancel the calibration, perform sensor maintenance and/or check the conditions, and repeat the calibration.

20. When readings have stabilized (or you **Accept** the Nominal value), the final screen is displayed. The calculated sensor slope and offset are shown.



21. Select **Finish** to program the sensor with the new calibration coefficients. The values will be written to the sensor and you will be asked if you want to see the calibration report.

TIP: *You can look at the calibration report right after calibrating, or at any time. See "Calibration History" in Section 10 for details.*

Rinse the sensor and front end of the instrument **very** thoroughly after calibrating in sodium sulfite solution. A good way to do this is to fill the Cal Cup with water, attach to instrument, and shake vigorously. This may need to be done a couple of times.

TIP: *The calibration solution may be flushed down the drain with running water, or saved in a separate container and used to rinse the sensors the next time you calibrate with the same solution.*

After everything is thoroughly rinsed, the D.O. sensor is ready to use.

Why does it take so long for the D.O. 100% to stabilize in air?

Paying attention to several factors can assure the shortest stabilization times possible within the stability algorithm:

- *The sensor membrane is perfectly dry.*
- *The ambient temperature is stable.*
- *The temperature sensor is submerged.*
- *The sensor has been fully conditioned.*

If these conditions are met, the sensor response should stabilize in 6-15 minutes.

Options for storing the sensor:

We recommend you leave the D.O. sensor installed in the instrument; this will assure you are able to take fast D.O. measurements on demand. A little water (distilled, deionized, or tap) or a damp sponge in the Cal Cup will keep the sensor membrane moist.

Remember that, as long as the D.O. sensor is installed, it is being conditioned.

If the sensor is removed from the instrument and then re-installed, conditioning will begin as soon as the sensor is detected by the instrument and displayed in the software.

SENSOR SLOPE AND OFFSET

The slope of a properly functioning sensor as calculated during the calibration process will typically be in the following ranges, depending on the membrane thickness:

1-mil membrane: between 30 and 67 nA/(mg/L)
2-mil membrane: between 15 and 34 nA/(mg/L)

If the calculated slope is much outside the stated range, the sensor may need maintenance. Refer to "Sensor Care and Handling" below.

The default offset for Quick Cal and 1-point calibrations is 2 nA. Offsets for 2-point calibrations should fall under 10 nA.

UNITS AND CALCULATED MEASUREMENTS

Four units are available for dissolved oxygen:

TIP: *To change unit preferences: In Win-Situ, select Preferences on the Options menu. In Pocket-Situ, select the Home site, then tap Setup in the command bar.*

- Oxygen concentration in milligrams of oxygen per liter of water (mg/L). Since a liter of pure water weighs 1000 grams, and a milligram is 1/1000 of a gram, this is equivalent to ppm (parts per million).
- Oxygen concentration in micrograms of oxygen per liter of water (µg/L).
- Oxygen concentration in microMolar (µmol/L), = mg/L x 31.25
- Oxygen saturation in % —100% D.O. being the maximum amount of oxygen that can be dissolved in water at a given atmospheric pressure, water temperature, and salinity. % saturation output is automatically corrected using the TROLL 9500's temperature, conductivity, and barometric pressure values (from a baro sensor on vented cable or from a user-entered input). If no conductivity sensor is present, salinity is assumed to be zero.

USAGE RECOMMENDATIONS AND CAUTIONS

The amount of oxygen that can be dissolved in water decreases at higher temperatures and decreases with increasing altitude (i.e., as barometric pressure drops) and salinity. In other words, as water becomes warmer and saltier, it can hold less and less dissolved oxygen.

During tests that include the D.O. channel, the MP TROLL 9500 automatically measures barometric pressure and temperature for compensation of D.O. readings.

The barometric pressure value at the time of calibration is stored in the sensor and will be used to correct D.O. readings for weather-induced pressure fluctuations taken at the same relative barometric pressure as the calibration. However, the large changes in barometric pressure due to changes in elevation are best accommodated by performing a recalibration. If you calibrate at sea level, for example, and use the instrument in the mountains, you should perform a recalibration at the new altitude.

Be sure to supply a barometric pressure value to correctly calculate dissolved oxygen measurements if the sensor will be attached to suspension wire or non-vented cable, . This can be done during calibration or prior to setting up a test.

To assure you are able to take fast D.O. measurements on demand, it is best to leave the D.O. sensor installed in the MP TROLL. This takes full advantage of the conditioning and polarization that was accomplished during calibration. After replacing the TROLL 9500 batteries, be sure to power the sensor for an hour or two before use, especially if the batteries were out for a while.

During the first day, some drift is to be expected. After 24 hours or so, the D.O. values can be expected to stabilize.

The D.O. sensor, like the other water-quality sensors, has been tested to 350 psi pressure (246 m, 807 ft). We recommend gradual submersion and retrieval—no faster than 4 ft per second.

STIRRING

Polarographic D.O. measurements drop in very stagnant water due to depletion of oxygen next to the membrane. A slight perturbation to the system will cause the D.O. measurements to return to normal.

Stirring is not necessary for a hand-held instrument, an instrument attached to a boat or floating object, or in any other situation where the water is moving.

When do I need to stir and when can I skip it?

Use a stirrer for best results when measuring D.O. in still or stagnant water.
If the water (or the person holding the instrument) is moving at all, you can probably safely skip the stirring. Any water movement, as for example when the instrument is hand-held, eliminates the need for the stirrer.

Stirring is recommended if the instrument is anchored to a fixed structure in stagnant conditions—for example, attached to a pier in a calm lake that has no underwater currents. If the wind is blowing and waves are slightly moving the cable, then stirring is probably not necessary.

Attaching the Stirrer

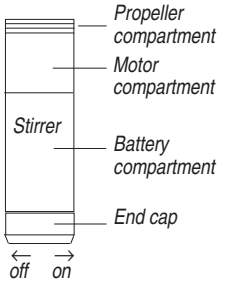
Install the stirrer accessory on the MP TROLL 9000 as follows:

1. Remove the nose cone from the MP TROLL 9500 and set it aside.
2. Screw the top of the stirrer (propeller end) to the stainless steel restrictor in place of the nose cone.

Starting the Stirrer

The stirrer is powered by two alkaline D-cells (installed). To start the motor, tighten the end cap.

The magnetic stir bar in the propeller compartment will start to spin. The stir bar is protected by a guard plate that may be removed for cleaning if necessary.



***TIP:** If the stir bar does not start spinning, try giving it a gentle nudge by sliding a narrow tool such as a screwdriver or key between the protective bars of the guard plate.*

To turn the stirrer off, back off the end cap until the stir bar stops spinning.

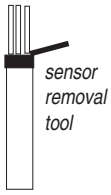
SENSOR CARE AND HANDLING

The D.O. sensor kit includes the following items for routine maintenance of the D.O. sensor:

- extra membrane module
- electrode filling solution (KCl electrolyte)
- cleaning solution and brush
- polishing strips (for cathode)
- storage bottle
- o-ring lubricant

SENSOR REMOVAL

Position the yoke of the sensor removal tool at the point where the sensor meets the sensor block and pry the sensor upward.



Always handle the sensor by the sides. Avoid touching the membrane at the sensor tip.

MAINTENANCE/INSPECTION

Inspect the sensor and membrane if readings begin to drift.

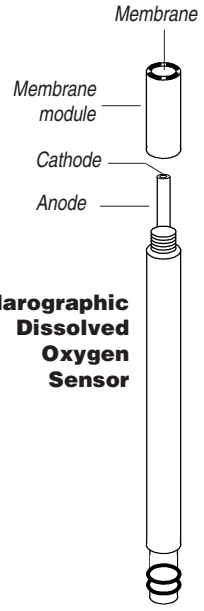
- Check for discoloration of the electrodes due to silver chloride (AgCl) deposition.
- Inspect the membrane for integrity of the surface, for the presence of algal growth or other contaminants, for crystallization that may indicate a leak in the membrane, and to ensure no air bubbles are trapped under the membrane.

CLEANING THE ELECTRODES

Remove the membrane module and clean the electrodes as follows:

Cathode. Use a polishing strip to buff the platinum cathode until it is shiny. This removes any deposits, increasing the chemically active surface of the electrode for a stronger D.O. signal.

Anode. If the sensor appears to be excessively discolored from its original matte grey color, clean the anode with ammonia and a soft brush. Extreme discoloration may be removed by soaking for a half-hour in ammonia before cleaning with a brush. The surface of the anode should appear uniform, but not necessarily mirror-like.



Polarographic Dissolved Oxygen Sensor

Regular cleaning will prevent pitting of the anode surface, caused by accumulated silver chloride deposition. Severe pitting cannot be removed; the sole remedy is to replace the sensor.

After cleaning, rinse thoroughly and shake to dry. Then fill and attach a new membrane module as follows.

REPLACING THE MEMBRANE MODULE

The D.O. sensor performs best in clean water. In environments with high organic content, the membrane can become fouled. Rips, tears and other damage will also affect membrane performance. For best results, replace the membrane when the slope and offset calculated during calibration change dramatically.

The current applied is so small that the electrolyte solution can be expected to last longer than the membrane in most applications

To replace a membrane module:

1. Make sure the area around port 2 is free of dirt and moisture, then remove the sensor. Remove and discard the used membrane module.
2. Inspect and clean the sensor as needed (see above).
3. Fill a new membrane cap with electrolyte and attach it to the sensor. Refer to "Filling the Membrane Module" earlier in this section.
4. Install and condition the sensor. Refer to "Conditioning a Newly Installed Sensor" earlier in this section.

Remember to condition the sensor for at least 2 hours, preferably 10 hours, before recalibrating with a new membrane. Even with all visible air bubbles removed, a certain amount of gas will be trapped under the membrane. The conditioning period will remove this excess oxygen.

SENSOR LIFE

The sensor body may be expected to last indefinitely so long as the silver coating is not rubbed off the anode during cleaning. The membrane module should be inspected regularly and replaced when it shows wear or damage and when the slope and offset calculated during calibration change dramatically.

STORAGE

Short-Term Storage (up to a two weeks)

Store assembled with membrane immersed in water. A suitable storage bottle is included in the sensor box.

Long-Term Storage

Remove the membrane module, rinse with deionized water, cap and store dry.

REFERENCES

Eaton, A.D., L.S. Clesceri, E.W. Rice, and A.E. Greenberg, eds., *Standard Methods for the Examination of Water and Wastewater,* 21st edition, Washington, D.C.: American Public Health Association, American Water Works Association, and Water Environment Federation, 2005. Section 4500-O G, Oxygen (Dissolved), Membrane Electrode Method.

EPA, Methods for Chemical Analysis of Water and Wastes, EPA/600/4-79-020, revised March 1983. Method 360.1, Oxygen, Dissolved, Membrane Electrode. Approved at 40 CFR Part 136.

THE RDO® OPTICAL DISSOLVED OXYGEN SENSOR

THEORY OF OPERATION

The RDO® Optical Dissolved Oxygen sensor measures dissolved oxygen using the principle of "dynamic luminescence quenching."

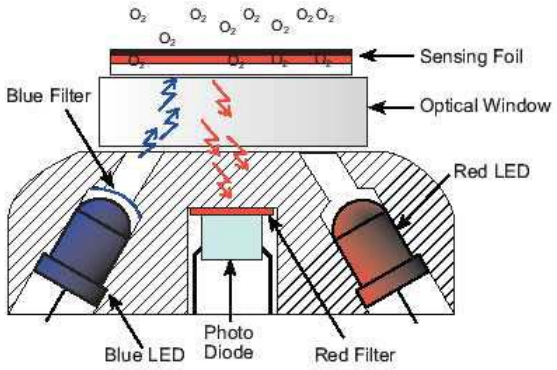
Certain molecules, called "luminophores," fluoresce when excited by light of a specific wavelength. Oxygen molecules act as dynamic fluorescence quenchers. The luminophores in the sensor are embedded in a gas-permeable sensing foil, which is protected by a gas-permeable black optical isolation coating.

In addition to the foil, the sensor contains a blue LED, a photodetector, and a DSP (Digital Signal Processor) chip. When the blue LED emits light, the sensing foil emits red photons; the presence of oxygen in the foil causes a reduction in red light detected by the photo diode. The LED is pulsed (on-time is approximately 200 msec) and the phase difference between the blue excitation light and the returned red light is measured by the DSP. The result is used to compute dissolved oxygen.

The amount of red light could be measured, but its intensity is affected by photo bleaching of the foil and other factors. A more reliable method is to measure the "phase" (or delay) of the returned signal. This measurement method is thus based on the "lifetime" rather than the "intensity" of the fluorescence.

COMPARISON TO POLAROGRAPHIC D.O. SENSOR

The RDO Optical Dissolved Oxygen sensor has several advantages over the more traditional electrochemical cell. Its solid-state design does not use membranes, filling solution, or other consumables. The sensor does not consume oxygen, thus it does not require flow past the sensor for measurement of D.O. It does not require conditioning before use or hydration when not in use. It exhibits very little drift, therefore it does not require frequent calibration. In the absence of biofouling, it does not need frequent routine maintenance. The single replaceable item (sensing foil) could last up to five years if not damaged.



The RDO Sensor and Salinity

Unlike an electrochemical cell, the Optical D.O. sensor does not respond to changes in salinity. Since the absolute solubility of oxygen is lower in salty water, it is advantageous to compensate D.O. concentration readings (µg/L, mg/L, µmol/L) to insure that the sensor accurately reports the concentration of dissolved oxygen in the presence of significant salinity. This can be accomplished by storing a salinity value in the sensor before taking measurements. The compensation algorithm is applied internally before concentration is reported. The degree of compensation is minimal at very low salinities, and several percent of reading at oceanic salinity levels.

The software prompts for a salinity value when you add a test. The value can be changed at any time by selecting the RDO sensor in the Navigation tree and clicking **Edit**, then "Edit RDO Salinity Value."

SENSOR INSTALLATION

You will need—

- Multi-Parameter TROLL 9500
- Lithium batteries (packaged separately)

  Use only Saft LSH-20 3.6V lithium D cells (the type supplied by In-Situ). Use of any other lithium battery will void the warranty of the RDO sensor and the TROLL 9500.

- Latest version of MP TROLL 9500 firmware—this comes loaded in a new instrument, or is available with download of new software on the In-Situ website at www.In-Situ.com
- RDO sensor package, with
  - flow restrictor
  - nose cone
  - installation adapter plate
  - rigid sensor cable harness with adapter board firmware
- Latest version of Win-Situ 4/ Pocket-Situ 4 software—this is shipped on a CD with a new MP TROLL 9500, or is available from the In-Situ website at www.In-Situ.com
- TROLL Com communication cable
- Desktop/laptop PC or PDA

UNPACK THE RDO SENSOR

The sensor is shipped in an Adapter/Restrictor/Nose cone assembly.

1. Remove the nose cone, pull out the packaging and the soft Cal Cup insert, unscrew the restrictor from the adapter. The RDO sensor is installed in the adapter with its cable coiled into the restrictor.

   The soft Cal Cup insert enables calibration of the Basic sensors when the RDO sensor is installed (the standard Cal Cup will not fit). It contains

   - an extra screw for the adapter plate
   - a sponge to create a moist environment for temporary storage of installed sensors that need to be kept wet

> *If you will be using the RDO sensor for low-flow monitoring, remove the sensor from the adapter plate and install it in the sealing adapter plate designed for the flow cell. Complete instructions are included with the flow cell (Catalog No. 0057600) and in Section 20 of this operator's manual.*

PREPARE THE MP TROLL 9500

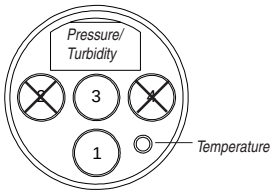
2. If using lithium batteries, install them in the MP TROLL 9500 following the instructions shipped with the batteries.

> *Please exercise great care in handling, installing, and shipping lithium batteries. Refer to the instructions, cautions and MSDS packed with the batteries.*

3. Remove the stainless steel restrictor or standard Cal Cup from the MP TROLL 9500 (if attached). This allows access to the sensor block with its four sensor ports.

4. Remove the plug or sensor from port 1 or 3 for installation of the RDO sensor. Port 1 is normally easier to access. TIP: If installing in port 3, you may wish to remove the port 2 sensor temporarily (if installed).

End view of sensor block



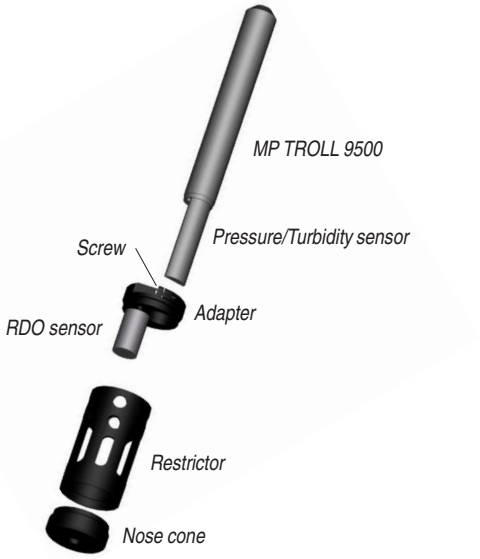
Step 3

Remove standard Cal Cup or restrictor

ATTACH THE RDO SENSOR TO THE TROLL 9500

5. Insert the front end of the MP TROLL 9500 through the large hole in the adapter, alongside the RDO sensor.

Step 5



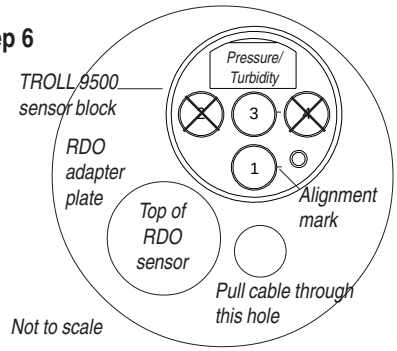
6. Press until the instrument's sensor block surface is flush with the adapter plate surface. Align the RDO sensor between sensor ports 1 and 2. Align the open hole for the RDO sensor cable beside port 1. Refer to the drawing below.

7. Tighten the adapter screw with a Phillips head screwdriver, not overly tight.

8. Feed the short black cable up through the open hole, so it is on the same side of the adapter plate as the TROLL 9500 sensor block (refer to the drawing below).

9. Remove the soft cap from the connector end of the RDO sensor cable harness. Align the mark on the side of the sensor with the alignment mark on the selected port (1 or 3). Or just visually align the 3-pin connector on the cable harness with the connector in the selected port.

Step 6



10. Press the cable harness into the port until you feel it dock with the connector. When properly inserted a small gap (width of the sensor removal tool) remains between the instrument body and the widest part of the cable harness, for ease of removal.
11. Rotate the RDO sensor slightly as needed so that the optical window area is facing outward (away from the other sensors).

TIP: *When a turbidity wiper is installed, be sure to pull the slack in the RDO adapter cable back against the TROLL 9500 body so it will not interfere with the wiper's rotation.*

The RDO sensor is now installed and ready to calibrate.

TIP: *New RDO sensors have been factory-calibrated at 0% and 100% dissolved oxygen. A field calibration at oxygen saturation (100%) should be done on a new sensor. For best results, a 0% calibration is also recommended.*

For field use, attach the black flow restrictor to the adapter plate. The small holes in the restrictor face toward the MP TROLL 9500 body. The nose cone is optional, but recommended for protection of the sensors.

When properly assembled to the TROLL 9500, the RDO sensor looks like this:

CALIBRATION

OVERVIEW

Calibration of the RDO Optical Dissolved Oxygen sensor has two parts:

- **Foil Coefficients:** Twenty constants ("coefficients") unique to each batch of sensing foil describe the sensor's behavior with respect to oxygen concentration and temperature. These coefficients are pre-loaded in a new sensor and *need to be changed only when the foil is changed*. Since changing the foil is not expected to be a frequent occurrence, this aspect of the calibration is deferred to the end of this chapter; see the section "Sensor Care & Handling."
- **Calibration Constants:**The sensor in combination with the sensing foil has four calibration constants (called "phase coefficients") that are automatically calculated when a two-point calibration is performed using two controlled oxygen concentrations. These phase coefficients are stored in the sensor. After changing or moving the foil a new calibration must be performed to obtain the best accuracy.

Nominal vs. Stable

To shorten the calibration time, you have the option to accept the calibration when "Nominal" stability is achieved. If the early value is accepted, the calibration point will be designated "USER SET" in the calibration report. If the calibration report indicates that calibration was performed through to stability then the instrument will operate as intended by In-Situ's quality standards. For more on calibration reports, see Section 10 of this manual.

TIP: *During calibration, salinity is set to 0 PSU. A salinity value stored in the sensor is restored after calibration is complete. For more information on storing a fixed salinity value in the sensor, see The RDO Sensor and Salinity earlier in this chapter.*

CALIBRATION SOLUTIONS

100% D.O. calibration is performed in water saturated with air. We recommend a container of clean water aerated with In-Situ's RDO bubbler cal kit (Catalog No. 0048580) or an aquarium pump.

0% D.O. calibration is performed in an oxygen-depleted solution. Sodium sulfite (Na_2SO_3, Catalog No. 0017670) is available from In-Situ Inc. Bubbled nitrogen may be used; in this case allow plenty of time for the oxygen to be completely purged from the water.

RECOMMENDED CALIBRATION FREQUENCY

Calibration frequency is more predictable than with electrochemical D.O. sensors, since the sensor does not drift appreciably and is not affected by fouling (except biofouling from organisms that generate or consume oxygen). If the foil is not mechanically damaged or moved, calibration can last a year or more.

TIP: *For best results, recalibrate the RDO Optical D.O. sensor once a year.*

Q: Why is there no Quick Cal option for the RDO Optical D.O. sensor ?

A: Quick Cal is used to calibrate sensors that are known to drift and otherwise lose measurement accuracy on a time scale shorter than desired for field use. Thus a Quick Cal provides a simple and potentially less accurate means to calibrate the sensor but in so doing will improve the sensor accuracy as compared to the state to which it may have drifted. It is less accurate but also less costly than removing the instrument to a laboratory setting to perform traditional multi-point calibrations.

Because the RDO sensor does not drift appreciably in media void of bio-fouling, there is nothing to be gained from a Quick Cal. A traditional two-point laboratory calibration once a year will result in accurate measurements. If biofouling is detected, thorough cleaning and subsequent calibration may need to be done more frequently.

TRADITIONAL TWO-POINT CALIBRATION

The optical D.O. sensor should be calibrated under stable and controlled conditions, such as are found in a laboratory setting.

One or both calibration points can be taken, in any order. If only one point is taken, the software retains the results of a previous calibration for the other point.

A 2-point calibration (100% and 0%) is recommended

- when you expect to measure very low D.O. values (< 5 mg/L),
- when required by Standard Operating Procedures,
- after replacing the sensing foil,
- once a year if the sensing foil has not been replaced.

OXYGEN SATURATION POINT

1. Submerge the RDO sensor in a container of clean water aerated with an aquarium pump or In-Situ's bubbler accessory. Insure the sensor is completely submerged.

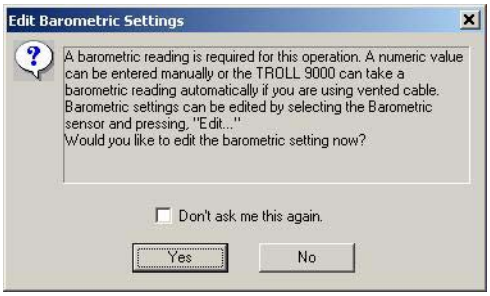
   Allow 5-10 minutes for temperature and oxygen equilibration.

TIP: *The equilibration time depends on the condition of the water wirh respect to temperature and exposure to air.*

2. Connect the MP TROLL 9500 to a PC and establish a connection in Win-Situ 4 or Pocket-Situ 4. Win-Situ screens are illustrated here. The Pocket-Situ interface is similar, with the Navigation tree at the top and the Information pane below it.
3. Select the MP TROLL 9500 in the Navigation tree. The software will automatically detect and display the installed sensors.
4. Select Rugged Dissolved Oxygen in the Parameters list.

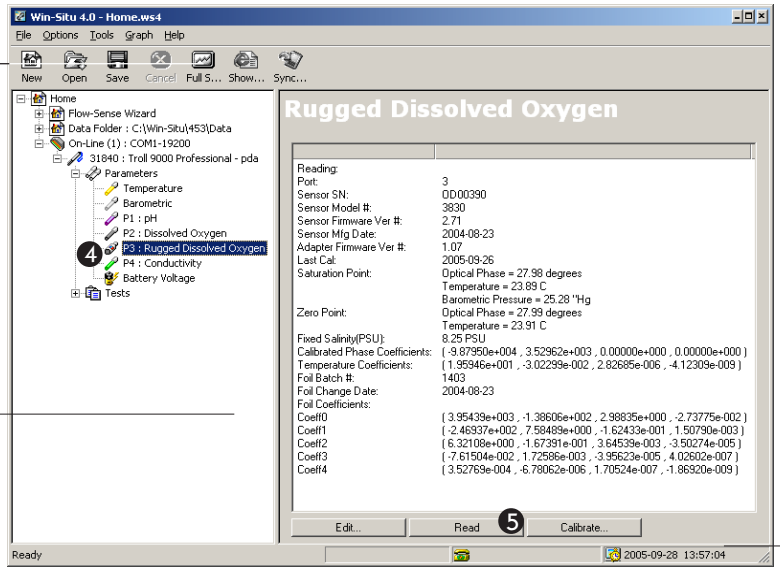
   Information on the RDO sensor is shown, including its serial number (SN), the foil batch number, and recent calibration information, as shown in the large screen at the bottom of the page.
5. Select **Calibrate**.
6. Before the RDO Calibration Wizard starts, you will be asked how you want to handle barometric pressure.

   Barometric pressure is important in converting measurement of D.O. concentration to percent saturation, and a value is required for accurate calibration. Cable venting is essential to obtain accurate measurement from the device's internal barometric pressure sensor, and the software cannot tell if this cable is vented, so please take a moment to supply this information.



(continued on the next page)

Full Screen button



TIP: *To see all of the information pane, you can click the "Full Screen" button on the Win-Situ toolbar.*

Information on the sensing foil

Device clock

The dialog box shown above asks if you wish to edit the barometric settings in the absence of vented cable. Do one of the following:

- If the TROLL 9500 is on **vented** cable now and will take measurements using **vented** cable, click No — and you may want to check the "Don't ask me this again" box.
- If the device is on **vented** cable now but will take measurements using **non-vented** cable, click Yes. In the Edit Barometric Channel screen, check the box indicating non-vented cable for measurements but vented cable for calibration/programming. For help, see Section 9, Monitoring Barometric Pressure.
- If the device is on **non-vented** cable now and will take measurements using **non-vented** cable, click Yes. In the Edit Barometric Channel screen, check the box indicating non-vented cable for measurements and enter a barometric pressure value. For help, see Section 9, Monitoring Barometric Pressure.

After dealing with barometric pressure, a screen like this will be shown for the Oxygen Saturation point.

7. When the sensor is situated in the calibration medium for Oxygen Saturation, click or tap **Run**.

   The display will continuously update as readings are taken and compared against the stabilization criteria.

- Status indicators:

  NOT TESTED is displayed until you begin the calibration by selecting Run.

  UNSTABLE indicates the sensor response does not meet the criteria for a valid calibration point.

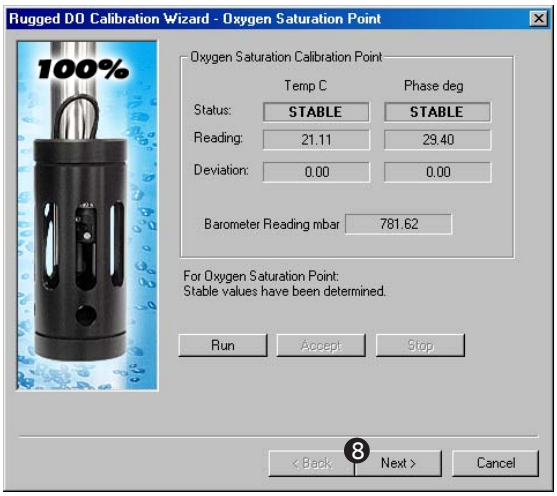
  NOMINAL indicates the deviation meets early stabilization criteria.

  The **Accept** button becomes available when nominal stability is achieved. You may accept the early value, or wait for complete stability. If you accept the early value, the status will be designated "USER SET" in the calibration report. (For more on calibration reports and the difference between Nominal and Stable, see Section 10 of this manual.)

  STABLE is displayed when the readings have stabilized sufficiently to take a valid calibration point.

- Reading: The temperature sensor response in degrees C, and RDO sensor response in degrees of phase angle. Win-Situ automatically detects stability in both parameters.
- Deviation: Change in response between the last 2 readings. This enables you to follow the progress of the stabilization, but deviation from the previous reading is not necessarily the best indicator of stability as the software is looking at longer-term trends.
- Current barometric pressure in your selected unit.

8. When readings have stabilized, the screen will appear similar to the one below, and you have several choices:



- Select **Next** to display the Zero Oxygen Point screen. Continue with step 9.
- Select **Next**, then **Next** again to finalize the calibration if you are performing a one-point calibration. Go to step 12.
- Select **Run** to run the oxygen saturation point again if the temperature did not appear stable, or you believe the sensor values did not "bottom out." Go back to step 7.

ZERO OXYGEN POINT

9. Immerse the RDO sensor in an oxygen-depleted medium:

   - Sodium sulfite (Na_2SO_3) solution is generally reliable if somewhat messy. Use a laboratory beaker or In-Situ's special zero-point cal cup. Be sure the small well in front of the sensing foil is filled with solution.
   - Nitrogen bubbling requires considerable time for oxygen to be completely purged from the water.

   Submerge the sensor completely, and check to be sure that there are no air bubbles on the sensing foil.

   Allow up to 15 minutes for temperature equilibration. A titanium sensor will reach equilibration before an acetal sensor.

10. When you are ready to take the calibration point, click or tap **Run** in the Zero Oxygen Point screen.

   The display will continuously update as readings are taken and compared against the stabilization criteria. Controls and status indicators are the same as for the Oxygen Saturation calibration point (step 7).

11. When readings have stabilized, the screen will appear similar to the one shown in step 8, and you have several choices:

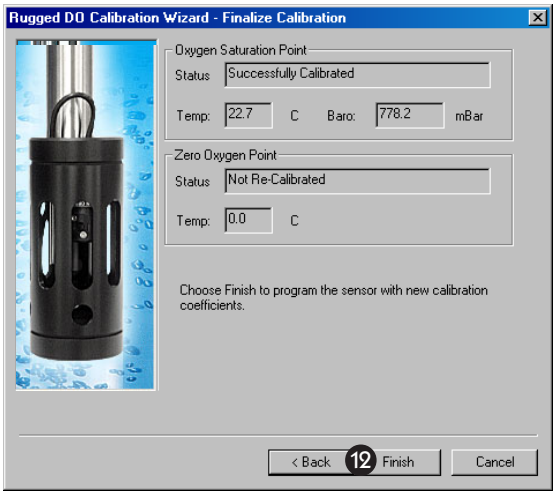
   - Select **Next** to finalize the calibration. Continue with step 12.
   - Select **Back** to calibrate the Oxygen Saturation point (step 7).

   TIP: *Sodium sulfite consumes oxygen aggressively. If performing the oxygen saturation point next, be sure to rinse the TROLL 9500 and RDO sensor* ***thoroughly*** *to avoid cross-contamination.*

   - Select **Run** to run the zero oxygen point again if the temperature did not appear stable, or you believe the sensor values did not "bottom out." Go back to step 10.

FINALIZE THE CALIBRATION

12. The final calibration screen is shown below. In this case, a one-point calibration at saturation was performed. To finalize the calibration click **Finish**.



   The values will be written to the sensor and you will be asked if you want to see the calibration report.

   TIP: *For more on Calibration Reports, see Section 10 of this manual.*

The RDO sensor is now calibrated and ready to take readings. To confirm this, take a reading by selecting the RDO sensor in the Navigation tree and clicking the **Read** button.

TIP: *If the units for the reading are not what you expect, it is easy to change the units selection: In Win-Situ, select Preferences on the Options menu. In Pocket-Situ, select the Home site, then tap Setup in the command bar.*

***TIP:** Rinse the sensor and front end of the instrument **very** thoroughly after calibrating in sodium sulfite solution to avoid cross-contamination.*

The solution may be poured back into the bottle, tightly capped, and reused.

If you suspect the power of the sodium sulfite is beginning to deteriorate, note the phase degrees calculated during a zero-point calibration. If this number changes significantly on your next calibration, then the solution is probably old and weak, and should be replaced.

DEGREES OF PHASE ANGLE

The phase (degrees) values calculated during calibration of the RDO sensor can be expected to fall within these ranges:

Oxygen Saturation	25 – 35 degrees
Zero Oxygen	50 – 70 degrees

UNITS AND CALCULATED MEASUREMENTS

Four units are available for dissolved oxygen:

***TIP:** To change unit preferences: In Win-Situ, select Preferences on the Options menu. In Pocket-Situ, select the Home site, then tap Setup in the command bar.*

- Oxygen concentration in milligrams of oxygen per liter of water (mg/L). Since a liter of pure water weighs 1000 grams, and a milligram is 1/1000 of a gram, this is equivalent to ppm (parts per million).
- Oxygen concentration in micrograms of oxygen per liter of water (µg/L).
- Oxygen concentration in microMolar (µmol/L), = mg/L x 31.25
- Oxygen saturation in % —100% D.O. being the maximum amount of oxygen that can be dissolved in water at a given atmospheric pressure, water temperature, and salinity. % saturation output is automatically corrected using the TROLL 9500's temperature, conductivity, and barometric pressure values (from a baro sensor on vented cable or from a user-entered input). If no conductivity sensor is present, salinity is assumed to be zero.

USAGE RECOMMENDATIONS AND CAUTIONS

The amount of oxygen that can be dissolved in water decreases at higher temperatures and decreases with increasing altitude (i.e., as barometric pressure drops) and salinity. In other words, as water becomes warmer and saltier, it can hold less and less dissolved oxygen.

During tests that include the RDO channel, the MP TROLL 9500 automatically measures barometric pressure and temperature for compensation of D.O. readings.

The barometric pressure value at the time of calibration is stored in the sensor and will be used to correct D.O. readings for weather-induced pressure fluctuations taken at the same relative barometric pressure as the calibration. However, the large changes in barometric pressure due to changes in elevation are best accommodated by performing a recalibration. If you calibrate at sea level, for example, and use the instrument in the mountains, you should perform a recalibration at the new altitude.

The bleaching effect of sunlight on the sensing foil is minimal with the opaque optical isolation layer. However, the frequent application of strong blue light will eventually have a bleaching effect on the foil. Therefore, the sampling interval should be set to the longest practicable interval while still capturing the necessary D.O. measurements. Laboratory tests have shown that the sensor can measure for more than a year at 2-second intervals, which translates to 5 years at 10-second intervals. Exposure to direct sunlight will also excite/bleach the foil over time but this effect is minimal with the protection provided by the opaque optical isolation layer.

The sensor exhibits a small linear pressure effect with increasing depth. It reads 1% lower for each 250 m of water depth. Since the maximum depth to which an MP TROLL 9500 can safely be submerged is 246 m (350 PSI = 246 m, 807 ft), this means that at 246 m you will have to multiply your readings by 1.01 to get the correct absolute values.

Please note that this compensation is not performed by the MP TROLL 9500, and the MP TROLL 9500 is depth limited by the PSI rating of the pressure sensor installed in the unit. Overall unit pressure rating without a pressure or turbidity sensor installed is 350 PSI (246 m, 807 ft).

Salinity

Unlike an electrochemical cell, the Optical D.O. sensor does not respond to changes in salinity. Since the absolute solubility of oxygen is lower in salty water, it is advantageous to compensate D.O. concentration readings (µg/L, mg/L, µmol/L) to insure that the sensor accurately reports the concentration of dissolved oxygen in the presence of significant salinity. This can be accomplished by storing a salinity value in the sensor before taking measurements. The compensation algorithm is applied internally before concentration is reported. The degree of compensation is minimal at very low salinities, and several percent of reading at oceanic salinity levels.

To store a salinity value in the RDO sensor, connect in Win-Situ or Pocket-Situ, select RDO in the Navigation tree, click **Edit**, in the next screen select "Edit RDO Salinity Value."

SENSOR CARE AND HANDLING

The RDO sensor requires very little maintenance. The only user-serviceable part of the sensor is the foil. The foil can last for up to five years if it is not damaged. The foil disc is protected by a robust black optical isolation coating. If it gets badly scratched (through cleaning or biofouling) it may need to be replaced.

BIOFOULING

Organisms that produce or consume oxygen, if attached to the area of the sensing foil, may artificially influence the sensor's measurement of the oxygen in the surrounding water. In addition, the sensor's response time may be increased.

To avoid this the sensor should be cleaned at regular intervals from a month to a year depending on the required accuracy and the fouling condition at the site.

CLEANING

Examine the visible area of the optical window—what you are seeing is the protective black optical isolation coating over the sensing foil. If it appears dirty, clean it as follows:

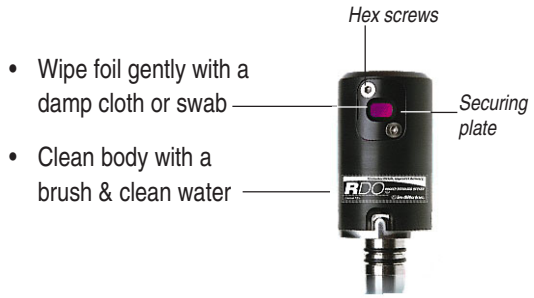
- Rinse with clean water from a squirt bottle or spray bottle.
- Or gently wipe with a clean wet cloth or cotton swab.
- If algal growth is present, clean gently with a soft brush.

TIP: *Cleaning should be done with caution so that the protective coating is not removed. If badly damaged, the sensing foil should be replaced.*

Calcareous fouling can normally be dissolved with household vinegar. If needed, remove the sensor from the MP TROLL 9500 and submerge it in vinegar overnight, or longer. If the marine growth remains, use clean cotton swabs to gently wipe it off after it has been softened by soaking in vinegar. After cleaning the sensor it should be thoroughly rinsed in clean tap water before storing or reuse.

Do not use organic solvents (e.g., acetone, chloroform, toluene) since they will damage the foil.

When cleaning, check to be sure the securing plate is firm and tight. If it is loose, and the foil has required heavy cleaning, it is prudent to remove the securing plate and clean the optical window. See instructions for replacing the sensing foil, below.



FOIL CHECK

The foil may continue to work even when quite heavily damaged. As long as sufficient fluorophore remains on the foil the sensor will measure correctly. If heavily damaged, we recommend the following steps:

1. Recalibrate the sensor with a standard two-point calibration.
2. Check the sensor reading in an air-bubbled water solution.
   a. If the sensor behaves normally (showing 100% saturation) the foil should function properly.
   b. If the sensor is not reading 100% saturation, replace the foil, update the foil coefficients, and perform a new two-point calibration.

REPLACING THE FOIL

1. Remove the two hex screws with the hex wrench supplied, remove the securing plate, and remove the sensing foil. It should not be necessary to remove the screws underneath the securing plate.
2. Check for foreign materials on the optical window, and clean it if necessary with a clean damp cloth or swab.
3. Center the new foil over the optical window, black side up. Replace the securing plate, and replace the hex screws. Be careful not to overtighten.
4. Update the foil coefficients, as described next.

UPDATING THE FOIL COEFFICIENTS

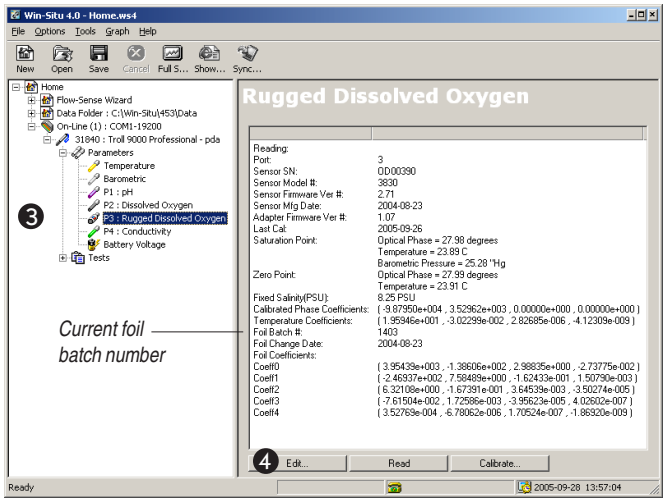
It is very important to update the foil coefficients in the sensor after the sensing foil is changed. Win-Situ can do this automatically provided the manufacturing batch number of the foil is known. If the new foil is from the same batch as your previous foil, you do not need to change the coefficients, but a new two-point calibration should be done.

Data collected when the wrong coefficients are loaded cannot be post-corrected.

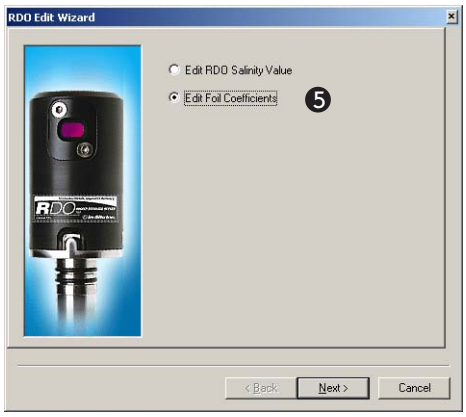
***TIP:** Before beginning the update procedure, locate the foil batch number in the sensing foil replacement kit. Also, ensure that you are using the latest release of Win-Situ 4 (always available in the Download area of the In-Situ website at www.In-Situ.com).*

Procedure

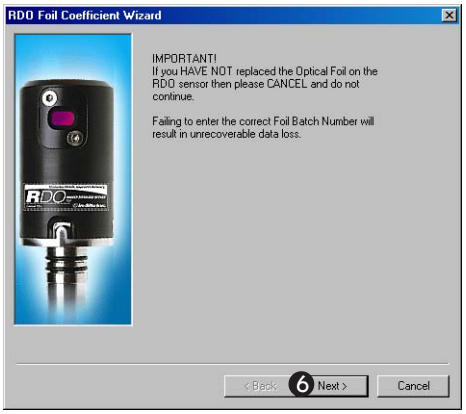
1. Connect the MP TROLL 9500 to a PC and establish a connection in Win-Situ 4 or Pocket-Situ 4.
2. Select the MP TROLL 9500 in the Navigation tree. The software will automatically detect and display the installed sensors.
3. Select Rugged Dissolved Oxygen in the Parameters list.
4. Select **Edit**.



5. In the next screen select Edit Foil Coefficients, click **Next**.



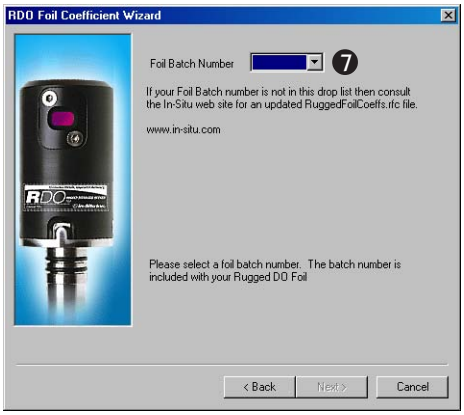
An information screen like this will be displayed.



If you have not replaced the sensing foil, or if the new foil is from the same batch as the previous foil, you do not need to edit the foil coefficients. Select Cancel.

6. Do one of the following:
   - If you have not replaced the sensing foil, you do not need to edit the foil coefficients. Select **Cancel**.
   - If you know the batch number of the new foil, select **Next** and continue with step 7.
   - If you do not know the batch number of the new foil, select **Cancel** and locate the batch number.

7. Select the foil batch number from the drop-down list.



8. After selecting the batch number . . .

. . . click **Next**.

9. In the Final screen, select **Finish** to update the foil coefficients. You also have the option to launch the calibration wizard after the coefficients are updated. **This choice is highly recommended.**

Be sure to recalibrate the sensor after replacing the foil and updating the foil coefficients. If the new foil is from the same batch as the old foil, the coefficients do not need to be updated, but a new two-point calibration should be performed.

RDO Sensor Summary

- Provide sufficient **power** to the RDO sensor. Lithium D-size batteries are required (supplied with the sensor).
- A yearly **recalibration** of the RDO sensor is recommended. Calibration is software-assisted. To do this, select the RDO sensor in the Navigation tree and click or tap **Calibrate**.
- The **foil coefficients** need to be updated only when the foil is changed. To change the coefficients, you will need to know the foil's batch number. Win-Situ can enter the coefficients automatically. To do this, select the RDO sensor in the Navigation tree and click or tap **Edit**. *Data collected when the wrong coefficients are loaded cannot be post-corrected.*
- **Recalibrate** the sensor after changing the sensing foil and updating the foil coefficients.
- **Recalibrate** the sensor if you move the foil.
- When a **turbidity wiper** is installed, be sure to pull the slack in the RDO adapter cable back against the TROLL 9500 body so it will not interfere with the wiper's rotation.
- To calibrate the **Basic sensors** with RDO installed, fill the soft plastic cal insert (it has an orange base) with calibration solution, slide it up around the sensors, including the RDO cable, and use the RDO restrictor as a support during calibration.
- The RDO Optical Dissolved Oxygen sensor will work properly only in **port 1 or 3** of the MP TROLL 9500. Remember that a combination pH/ORP sensor will operate properly only in port 1, and a turbidity wiper accessory only in port 3.
- Basic **sensors that require hydration** (pH, ORP) may be stored in the cal cup insert with a moist sponge for short periods of time. For long-term storage, remove the RDO sensor—it is not necessary to remove it from the adapter—with restrictor and nose cone. Attach the standard TROLL 9500 Cal Cup with a moist sponge in the bottom.
- The RDO sensor is shipped with an adapter plate suitable for monitoring in groundwater and surface water sites. To use the RDO sensor for **low-flow monitoring,** remove it from that adapter plate and install it in the sealing adapter plate specifically designed for the flow cell. Complete instructions are included with the flow cell (Catalog No. 0057600) and in Section 20 of this operator's manual.

14 OXIDATION-REDUCTION POTENTIAL

WHAT IS ORP?

Oxidation Reduction Potential (ORP) is a measure of a water system's capacity to either release or gain electrons in chemical reactions. The process of oxidation involves losing electrons while reduction involves gaining electrons. Oxidation and reduction (redox) reactions control the behavior of many chemical constituents in drinking water, wastewater, and aquatic environments. The reactivity and solubility of critical elements in living systems is strongly dependent on redox conditions. ORP values are used much like pH values to determine water quality. While pH values characterize the relative state of a system for receiving or donating hydrogen ions (acting as a base or an acid), ORP values characterize the relative state of a system for gaining or losing electrons. ORP values are affected by all oxidizing and reducing agents, not just acids and bases.

WHY MEASURE ORP?

The effect that potable water has on plumbing is directly related to its ORP value. Unfavorable values can cause excessive corrosion, leading to expensive repairs. ORP is one parameter that can be monitored during the disinfecting process for drinking water, swimming pool water, and spa water.

The life expectancy of bacteria in water is related to ORP. In fact, studies have shown that the life span of bacteria in water is more dependent on the ORP value than on the chlorine concentration. For swimming pools at a normal pH value between 7.2 and 7.6, the ORP value must be kept above 700 mV to kill unwanted organisms. Hypochlorite or other oxidizing agents must be added when the ORP falls below 700 mV. In contrast, natural waters need a much lower ORP value in order to support life. Generally ORP values above 400 mV are harmful to aquatic life. Ideally the ORP value in salt water aquariums should be kept between 350 and 390 mV. ORP levels below 300 mV are to be avoided. An oxidizing environment is needed to convert any ammonia (NH_3) to nitrites (NO_2^-) and nitrates (NO_3^-). Ammonia levels as low as 0.002 mg/l can be harmful to some fish species.

Typical ORP values

Fluid	ORP (mV)
Salt water aquarium	~ 350
Harmful to aquatic life	> 400
Properly chlorinated swimming pool	> 700

The determination of ORP is particularly worthwhile in water that contains a relatively high concentration of a redox-active species, e.g., the salts of many metals (Fe_2^+, Fe_3^+) and strong oxidizing (chlorine) and reducing (sulfite ion) agents. Thus, ORP can sometimes be utilized to track the metallic pollution of ground- or surface water, or to determine the chlorine content of wastewater effluent. However, ORP is a nonspecific measurement—that is, the measured potential is reflective of a combination of the effects of all the dissolved species in the medium. Because of this factor, the measurement of ORP in relatively clean environmental water (ground, surface, estuarine, and marine) has only limited utility unless a predominant redox-active species is known to be present. Care is required not to "over-interpret" ORP data unless specific information about the site is known.

THE pH/ORP SENSOR

The single-junction, three-electrode sensor uses a potentiometric method to measure pH and ORP in a test solution. The pH electrode consists of a pH-sensitive glass whose voltage is proportional to the hydrogen ion concentration. The ORP electrode serves as an electron donor or acceptor depending upon the test solution. The reference electrode supplies a constant stable output for comparison. Electrical contact is made with the test solution using a saturated potassium chloride (KCl) solution. The electrode behavior is described by the Nernst equation:

$$E_m = E_o - (RT/nF) \ln \{[ox] / [red]\}$$

where

E_m is the potential from the ORP electrode,

E_o is related to the potential of the reference electrode,

R is the Gas Law constant,

F is Faraday's constant,

T is the temperature in Kelvin,

n is the number of electrons,

[ox] is the oxidant concentration in moles/L, and

[red] is the reductant concentration in moles/L.

Most natural waters contain many species that are involved in the redox process so that it is not possible to calculate the ORP using the Nernst equation. All redox species do however reach equilibrium. A Standard solution of known redox potential for a particular ORP electrode is used to calibrate ORP. The sensor then gives a calibrated response in mV when placed in a sample.

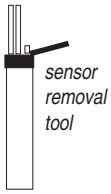
SENSOR INSTALLATION

The MP TROLL 9500 may be shipped with a pH/ORP sensor installed. If installation is necessary, unpack and install the sensor in port 1 of the MP TROLL 9500 as follows.

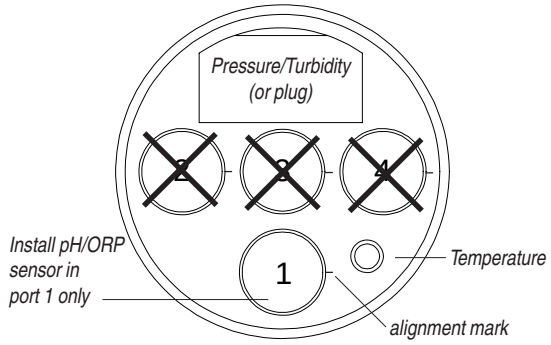
The combination pH/ORP sensor will work properly only in port 1.

***TIP:** To ensure optimum response for a new or previously stored sensor, rinse off the soaking solution, then soak the sensor in clean water for at least 15 minutes before calibrating.*

1. Remove the restrictor or Cal Cup from the front end of the TROLL 9500. This allows access to the sensor block shown below.
2. Remove the sensor hydration bottle and set aside for future use.
3. Rinse the sensor in clean water to remove the soaking solution. Soak the sensor in clean water for at least 15 minutes before calibrating.
4. Remove any moisture or dirt from the area around port 1, then use the sensor removal tool to remove the plug from the port. Retain the plug for future use.



pH/ORP Sensor Position



5. Remove any moisture or dirt from the port connector with a clean swab or tissue.
6. Remove the cap from the sensor connector. Check lubrication of the o-rings. If they appear dry, apply a silicone lubricant.
7. Visually align the sensor connector pins with the port connector pins.
8. Press the sensor firmly into the port until you feel it dock with the port connector. When properly inserted a small gap (the width of the sensor removal tool) remains between the widest part of the sensor and the instrument body, for ease of removal.

CALIBRATION

OVERVIEW

A one-point calibration in a solution with a known potential at a given temperature is sufficient to calibrate ORP. Software options:

- **Quick Cal:** Calibrates ORP (and optionally pH, polarographic D.O., and conductivity) at one time with one solution.
- **Traditional calibration:** A one-point calibration in a solution specifically formulated for calibrating ORP. Results in calculation of sensor offset.
- **Default coefficients:** Resets the sensor's factory defaults. No solutions are required.

Nominal vs. Stable

To shorten the calibration time, you have the option to accept the calibration when "Nominal" stability conditions are achieved. If the early value is accepted, the calibration point will be designated "USER SET" in the calibration report. If the calibration was performed through to stability ("STABLE" in the calibration report), the sensor will operate as intended by In-Situ's quality standards.

CALIBRATION SOLUTIONS

Only one solution is required for ORP calibration. Quick Cal and ZoBell's solution are available from In-Situ Inc. A custom solution may be used in a Traditional calibration if its milliVolt value at the calibration temperature is known.

Please note that a pH/ORP sensor requires separate calibrations for pH and ORP. The Quick Cal procedure produces excellent results for ORP so long as the solution is stored as recommended and used before its expiration date. After performing a Quick Cal for ORP, we recommend a 2- or 3-point Traditional calibration for pH, as described in Section 11 of this manual.

RECOMMENDED CALIBRATION ORDER FOR pH AND ORP

The pH/ORP sensor requires separate calibrations for pH and ORP. A suggested calibration scenario is as follows:

A. First, Quick-Cal ORP (plus, optionally, other installed Basic sensors). For the procedure, see Section 3, Getting Started.

B. Then, perform a 2- or 3-point Traditional pH calibration as described in Section 11 of this manual.

TRADITIONAL ORP CALIBRATION PROCEDURE

If you wish to perform a traditional calibration with a dedicated ORP calibration solution, use the following procedure.

1. With a pH/ORP sensor installed and plugs or sensors in the other ports, rinse the front end of the MP TROLL 9500 in clean water. For best results, rinse again in a portion of the calibration solution.
2. Fill the Cal Cup with ZoBell's or other custom ORP calibration solution.
3. Attach the Cal Cup to the MP TROLL 9500. Thread the Cal Cup onto the body until seated against the o-ring, then back off slightly to avoid overtightening.
4. Connect the MP TROLL 9500 to a PC and establish a connection in Win-Situ 4 or Pocket-Situ 4.
5. Select the MP TROLL 9500 in the Navigation tree. The software will automatically detect and display the installed sensors. (This can take a moment.)
6. Select ORP in the Parameters list. The sensor serial number (SN) and recent calibration information is displayed.

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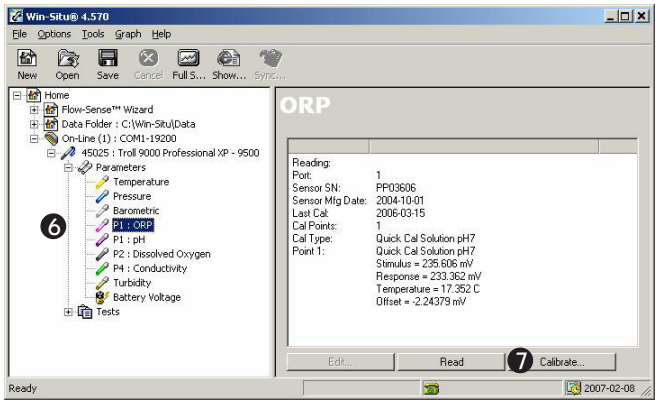

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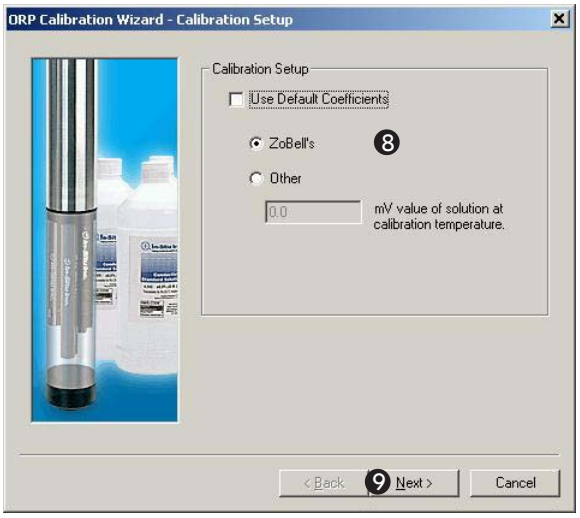
7. Select **Calibrate** to launch the ORP Calibration Wizard.
8. In the ORP Calibration Wizard, select the solution the sensor is soaking in. For ZoBell's, the reference milliVolt value is available in the software. For a custom solution, select "Other" and enter the mV of the solution at the calibration temperature.



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9. Select **Next** to continue.
10. In the next screen, select **Run** to begin the stabilization.

    The display will continuously update as readings are taken and compared against the stabilization criteria.

Indicators during Calibration

- **Status:**

  NOT TESTED is displayed until you begin the calibration by selecting Run.

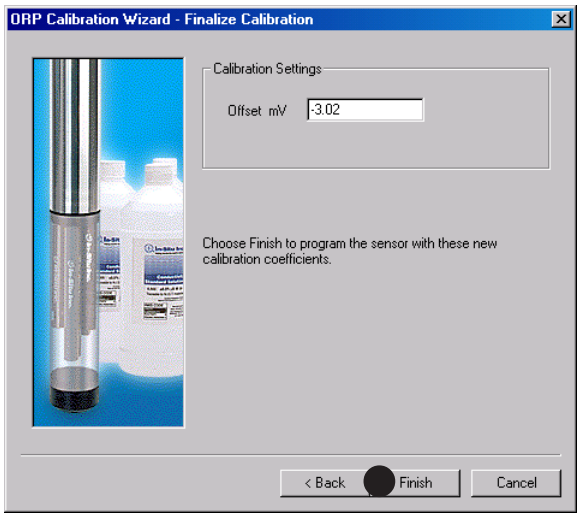
  UNSTABLE indicates the sensor response does not meet the criteria for a valid calibration point.

  NOMINAL indicates the sensor deviation meets early stabilization criteria.

  The **Accept** button becomes available when nominal stability is achieved. You may accept the early value, or wait for complete stability. If you accept the early value, the calibration point will be designated "USER SET" in the calibration report. (For more on calibration reports, see "Calibration History" in Section 10.)

  STABLE is displayed when the readings have stabilized sufficiently to take a valid calibration point. The calibration proceeds automatically to the next screen.
- **Temperature** is displayed for your information.
- **Sensor Reading:** The current sensor response in milliVolts.
- **Sensor Deviation:** Change in sensor response between the last two readings. This enables you to follow the progress of the stabilization, but deviation from the previous reading is not necessarily the best indicator of stability as the software is looking at longer-term trends.

11. The final screen shows the calculated sensor offset. This value should be 0 mV ± 20 mV.



12. Select **Finish** to write this value to the sensor.

The ORP sensor is now calibrated and ready to use.

TIP: *You can look at the calibration report right after calibrating, or at any time. See "Calibration History" in Section 10 for details.*

TIP: *The calibration solution may be flushed down the drain with running water, or saved in a separate container and used to rinse the next time you calibrate with the same solution.*

Options for storing sensors:

- If the instrument will be used in a day or so, leave the sensors installed. Remove the Cal Cup and rinse it and the sensors. Add 50-100 mL of tap water to the Cal Cup. Return the probe to the Cal Cup for transport to the field site.
- For longer storage, see the section on Sensor Care and Handling later in this chapter.

RESETTING DEFAULT COEFFICIENTS

The sensor's calibration may be reset back to factory defaults at any time. This is a good option if the results of a recent calibration are suspect because the cal solution has been exposed to air or has otherwise deteriorated

1. With a pH/ORP sensor installed, establish a connection to the instrument in Win-Situ 4 or Pocket-Situ 4.
2. Select ORP in the Parameters list and click **Calibrate**.
3. In the first screen, select Use Default Coefficients, then **Next**.
4. In the final screen, click **Finish** to send the values to the sensor.

SENSOR OFFSET

The offset for ORP is a traditional "zero offset," and is typically 0 ± 20 mV. If the offset calculated during calibration is outside this range, inspect the sensor. If it is clean, then the fault was probably with the cal solution (aging, exposure to air, etc.). In this case, resetting the factory defaults for ORP can often restore the sensor performance.

UNITS AND CALCULATED MEASUREMENTS

ORP readings may be displayed in Volts or milliVolts. No calculated measurements are available.

RECOMMENDED CALIBRATION FREQUENCY

Calibration frequency will depend on the nature of the sample and the degree of accuracy required. In clean water samples, the sensor could retain its accuracy for 2-6 weeks. Recalibrate the sensor—

- after replacing the reference junction and/or the filling solution,
- during routine, scheduled maintenance,
- every 2-6 weeks in the absence of other indications.

NORMALIZATION TO STANDARD HYDROGEN ELECTRODE VALUES

ORP values are dependent on solution composition, temperature, and sensor type. ORP (Eh) values reported in the literature are often normalized to the standard hydrogen electrode as a standard reference electrode. Since the standard hydrogen electrode is extremely fragile, it is impractical to use in the field. In-Situ's sensor uses a silver/silver-chloride reference electrode in place of the standard hydrogen electrode.

The following equation may be used to normalize the readings reported by our sensor calibrated with our solution to standard hydrogen electrode values (±50 mV).

$$ORP_{SHE} = ORP_{observed} + \{215.81 - T_C * [0.77942 + T_C * 0.001934]\}$$

where ORP_{SHE} is the sample potential relative to the standard hydrogen electrode

$ORP_{observed}$ is the sample potential relative to the In-Situ reference electrode

T_C is the sample temperature in °C

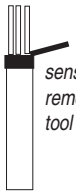
ORP measured by a sensor immersed in a solution should not be equated with thermodynamic Eh. Differences may occur due to lack of chemical equilibrium, presence of multiple redox couples, sensor poisoning, and other factors.

In addition, like all platinum ORP electrodes, In-Situ's pH/ORP sensor may give unstable readings in solutions containing chromous, vanadous, titanous, and other ions that are stronger reducing agents than hydrogen or platinum.

USAGE RECOMMENDATIONS AND CAUTIONS

- ORP readings vary slightly with temperature, but are not easily corrected because, unlike pH, the ORP value depends on the activity of many ions in solution. pH values are more easily corrected because they are due to the activity of one ion, H^+.

SENSOR CARE AND HANDLING


sensor removal tool

SENSOR REMOVAL

Use the sensor removal tool to pop the sensor out.

MAINTENANCE/INSPECTION/CLEANING

If the platinum ORP sensor appears dull or fouled, it may be cleaned with a swab dipped in alcohol. Rub gently until the platinum appears shiny. Rinse in clean water.

If a film develops on the glass electrode, or if the sensing glass or junction become dehydrated, the response may be sluggish or erratic, or the sensor may fail to calibrate. In these cases, rinse the sensor in 90% isopropyl alcohol, then soak in storage solution (Catalog No. 0065370) for at least an hour, overnight if needed. If this does not restore the response, try soaking in 0.1 M HCl solution for 5-10 minutes, followed by a thorough rinse in clean water. If the response has still not improved, replace the filling solution, or the junction.

Note: The following maintenance instructions apply to In-Situ's newest pH/ORP sensor (cat. no. 0059520). Older sensors (cat. no. 0032010 & 0032020, now discontinued) are not user-serviceable.

REPLACING THE FILLING SOLUTION

Replace the filling solution every 5-6 months, or when:

- The sensor fails to calibrate with reasonable slope and offset
- Readings drift
- Readings during calibration at pH 7 are outside the range 0±20 mV

1. Unscrew the reference junction as shown.

2. Holding the sensor at an angle, shake out the old filling solution.
3. Protect the connector end of the sensor with the soft cap it shipped with, or wrap the sensor in a paper towel to prevent solution from entering the connector.
4. Using the dispenser cap on the filling solution bottle, insert the tube into the bottom of the empty reservoir. Squeeze a steady stream of solution into the reservoir until it overflows and no bubbles are observed.

   Continue to add solution while withdrawing the tube.

5. Screw in the reference junction, and hand-tighten until snug. Some filling solution will overflow. Wipe the excess off the sensor body.
6. Soak the sensor in tap water for at least 15 minutes.
7. Recalibrate the sensor.

If necessary, thoroughly clean the electrical connector to remove filling solution: Using a disposable pipette, fill the connector with isopropyl alcohol (70% to 100%). Shake to dry. Repeat 3 times. Dry overnight. When thoroughly dry, recalibrate.

REPLACING THE JUNCTION

Replace the junction when the sensor fails to calibrate, even after replacing the filling solution.

1. Unscrew the reference junction and discard.
2. Replace the filling solution and screw in a new reference junction as described above.
3. Soak for 15 minutes in tap water, then recalibrate the sensor.

***TIP:** Keep the junction damp at all times to avoid a lengthy rewetting process.*

STORAGE

Short-Term Storage (several days)

Store in the Cal Cup in tap water.

Long-Term Storage (up to several weeks)

Remove the sensor and store in the electrode storage bottle with 10-20 mL of storage solution (Catalog No. 0065370). Tighten the cap to prevent drying. Prior to use, condition the sensor by rinsing with deionized or tap water and soaking for 15 minutes.

REFERENCES

Eaton, A.D., L.S. Clesceri, E.W. Rice, and A.E. Greenberg, eds., *Standard Methods for the Examination of Water and Wastewater,* 21st edition, Washington, D.C.: American Public Health Association, American Water Works Association, and Water Environment Federation, 2005. Section 2580, Oxidation-Reduction Potential.

15 AMMONIUM

WHAT IS AMMONIUM ?

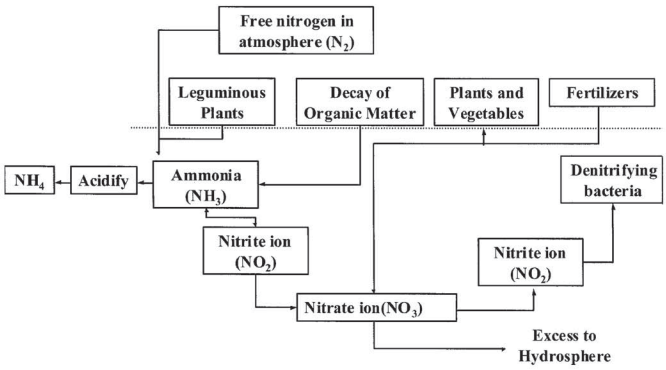
Ammonium (NH_4^+) is the ionized form of ammonia (NH_3). Ammonia and ammonium are naturally occurring forms of nitrogen, part of the nitrogen cycle. In natural waters they exist in two forms: Dissolved ammonia gas (NH_3) is highly toxic to aquatic life, while ammonium, the ionized form (NH_4^+), is not. Both may be grouped together as "total ammonia."

The ammonia/ammonium equilibrium in water is closely related to pH levels. At a pH of 6.5 almost all ammonia is in the form of ammonium. However, as the pH increases (becomes more basic), ammonium is changed into harmful ammonia. Ammonium ions are the predominant species in most unpolluted natural water systems where the pH is typically less than 9. Even a small amount of ammonia is detrimental to fish while a moderate amount of ammonium is tolerated. The lethal dose of ammonia for trout is only 0.2 mg/L.

WHY MEASURE AMMONIUM?

Major sources of ammonium are wastewater from sewage treatment plants, and nitrogen in fertilizers which is transformed to ammonium in soil by microorganisms. Ammonia/ammonium can be a key parameter in the assessment of water and wastewater quality. Measurement of ammonium can yield information on the composition and movement of pollutants in groundwater and surface water, landfill leachate, runoff from agricultural activities, waste concentrations in fisheries, and nutrient levels in natural water bodies.

THE NITROGEN CYCLE



THE AMMONIUM SENSOR

The In-Situ sensor is an ion-selective electrode (ISE) that is selective for the ammonium ion (NH_4^+). It is a double-junction combination ISE with a silver/silver-chloride reference half-cell, PVC sensing membrane, and reference electrolyte gel. It measures the concentration in parts per million of ammonium ion in solution (calculated as nitrogen, ppm as N).

SENSOR PREPARATION

To ensure optimum membrane response, the ammonium sensor should be thoroughly hydrated in an appropriate solution before calibration. A good way to do this is to allow the sensor to soak in the solution you plan to use for the first calibration point (lowest concentration) for at least 15 minutes and up to several days before calibration and use.

- 1.4 ppm N for calibration in the lower range (concentrations less than 14 ppm N)
- 140 ppm N for calibration in the upper range (concentrations of 14 ppm N and up)

The sensor kit includes an empty bottle for this purpose.

SENSOR INSTALLATION

Unpack the ammonium sensor, hydrate it as above, and install in port 1, 2, or 3 in the sensor block at the front end of the MP TROLL 9500 as follows.

TIP: *Remember that a polarographic D.O. sensor (if present) will operate properly only in port 2 and a turbidity wiper accessory only in port 3.*

1. Remove the restrictor from the front end of the MP TROLL 9500. This allows access to the sensor block depicted in the drawing below.
2. Remove the sensor's protective cap or storage bottle and set aside for future storage of the sensor. If the connector end is covered with a cap, remove it also.
3. Remove any moisture or dirt from the area around the port where you will install the sensor, then use the sensor removal tool to remove the plug from the port where you will install the sensor.

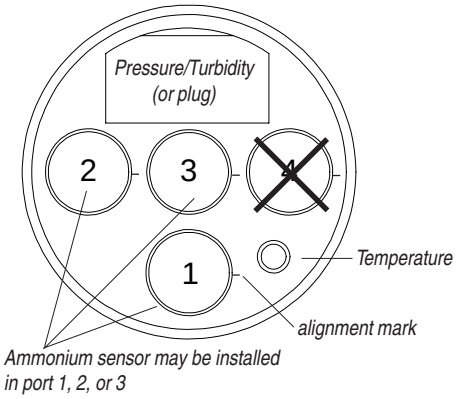
sensor removal tool

4. Remove any moisture or dirt from the port connector with a clean swab or tissue.
5. Check lubrication of the sensor o-rings.

TIP: The sensor o-rings require generous lubrication before installation. New sensors will be lubricated at the factory. If the o-rings appear dry, apply apply a silicone lubricant before installation.

6. Handling the sensor by the sides, not the tip, align the mark on the side of the sensor with the mark on the port.

Avoid touching the membrane at the tip of the sensor. Contaminants on the membrane can change its properties and affect measurements.



7. Use the sensor insertion tool to firmly press the sensor into the port until you feel it dock with the connector at the bottom. When properly inserted a small gap (width of the sensor removal tool) remains between the widest part of the sensor and the instrument body, for ease of removal.

sensor insertion tool

CALIBRATION

OVERVIEW

The software offers several options for ammonium calibration.

- **Three-point bithermal** ("two-temperature") calibration. The first two calibration points are taken in solutions of different concentrations at the same temperature. The third point uses one of these solutions at a temperature that is at least 10° higher or lower depending on anticipated field conditions. This type of calibration allows determination of the sensor's "isopotential point"—the ion concentration at which changes in temperature do not cause a change in sensor response (voltage). A three-point bithermal calibration is recommended before the first use of the sensor, and regularly thereafter, to insure accurate readings at all potential temperatures.
- **Two-point isothermal** ("same temperature") calibration using solutions of two different concentrations. A two-point isothermal calibration calculates the sensor's slope and offset but cannot compute the isopotential point. For best results this type of calibration should be carried out as close as possible to the temperature at which the sensor will be used. Or, It may be performed after a previous three-point bithermal calibration to recalculate the slope and offset of an aging sensor while retaining the previously calculated isopotential point.
- **Single-point** calibration. After the initial three-point bithermal calibration has established the sensor slope, offset, and isopotential point, a single-point calibration may be used with good results to adjust the offset on a daily basis.

CALIBRATION SOLUTIONS

Ammonium chloride (NH_4Cl) solutions certified to N.I.S.T. standards are supplied in the In-Situ Ammonium Calibration Kits:

14.0 ppm as N
140 ppm as N
1400 ppm as N

Specialized calibration kits are available for calibrating the ammonium sensor for low-range and high-range measurements:

Low range: two quarts each 14 ppm and 140 ppm
High range: two quarts each 140 ppm and 1400 ppm

RECOMMENDED CALIBRATION FREQUENCY

Ion-selective electrodes are inherently unstable and drift is quite normal. To achieve the most accurate sensor response, we recommend a complete three-point bithermal calibration once a week, with a single-point calibration daily or after 4-6 hours of use.

PREPARING TO CALIBRATE

You will need:

- MP TROLL 9500 with the hydrated ammonium sensor installed and sensors or plugs in the other sensor ports
- Cal Cup
- One, two, or three ammonium calibration solutions, selected for the range you expect to measure. When performing a multi-point calibration, begin with the lowest-concentration solution.
- For a three-point bithermal calibration: a temperature bath, or container of ice large enough to hold the Cal Cup (and stirrer, if used).
- Stirrer: Use a stirrer during calibration if it will also be used in the field—for example, in stagnant or very slowly moving water. The more closely calibration conditions reflect field conditions, the more successful the calibration. For more information on the stirrer, see "Stirring" in Section 10.

AMMONIUM CALIBRATION PROCEDURE

1. Rinse the Cal Cup and front end of the MP TROLL 9500 in clean water. Shake to dry.

   For best results, follow this with a rinse in a portion of the selected calibration solution. Discard the rinse solution.

2. Insure the black PVC base (or the stirrer) is attached to the Cal Cup, and fill the Cal Cup to the fill line with the selected calibration solution.
   - Begin with the lowest concentration when performing a multi-point calibration.
   - With a full complement of sensors installed, use the lower line as a guide.
   - With 1 or 2 removable sensors installed, fill to the upper line.

3. Insert the front end of the MP TROLL 9500 into the open end of the Cal Cup. Thread the Cal Cup onto the body until seated against the o-ring, then back off slightly to avoid overtightening.

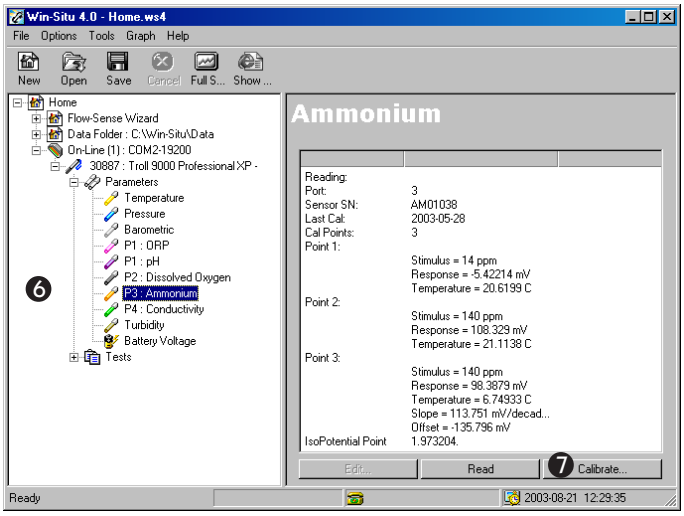
   To stabilize the instrument, you may wish to use a calibration stand or other support.

4. Connect the MP TROLL 9500 to a PC and establish a connection in Win-Situ 4 or Pocket-Situ 4. Win-Situ screens are illustrated here. The Pocket-Situ interface is similar, with the Navigation tree at the top of the screen and the Information pane below it.

5. Select the MP TROLL 9500 in the Navigation tree.

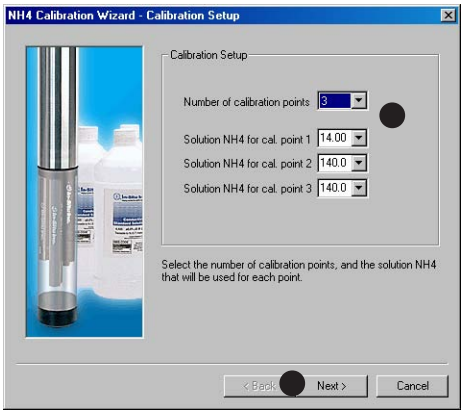
   The software will automatically detect and display the installed sensors. If one or more sensors is installed in the wrong port, an error message will be displayed. Simply remove the sensor and install it in the correct position, then "refresh" the device before continuing.

6. Select Ammonium in the Parameters list. The sensor serial number (SN) and recent calibration information is displayed.



7. Select **Calibrate**.

The Ammonium Calibration Wizard starts. A screen like this is displayed.

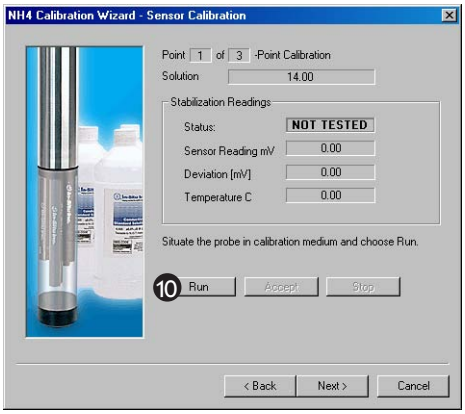


8. Select the number of calibration points for this calibration, and the concentration (ppm) of the calibration solution for each point.

   Cal point 1 is the solution the sensor is soaking in now, the lowest concentration for a multi-point calibration. If doing a three-point bithermal cal, choose cal point 3 to be the same as either cal point 1 or cal point 2.

9. Select **Next** to continue.

10. In the next screen, select **Run** to begin the stabilization.



The display will continuously update as readings are taken and compared against the stabilization criteria.

- Status indicators:

  NOT TESTED is displayed until you begin the calibration by selecting Run.

  UNSTABLE indicates the sensor response does not meet the criteria for a valid calibration point.

  NOMINAL indicates the sensor deviation meets early stabilization criteria.

  The **Accept** button becomes available when nominal stability is achieved. You may accept the early value, or wait for complete stability. If you accept the early value, the calibration point will be designated "USER SET" in the calibration report. (For more on calibration reports, see "Calibration History" in Section 10.)

  STABLE is displayed when the readings have stabilized sufficiently to take a valid calibration point. The calibration proceeds automatically to the next screen.

- Sensor Reading: The current sensor response in milliVolts.
- Deviation: Change in sensor response between the last two readings.
- Current temperature is also displayed.

11. If doing a single-point calibration, go to step 16.

    For a multi-point calibration, the Wizard returns to the screen shown at step 10 and waits for you to situate the probe in the next calibration solution and click Run.

12. Remove the Cal Cup, discard the first solution, rinse the Cal Cup and the front end of the instrument with clean water, followed by a rinse in the next calibration solution, refill the Cal Cup with the second solution, and attach it to the instrument.

13. Select **Run** to begin the stabilization for cal point 2. Status indicators and controls are the same as for cal point 1 (step 10).

    TIP: *The used calibration solution may be flushed down the drain with running water, or saved in a separate container and used as a rinse the next time you calibrate with the same solution.*

    Again wait for Stable status (or click Accept when Nominal is indicated).

    If doing a two-point calibration, go to step 16.

14. For the third calibration point, use the cal point 1 or cal point 2 solution (as specified in step 8) but change the temperature by at least 10°C. A convenient way to do this is to move the probe—Cal Cup and all—into a temperature-controlled bath or container of ice. Allow time for the sensor to reach thermal equilibration with the solution temperature. With stirring or agitation, this should take about 10 minutes, perhaps up to 30 minutes if left undisturbed.

15. When the temperature is stable, select **Run** for cal point 3.

    When Nominal is accepted or Stable is indicated for cal point 3, the final screen is displayed.

16. The final screen of the Calibration Wizard shows the sensor slope and offset calculated during the calibration process. For a three-point bithermal calibration, the calculated isopotential point is shown. If a single-point calibration has been performed, the isopotential point is the one calculated during the last three-point bithermal calibration.

17. Select **Finish** to program the sensor with the newly calculated calibration coefficients.

The ammonium sensor is now calibrated and ready to use.

TIP: You can look at the calibration report right after calibrating, or at any time. See "Calibration History" in Section 10 for details.

Options for storing sensors:

The ammonium sensor should calibrated immediately before use. If storage is necessary, remove the sensor from the instrument and immerse in 14 ppm N solution, for later use in the low ammonium range, or 140 ppm N solution, for use in the high range.

SENSOR SLOPE AND OFFSET

The expected slope for a new sensor is about 56 (± 2) mV per decade of concentration (ppm). The calibration curve begins to deviate from linear at about 1 ppm. The sensor's zero offset is recalculated with each single-point calibration.

UNITS AND CALCULATED MEASUREMENTS

Ammonium ion concentration is reported in ppm (equivalent to mg/L). No calculated measurements are currently available.

USAGE RECOMMENDATIONS AND CAUTIONS

Ammonium Sensor	
Operating Temperature	-5°C to 40°C (23°F to104°F) continuous temperature; can tolerate up to 50°C (122°F) intermittently
Pressure Rating	20 psi (14 m, 46 ft)
pH range	up to 8.5

Do not submerge the ammonium sensor deeper than 46 ft (14 m). Do not use in the basic pH range (8.5 or higher).

pH

The sensor's pH range is that range over which a change in pH will not cause a significant change in the measured voltage. It is the plateau on a graph of pH against mV at constant concentration of the detected ion. Outside this range, a change in pH may cause a significant change in the measured mV.

TEMPERATURE

The higher the temperature, the shorter the lifetime of the electrode. 1°C difference in temperature causes a 2% error at 10 ppm, unless a bithermal calibration is performed.

CONDUCTIVITY

In saline waters (conductivities of 1,000 µS/cm or higher), the presence of interfering ions such as sodium or potassium may limit the usability of the ammonium sensor.

POTENTIAL INTERFERENCES

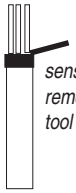
The following table lists concentrations of possible interfering ions that cause 10% error at various levels of NH_4^+.

Ion	100 ppm NH_4^+	10 ppm NH_4^+	1 ppm NH_4^+
Cs^+	100	10	1
K^+	270	27	2.7
Tl^+	3100	310	31
H^+	pH 1.6	pH 2.6	pH 3.6
Ag^+	270,000	27,000	2700
Li^+	35,000	3500	350
Na^+	11,100	1,100	110

SENSOR CARE AND HANDLING

SENSOR REMOVAL

Position the yoke of the sensor removal tool at the point where the sensor meets the sensor block and pry the sensor upward.



sensor removal tool

Avoid touching the membrane at the tip of the sensor. Contaminants on the membrane can change its properties and affect measurements.

MAINTENANCE/INSPECTION/CLEANING

As long as extreme pH and high organic solvent content is avoided, the sensor should last for several months at room temperature. Eventually some of the components will leach out, and this will affect the response (detection limit and scope), but this can be compensated through calibration.

If film buildup is visible on the membrane, rinse under a gentle stream of clean water, or swish gently in a mild detergent solution, rinse well with clean water, and shake to dry.

To avoid depletion of the reference solution, do not allow the sensor to soak in pure water for more than a few minutes at a time.

The electrode is not customer-refillable.

STORAGE

Store the sensor immersed in 14 or 140 ppm N solution, depending on usage requirements, rather than dry or in DI water.

REFERENCES

Eaton, A.D., L.S. Clesceri, E.W. Rice, and A.E. Greenberg, eds., *Standard Methods for the Examination of Water and Wastewater,* 21st edition, Washington, D.C.: American Public Health Association, American Water Works Association, and Water Environment Federation, 2005. Section 4500-NH_3 Nitrogen (Ammonia). D. Ammonia-Selective Electrode Method.

EPA, Methods for Chemical Analysis of Water and Wastes, EPA/600/4-79-020, revised March 1983. Method 350.3, Nitrogen, Ammonia, Potentiometric, Ion Selective Electrode. Approved at 40 CFR Part 136.

Rundle, Chris C., A Beginners Guide to Ion-Selective Electrode Measurements. Nico2000 Ltd., London, UK. On the web at www.nico2000.net

U.S. Geological Survey, Office of Water Quality Technical Memorandum 93.12: Water Resources Division Nomenclature Conventions for Reporting Concentrations of Ammonium Ions and Ammonia in Natural Waters. August 26, 1993.

16 CHLORIDE

WHAT IS CHLORIDE?

Chloride (Cl^-) is a highly soluble ion in water and can potentially be present in high concentrations. Chloride enters the water supply when runoff from rain or irrigation dissolves a variety of chloride-containing salts in rock and soil. Freshwater sources, streams, lakes, and underground aquifers typically have less than 10 ppm Cl^-. Some waters with as little as 250 ppm Cl^- will taste salty to sensitive individuals, especially if the sodium cation (Na^+) is also present. Wastewater from sewage or industrial facilities will normally contain higher amounts of chloride. Chloride is naturally present in higher concentrations near coastal areas where it can infiltrate canals and sewers.

WHY MEASURE CHLORIDE?

Chloride ions are not toxic to humans. However, a high chloride content may harm some structures, especially those made of metal. Chloride can increase the rate of corrosion on metals in the presence of water. Vegetation is also sensitive to the amount of chloride in the soil. Agriculturally productive soils can be turned into unproductive wastelands over a period of time by irrigating with water containing high amounts of chloride. The WHO (World Health Organization) has established 100 ppm Cl^- as a maximum for water used for irrigation, while 250 ppm Cl^- is the maximum for drinking water.

THE CHLORIDE SENSOR

The In-Situ sensor is an ion-selective electrode (ISE) that is selective for the chloride ion (Cl^-). It is a double-junction combination ISE with a silver/silver-chloride reference half-cell, solid-state sensing electrode, and reference electrolyte gel. It measures the concentration in parts per million of chloride ion in solution (ppm Cl^-).

Typical Chloride values

Fresh water	< 10 ppm Cl^-
Sea water	20,000 ppm Cl^-
Irrigation water standard (WHO)	100 ppm Cl^-
Drinking water standard (WHO)	250 ppm Cl^-

SENSOR PREPARATION

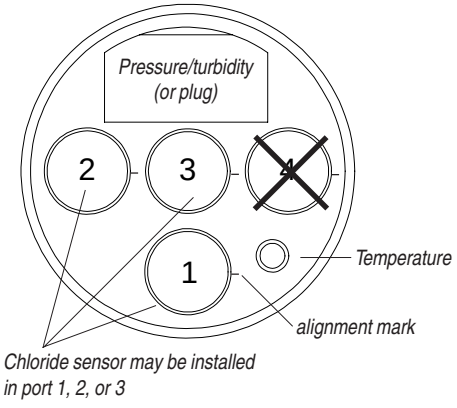
To insure the chloride sensor is thoroughly hydrated, soak it in distilled water for about 15 minutes before installation. The sensor kit includes an empty bottle for this purpose. Unlike the ammonium and nitrate sensors, the solid-state chloride sensor does not require soaking in a solution of specific concentration.

SENSOR INSTALLATION

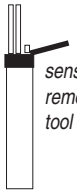
Unpack the chloride sensor, hydrate it as described above, and install in port 1, 2, or 3 in the sensor block at the front end of the MP TROLL 9500 as follows.

TIP: *Remember that a polarographic D.O. sensor (if present) will operate properly only in port 2, and a turbidity wiper accessory only in port 3.*

1. Remove the restrictor from the front end of the MP TROLL 9500. This allows access to the sensor block depicted in the drawing below.



2. Remove the sensor's protective cap or storage bottle and set aside for future storage of the sensor.
3. Remove any moisture or dirt from the area around the port where you will install the sensor, then use the sensor removal tool to remove the plug from the port where you will install the sensor.



sensor removal tool

4. Remove any moisture or dirt from the port connector with a clean swab or tissue.
5. Check lubrication of the sensor o-rings.

TIP: The sensor o-rings require generous lubrication before installation. New sensors will be lubricated at the factory. If the o-rings appear dry, apply apply a silicone lubricant before installation.

6. Handling the sensor by the sides, not the tip, align the mark on the side of the sensor with the mark on the port.
7. Use the sensor insertion tool to firmly press the sensor into the port until you feel it dock with the connector at the bottom. When properly inserted a small gap (width of the sensor removal tool) remains between the widest part of the sensor and the instrument body, for ease of removal.

sensor insertion tool

CALIBRATION

OVERVIEW

The software offers several options for chloride calibration.

- **Three-point bithermal** ("two-temperature") calibration. The first two calibration points are taken in solutions of different concentrations at the same temperature. The third point uses one of these solutions at a temperature that is at least 10° higher or lower depending on anticipated field conditions. This type of calibration allows determination of the sensor's "isopotential point"—the ion concentration at which changes in temperature do not cause a change in sensor response (voltage). A three-point bithermal calibration is recommended before the first use of the sensor, and regularly thereafter, to insure accurate readings at all potential temperatures.
- **Two-point isothermal** ("same temperature") calibration using solutions of two different concentrations. A two-point isothermal calibration calculates the sensor's slope and offset but cannot compute the isopotential point. For best results this type of calibration should be carried out as close as possible to the temperature at which the sensor will be used. Or, it may be performed after a previous three-point bithermal calibration to recalculate the slope and offset of an aging sensor while retaining the previously calculated isopotential point.
- **Single-point** calibration. After the initial three-point bithermal calibration has established the sensor slope, offset, and isopotential point, a single-point calibration may be used with good results to adjust the offset on a daily basis.

CALIBRATION SOLUTIONS

Ammonium chloride (NH_4Cl) solutions certified to N.I.S.T. standards are supplied in the In-Situ Chloride Calibration Kits:

35.5 ppm Cl^-
355 ppm Cl^-
3545 ppm Cl^-

Specialized calibration kits are available for calibrating the chloride sensor for low-range and high-range measurements:

Low range: two quarts each 35.5 ppm and 355 ppm
High range: two quarts each 355 ppm and 3545 ppm

RECOMMENDED CALIBRATION FREQUENCY

Ion-selective electrodes are inherently unstable and drift is quite normal. To achieve the most accurate sensor response, we recommend a complete three-point bithermal calibration once a week, with a single-point calibration daily or after 4-6 hours of use.

PREPARING TO CALIBRATE

You will need:

- MP TROLL 9500 with the hydrated chloride sensor installed and sensors or plugs in the other sensor ports
- Cal Cup
- One, two, or three chloride calibration solutions, selected for the range you expect to measure. When performing a multi-point calibration, begin with the lowest-concentration solution.
- For a three-point bithermal calibration: a temperature bath, or a container of ice large enough to hold the Cal Cup (and stirrer, if used).
- Stirrer: Use a stirrer during calibration if it will also be used in the field—for example, in stagnant or very slowly moving water. The more closely calibration conditions reflect field conditions, the more successful the calibration. For more information on the stirrer, see "Stirring" in Section 10.

CHLORIDE CALIBRATION PROCEDURE

1. Rinse the Cal Cup and front end of the MP TROLL 9500 in clean water. Rinse very thoroughly if the chloride sensor has recently been exposed to pH buffers during a pH calibration. Shake to dry.

   For best results, follow this with a rinse in a portion of the selected calibration solution. Discard the rinse solution.

2. Insure the black PVC base (or the stirrer) is attached to the Cal Cup, and fill the Cal Cup to the fill line with the selected calibration solution.

   - Begin with the lowest concentration when performing a multi-point calibration.
   - With a full complement of sensors installed, use the lower line as a guide.
   - With 1 or 2 removable sensors installed, fill to the upper line.

3. Insert the front end of the MP TROLL 9500 into the open end of the Cal Cup. Thread the Cal Cup onto the body until seated against the o-ring, then back off slightly to avoid overtightening.

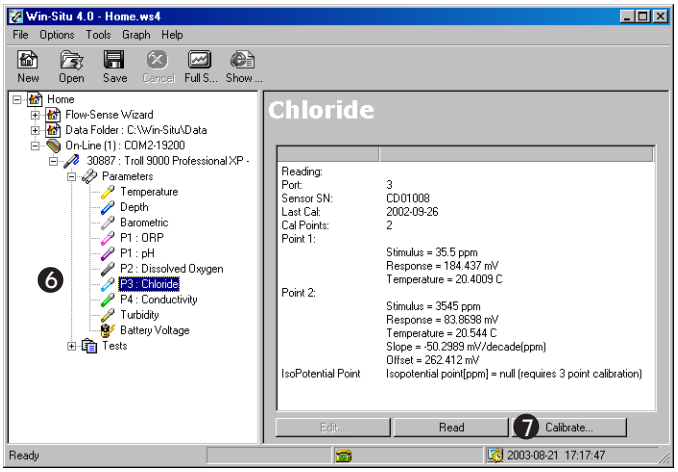
   To stabilize the instrument, you may wish to use a calibration stand or other support.

4. Connect the MP TROLL 9500 to a PC and establish a connection in Win-Situ 4 or Pocket-Situ 4. Win-Situ screens are illustrated here. The Pocket-Situ interface is similar, with the Navigation tree at the top of the screen and the Information pane below it.

5. Select the MP TROLL 9500 in the Navigation tree.

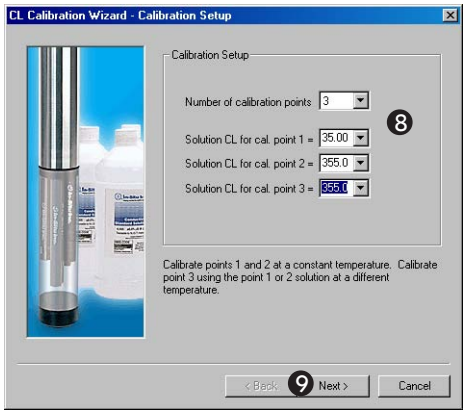
   The software will automatically detect and display the installed sensors. If one or more sensors is installed in the wrong port, an error message will be displayed. Simply remove the sensor and install it in the correct position, then “refresh” the device before continuing.

6. Select Chloride in the Parameters list. The sensor serial number (S/N) and recent calibration information is displayed.



7. Select **Calibrate**.

   The Chloride Calibration Wizard starts. A screen like this is displayed.

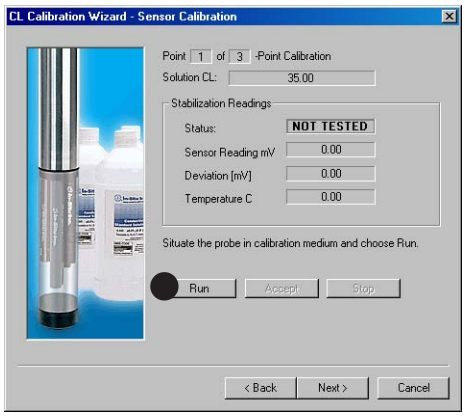


8. Select the number of calibration points for this calibration, and the concentration (ppm) of the calibration solution for each point.

   Cal point 1 is the solution the sensor is soaking in now, the lowest concentration for a multi-point calibration. If doing a three-point bithermal cal, choose cal point 3 to be the same as either cal point 1 or cal point 2.

9. Select **Next** to continue.

10. In the next screen, select **Run** to begin the stabilization.



The display will continuously update as readings are taken and compared against the stabilization criteria.

- Status indicators:

  NOT TESTED is displayed until you begin the calibration by selecting Run.

  UNSTABLE indicates the sensor response does not meet the criteria for a valid calibration point.

  NOMINAL indicates the sensor deviation meets early stabilization criteria.

  The **Accept** button becomes available when nominal stability is achieved. You may accept the early value, or wait for complete stability. If you accept the early value, the calibration point will be designated "USER SET" in the calibration report. (For more on calibration reports, see "Calibration History" in Section 10.)

  STABLE is displayed when the readings have stabilized sufficiently to take a valid calibration point. The calibration proceeds automatically to the next screen.

- Sensor Reading: The current sensor response in milliVolts.
- Deviation: Change in sensor response between the last two readings.
- Current temperature is also displayed.

11. If doing a a single-point calibration, go to step 16.

    For a multi-point calibration, the Wizard returns to the screen shown at step 10 and waits for you to situate the probe in the next calibration solution and click Run.

12. Remove the Cal Cup, discard the first solution, rinse the Cal Cup and the front end of the instrument in clean water, followed by a rinse in the next calibration solution, refill the Cal Cup with the second solution, and attach it to the instrument.

    ***TIP:** The used calibration solution may be flushed down the drain with running water, or saved in a separate container and used to rinse the sensors the next time you calibrate with the same solution.*

13. Select **Run** to begin the stabilization for cal point 2. Status indicators and controls are the same as for cal point 1 (step 10).

    Again wait for Stable status (or click Accept when Nominal is indicated).

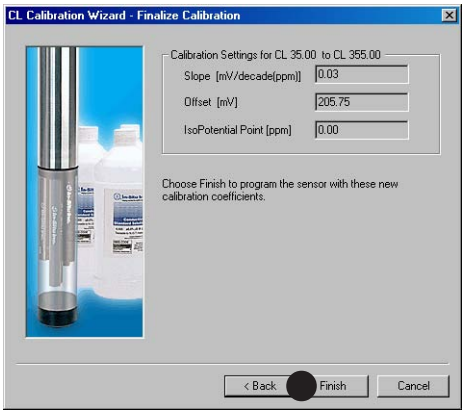
    If doing a two-point calibration, go to step 16.

14. For the third calibration point, use the cal point 1 or cal point 2 solution (as specified in step 8) but change the temperature by at least 10°C. A convenient way to do this is to move the probe—Cal Cup and all—into a temperature-controlled bath or container of ice. Allow time for the sensor to reach thermal equilibration with the solution temperature. With stirring or agitation, this should take about 10 minutes, perhaps up to 30 minutes if left undisturbed.

15. When the temperature is stable, select **Run** for cal point 3.

    When Nominal is accepted or Stable is indicated for cal point 3, the final screen is displayed.

16. The final screen of the Calibration Wizard shows the calculated sensor slope and offset. For a three-point bithermal calibration, the isopotential point is shown. If a single-point calibration has been performed, the isopotential point is the one calculated during the last three-point bithermal calibration.



17. Select **Finish** to program the sensor with the newly calculated calibration coefficients.

The chloride sensor is now calibrated and ready to use.

TIP: *You can look at the calibration report right after calibrating, or at any time. See "Calibration History" in Section 10 for details.*

Options for storing sensors:

The sensor should calibrated immediately before use. If storage is necessary, remove the sensor from the instrument and immerse in 35 ppm Cl solution, for later use in the low chloride range, or 355 ppm Cl solution, for use in the high range.

SENSOR SLOPE AND OFFSET

The expected slope for a new sensor is about 57 (± 2) mV per decade of concentration (ppm). The calibration curve begins to deviate from linear at about 10 ppm. The sensor's zero offset is recalculated with each single-point calibration.

UNITS AND CALCULATED MEASUREMENTS

Chloride ion concentration is reported in ppm (equivalent to mg/L). No calculated measurements are available.

USAGE RECOMMENDATIONS AND CAUTIONS

Chloride sensor	
Operating Temperature	-5°C to 50°C (23°F to 122°F) continuous temperature; can tolerate up to 60°C (140°F) intermittently
Pressure Rating	100 psi (70 m, 231 ft)
pH range	2 to 12

Do not submerge the chloride sensor deeper than 231 ft (70 m).

pH EFFECTS

The sensor's pH range is that range over which a change in pH will not cause a significant change in the measured voltage. It is the plateau on a graph of pH against mV at constant concentration of the detected ion. Outside this range, a change in pH may cause a significant change in the measured mV.

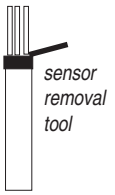
POTENTIAL INTERFERENCES

The table on this page lists possible interfering ions that cause 10% error at various levels of Cl^-.

Ion	100 ppm Cl^-	10 ppm Cl^-	1 ppm Cl^-
OH^-	8000	800	80
NH_3	12	1.2	0.12
$S_2O_3^{2-}$	1	0.1	0.01
Br^-	0.3	0.03	0.003
S^{2-}	10^{-4}	10^{-5}	10^{-6}
I^-	$5x10^{-5}$	$5x10^{-6}$	$5x10^{-7}$
CN^-	$2x10^{-5}$	$2x10^{-6}$	$2x10^{-7}$
Complexes with Bl^{3+}, Cd^{2+}, Mn^{2+}, Pb^{2+}, Sn^{2+}, Tl^{3+} and reducing agents			

SENSOR CARE AND HANDLING

SENSOR REMOVAL



To remove the sensor, position the yoke of the sensor removal tool at the point where the sensor meets the sensor block and pry the sensor upward.

MAINTENANCE/INSPECTION/CLEANING

If a film should form on the top of the membrane, use a swab to remove it, followed by a rinse in deionized water and soaking for a few minutes in a solution of 35 ppm or 355 ppm Cl.

To avoid depletion of the reference solution, do not allow the sensor to soak in pure water for more than a few minutes at a time.

The electrode is not customer-refillable.

STORAGE

Store the sensor immersed in 35 or 355 ppm Cl solution, depending on usage requirements. For longer-term storage, it may be rinsed and stored dry to avoid depletion of the reference solution.

17 NITRATE

WHAT IS NITRATE ?

Nitrogen is an essential nutrient for plants and animals. It exists in the environment in many different forms, constantly being replenished as part of the nitrogen cycle. Nitrate (NO_3^-) is one form of nitrogen in the ecosystem that is very soluble in water. Nitrate enters the water system when runoff from rainfall or irrigation washes through soils that contain nitrate. The nitrate dissolves in the water and is carried to nearby streams and lakes. It also permeates downward into the soil where it may enter underground aquifers. The concentration of nitrogen in a body of water depends mostly upon the land cover and soil type. Highest concentrations are associated with shallow groundwater and agricultural use of the land. Agriculture is a large contributor to the pollution of surface water and groundwater because of the use of fertilizers that contain nitrate. Also, densely populated livestock produce large quantities of manure that can be changed into nitrate upon decay.

Nitrate remains in surface water until it is consumed as a nutrient by plants or other organisms. Surface streams have nitrate concentrations ranging from 0.1 to 20 ppm N. Levels as high as 30 ppm N are found in wastewater discharges and wastewater effluent plants while levels as low as 0.05 ppm N are found in unpolluted groundwater.

WHY MEASURE NITRATE?

High nitrate levels in drinking water are associated with health problems. Nitrate is reduced to nitrite in the digestive system, where it may then oxidize iron in the hemoglobin molecule of red blood cells to form methemoglobin. Methemoglobin lacks the capacity to bind and carry oxygen to tissues. As a result of this health risk, the EPA has established 10 ppm N as the maximum limit of nitrate in drinking water for the USA.

High levels of nitrate in lakes can lead to a process called eutrophication. Nitrates are nutrients for aquatic plants and algae, causing overproduction when present in excessive levels. This accelerated growth or bloom can eventually lead to a number of negative impacts on the aquatic environment such as a reduction in dissolved oxygen, which can lead to the death of fish and other aquatic life. Reduction of sunlight to submerged aquatic vegetation due to increased coverage on the surface causes a corresponding reduction in photosynthesis and eventual death.

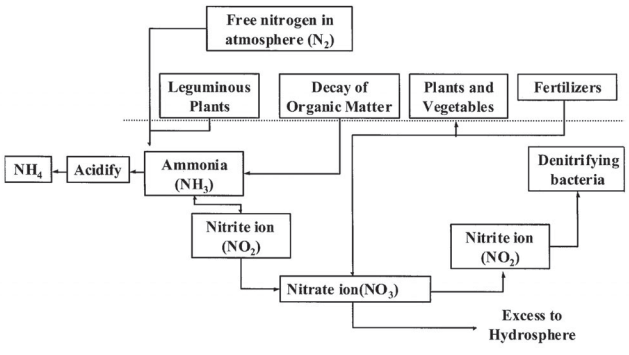
Typical Nitrate values

Unpolluted groundwater	0.05 ppm N
Surface water	0.1 to 20 ppm N
Waste water	~ 30 ppm N
Drinking water standard (EPA)	10 ppm N

THE NITRATE SENSOR

The In-Situ sensor is an ion-selective electrode (ISE) that is selective for the nitrate ion (NO_3^-). It is a double-junction combination ISE with a silver/silver-chloride reference half-cell, PVC membrane, and reference electrolyte gel. It measures the concentration in parts per million of nitrate ion in solution (calculated as nitrogen, ppm as N).

THE NITROGEN CYCLE



SENSOR PREPARATION

To ensure optimum membrane response, the nitrate sensor should be thoroughly hydrated in an appropriate solution before calibration. A good way to do this is to allow the sensor to soak in the solution you plan to use for the first calibration point (lowest concentration) for at least 15 minutes and up to several days before calibration and use.

- 1.4 ppm N for calibration in the lower range (concentrations less than 14 ppm N)
- 140 ppm N for calibration in the upper range (concentrations of 14 ppm N and up)

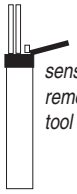
The sensor kit includes an empty bottle for this purpose.

SENSOR INSTALLATION

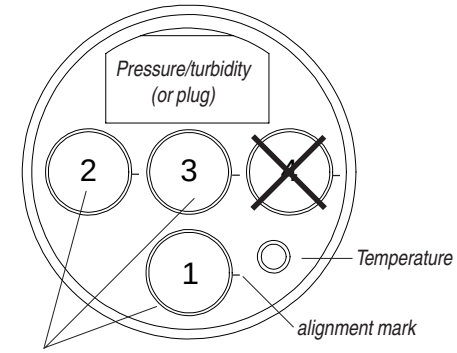
Unpack the nitrate sensor, hydrate it as above, and install in port 1, 2, or 3 in the sensor block at the front end of the MP TROLL 9500 as follows.

TIP: *Remember that a polarographic D.O. sensor (if present) will operate properly only in port 2, and a turbidity wiper accessory only in port 3.*

1. Remove the restrictor from the front end of the MP TROLL 9500. This allows access to the sensor block depicted in the drawing below.
2. Remove the sensor's protective cap or storage bottle and set aside for future storage of the sensor. If the connector end is covered with a cap, remove it also.
3. Remove any moisture or dirt from the area around the port where you will install the sensor, then use the sensor removal tool to remove the plug from the port where you will install the sensor.



sensor removal tool



4. Remove any moisture or dirt from the port connector with a clean swab or tissue.
5. Check lubrication of the sensor o-rings.

TIP: The sensor o-rings require generous lubrication before installation. New sensors will be lubricated at the factory. If the o-rings appear dry, apply apply a silicone lubricant before installation.

6. Handling the sensor by the sides, not the tip, align the mark on the side of the sensor with the mark on the port.

Avoid touching the membrane at the tip of the sensor. Contaminants on the membrane can change its properties and affect measurements.

7. Use the sensor insertion tool to firmly press the sensor into the port until you feel it dock with the connector at the bottom. When properly inserted a small gap (width of the sensor removal tool) remains between the widest part of the sensor and the instrument body, for ease of removal.

sensor insertion tool

CALIBRATION

OVERVIEW

The software offers several options for nitrate calibration.

- **Three-point bithermal** ("two-temperature") calibration. The first two calibration points are taken in solutions of different concentrations at the same temperature. The third point uses one of these solutions at a temperature that is at least 10° higher or lower depending on anticipated fieldconditions. This type of calibration allows determination of the sensor's "isopotential point"—the ion concentration at which changes in temperature do not cause a change in sensor response (voltage). A three-point bithermal calibration is recommended before the first use of the sensor, and regularly thereafter, to insure accurate readings at all potential temperatures.
- **Two-point isothermal** ("same temperature") calibration using solutions of two different concentrations. A two-point isothermal calibration calculates the sensor's slope and offset but cannot compute the isopotential point. For best results this type of calibration should be carried out as close as possible to the temperature at which the sensor will be used. Or, It may be performed after a previous three-point bithermal calibration to recalculate the slope and offset of an aging sensor while retaining the previously calculated isopotential point.

- **Single-point** calibration. After the initial three-point bithermal calibration has established the sensor slope, offset, and isopotential point, a single-point calibration may be used with good results to adjust the offset on a daily basis.

CALIBRATION SOLUTIONS

Sodium nitrate ($NaNO_3$) solutions certified to N.I.S.T. standards are supplied in the In-Situ Nitrate Calibration Kits:

14.0 ppm as N
140 ppm as N
1400 ppm as N

Specialized calibration kits are available for calibrating the nitrate sensor for low-range and high-range measurements:

Low range: two quarts each 14.0 ppm and 140 ppm
High range: two quarts each 140 ppm and 1400 ppm

RECOMMENDED CALIBRATION FREQUENCY

Ion-selective electrodes are inherently unstable and drift is quite normal. To achieve the most accurate sensor response, we recommend a complete three-point bithermal calibration once a week, with a single-point calibration daily or after 4-6 hours of use.

PREPARING TO CALIBRATE

You will need:

- MP TROLL 9500 with the hydrated nitrate sensor installed and sensors o0r plugs in the other sensor ports
- Cal Cup
- One, two, or three nitrate calibration solutions, selected for the range you expect to measure. When performing a multi-point calibration, begin with the lowest-concentration solution
- For a three-point bithermal calibration: a temperature bath, or a container of ice large enough to hold the Cal Cup (and stirrer, if used).
- Stirrer: Use a stirrer during calibration if it will also be used in the field—for example, in stagnant or very slowly moving water. The more closely calibration conditions reflect field conditions, the more successful the calibration. For more information on the stirrer, see “Stirring” in Section 10.

NITRATE CALIBRATION PROCEDURE

1. Rinse the Cal Cup and front end of the MP TROLL 9500 in clean water. Shake to dry.

   For best results, follow this with a rinse in a portion of the selected calibration solution. Discard the rinse solution.

2. Insure the black PVC base (or the stirrer) is attached to the Cal Cup, and fill the Cal Cup to the fill line with the selected calibration solution.

   - Begin with the lowest concentration when performing a multi-point calibration.
   - With a full complement of sensors installed, use the lower line as a guide.
   - With 1 or 2 removable sensors installed, fill to the upper line.

3. Insert the front end of the MP TROLL 9500 into the open end of the Cal Cup. Thread the Cal Cup onto the body until seated against the o-ring, then back off slightly to avoid overtightening.

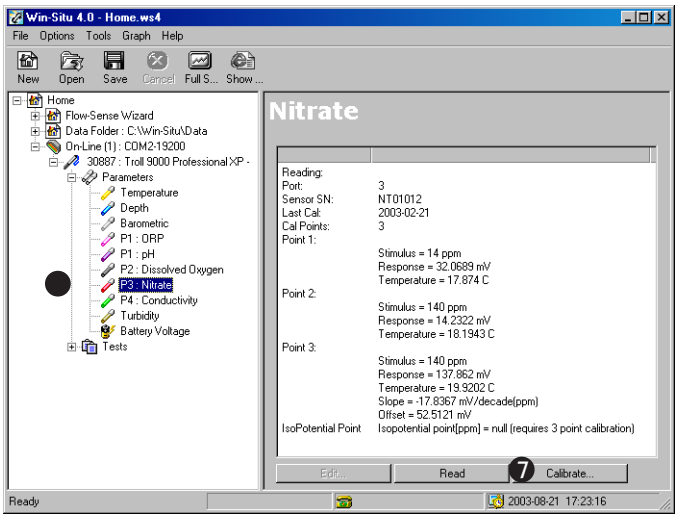
   To stabilize the instrument, you may wish to use a calibration stand or other support.

4. Connect the MP TROLL 9500 to a PC and establish a connection in Win-Situ 4 or Pocket-Situ 4. Win-Situ screens are illustrated here. The Pocket-Situ interface is similar, with the Navigation tree at the top of the screen and the Information pane below it.

5. Select the MP TROLL 9500 in the Navigation tree.

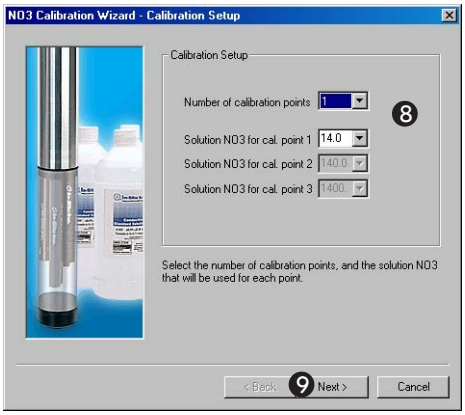
   The software will automatically detect and display the installed sensors. If one or more sensors is installed in the wrong port, an error message will be displayed. Simply remove the sensor and install it in the correct position, then “refresh” the device before continuing.

6. Select Nitrate in the Parameters list. The sensor serial number (SN) and recent calibration information is displayed.



7. Select **Calibrate**.

   The Nitrate Calibration Wizard starts. A screen like this is displayed.

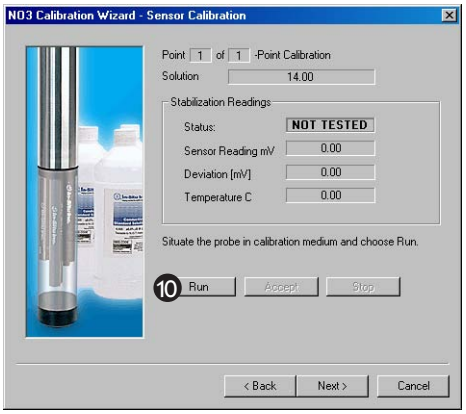


8. Select the number of calibration points for this calibration, and the concentration (ppm) of the calibration solution for each point.

   Cal point 1 is the solution the sensor is soaking in now, the lowest concentration for a multi-point calibration. If doing a three-point bithermal cal, choose cal point 3 to be the same as either cal point 1 or cal point 2.

9. Select **Next** to continue.

10. In the next screen, select **Run** to begin the stabilization.



   The display will continuously update as readings are taken and compared against the stabilization criteria.

- Status indicators:

  NOT TESTED is displayed until you begin the calibration by selecting Run.

  UNSTABLE indicates the sensor response does not meet the criteria for a valid calibration point.

  NOMINAL indicates the sensor deviation meets early stabilization criteria.

  The **Accept** button becomes available when nominal stability is achieved. You may accept the early value, or wait for complete stability. If you accept the early value, the calibration point will be designated “USER SET” in the calibration report. (For more on calibration reports, see “Calibration History” in Section 10.)

  STABLE is displayed when the readings have stabilized sufficiently to take a valid calibration point. The calibration proceeds automatically to the next screen.

- Sensor Reading: The current sensor response in milliVolts.
- Deviation: Change in sensor response between the last two readings.
- Current temperature is also displayed

11. If doing a single-point calibration, go to step 16.

    For a multi-point calibration, the Wizard returns to the screen shown at step 10 and waits for you to situate the probe in the next calibration solution and click Run.

12. Remove the Cal Cup, discard the first solution, rinse the Cal Cup and the front end of the instrument with clean water, followed by a rinse in the next calibration solution, refill the Cal Cup with the second solution, and attach it to the instrument.

    TIP: *The used calibration solution may be flushed down the drain with running water, or saved in a separate container and used as a rinse the next time you calibrate with the same solution.*

13. Select **Run** to begin the stabilization for cal point 2. Status indicators and controls are the same as for cal point 1 (step 10).

    Again wait for Stable status (or click Accept when Nominal is indicated).

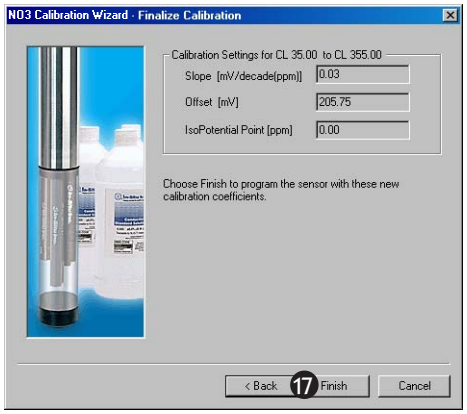
    If doing a two-point calibration, go to step 16.

14. For the third calibration point, use the cal point 1 or cal point 2 solution (as specified in step 8) but change the temperature by at least 10°C. A convenient way to do this is to move the probe—Cal Cup and all—into a temperature-controlled bath or container of ice. Allow time for the sensor to reach thermal equilibration with the solution temperature. With stirring or agitation, this should take about 10 minutes, perhaps up to 30 minutes if left undisturbed.

15. When the temperature is stable, select **Run** for cal point 3.

    When Nominal is accepted or Stable is indicated for cal point 3, the final screen is displayed.

16. The final screen of the Calibration Wizard shows the sensor slope and offset calculated during the calibration process. For a three-point bithermal calibration, the calculated isopotential point is shown. If a single-point calibration has been performed, the isopotential point is the one calculated during the last three-point bithermal calibration.



17. Select **Finish** to program the sensor with the newly calculated calibration coefficients.

The nitrate sensor is now calibrated and ready to use.

TIP: *You can look at the calibration report right after calibrating, or at any time. See "Calibration History" in Section 10 for details.*

Options for storing sensors:

The sensor should calibrated immediately before use. If storage is necessary, remove the sensor from the instrument and immerse in 14 ppm N solution, for later use in the low nitrate range, or 140 ppm N solution, for use in the high range.

SENSOR SLOPE AND OFFSET

The expected slope for a new sensor is about 57 (± 2) mV per decade of concentration (ppm). The calibration curve begins to deviate from linear at about 10 ppm. The sensor's zero offset is recalculated with each single-point calibration.

UNITS AND CALCULATED MEASUREMENTS

Nitrate ion concentration is reported in ppm (equivalent to mg/L). No calculated measurements are available.

USAGE RECOMMENDATIONS AND CAUTIONS

Nitrate Sensor	
Operating Temperature	-5°C to 40°C (23°F to104°F) continuous temperature; can tolerate up to 50°C (122°F) intermittently
Pressure Rating	20 psi (14 m, 46 ft)
pH range	2.5 to 11

Do not submerge the nitrate sensor deeper than 46 ft (14 m).

TEMPERATURE

The higher the temperature, the shorter the lifetime of the electrode. 1°C difference in temperature causes a 2% error at 10 ppm, unless a bithermal calibration is performed.

POTENTIAL INTERFERENCES

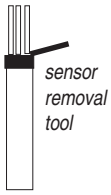
The following table shows concentrations of possible interfering ions that cause 10% error at various levels of NO_3^-.

Ion	100 ppm NO_3^-	10 ppm NO_3^-	1 ppm NO_3^-
ClO_4^-	0.01	0.001	0.0001
I^-	0.5	0.05	0.005
ClO_3^-	5	0.5	0.05
CN^-	10	1	0.1
Br^-	70	7	0.7
NO_2^-	70	7	0.7
HS^-	100	10	1
HCO_3^-	1000	100	10
CO_3^{2-}	2000	200	20
Cl^-	3000	300	30
$H_2PO_4^-$	5000	500	50
HPO_4^{2-}	5000	500	50
PO_4^{3-}	5000	500	50
AcO^-	20,000	2000	200
F^-	60,000	6000	600
SO_4^{2-}	100,000	10,000	1000

SENSOR CARE AND HANDLING

SENSOR REMOVAL

Position the yoke of the sensor removal tool at the point where the sensor meets the sensor block and pry the sensor upward.



sensor removal tool

Avoid touching the membrane at the tip of the sensor. Contaminants on the membrane can change its properties and affect measurements.

MAINTENANCE/INSPECTION/CLEANING

As long as extreme pH and high organic solvent content is avoided, the sensor should last for several months at room temperature. Eventually some of the components will leach out, and this will affect the response (detection limit and scope), but this can be compensated through calibration.

If film buildup is visible on the membrane, rinse under a gentle stream of clean water, or swish gently in a mild detergent solution, rinse well with clean water, and shake to dry.

To avoid depletion of the reference solution, do not allow the sensor to soak in pure water for more than a few minutes at a time.

The electrode is not customer-refillable.

STORAGE

Store the sensor immersed in 14 or 140 ppm N solution, depending on usage requirements, rather than dry or in DI water.

REFERENCES

Eaton, A.D., L.S. Clesceri, E.W. Rice, and A.E. Greenberg, eds., *Standard Methods for the Examination of Water and Wastewater,* 21st edition, Washington, D.C.: American Public Health Association, American Water Works Association, and Water Environment Federation, 2005. Section 4500-NO_3^- D. Nitrate Electrode Method.

EPA, Methods for Chemical Analysis of Water and Wastes, EPA/600/4-79-020, revised March 1983. Method 350.3, Nitrogen, Ammonia, Potentiometric, Ion Selective Electrode. Approved at 40 CFR Part 136.

Rundle, Chris C., A Beginners Guide to Ion-Selective Electrode Measurements. Nico2000 Ltd., London, UK. On the web at www.nico2000.net

18 TURBIDITY

WHAT IS TURBIDITY?

Turbidity is an indirect measure of the clarity or transparency of water, and thus an important indicator of its condition and productivity. Created by suspended matter and microscopic organisms, turbidity causes light to be scattered and absorbed rather than transmitted directly through water. Turbidity is the physical characteristic of the solution that causes light scattering. Turbidity is the opposite of clarity.

The APHA reference work *Standard Methods* (Eaton and others, 2005) defines turbidity as "an expression of the optical property that causes light to be scattered and absorbed rather than transmitted with no change in direction or flux level through the sample."

Turbidity is not . . .

- a direct measure of clarity.
- a measure of color.
- a measure of suspended solids; it is a measure of their light-scattering abilities.

The In-Situ Turbidity sensor* is in conformance with the ISO 7027 turbidity standard which specifies 90° scattered light.

WHY MEASURE TURBIDITY?

Turbidity measurements

- can provide a reasonable estimate of the *total suspended solids* or sediments (TSS) concentration in water.
- can tell us something about the health of a natural water body. Clear water lets light penetrate more deeply into a lake or stream than does murky water. This light allows photosynthesis to occur and oxygen to be produced.

Typical turbidity values

EPA drinking water	0.3 - 0.5 NTU
Treated water	0 - 1 NTU
Fresh water, >21.5" visibility	< 10 NTU
Fresh water, 2.5" visibility	240 NTU
Short-term stress to aquatic life	> 10 NTU
Unsafe level for most aquatic life	> 100 NTU

- can be a useful indicator of runoff into surface water systems.
- in flow-cell or in-line applications, when pumping water at very low rates, can provide a good indication of true formation water.

Higher turbidity levels make it more costly to treat surface water for use as drinking water. Controlling turbidity may be an effective way to protect against pathogens in drinking water.

Aesthetic considerations also play a role in our desire to quantify turbidity: Most people would rather look at, drink, or swim in clear water than in water that appears cloudy, and closely associate appearance with the health of the body of water.

HOW IS TURBIDITY MEASURED?

Historical methods for measuring turbidity relied on subjective estimates that depended largely on the eye of the beholder.

In the Jackson Candle method, for example, a candle flame is observed through the length of a glass tube into which a fluid sample is poured until the rays of transmitted and scattered light appear equal and the flame essentially disappears. Among several drawbacks to this method, the reproducibility of standards formulated from natural sediments was difficult to control.

The Secchi disk method used in limnological studies involves submerging a weighted, black-and-white

* Contains an assembly, US Pat. No. 6,842,243

painted metal plate until the pattern can no longer be detected. The plate is then pulled up until it is visible again. The average of the two depths provides an estimate of water clarity or transparency.

Modern turbidimeters measure the loss in intensity of a light beam as it passes through a solution containing suspended and dissolved particles that are large enough to scatter the light. The method is based upon a comparison of the intensity of light scattered by the sample with the intensity of light scattered by a standard reference suspension. The *nephelometer* is a particular type of turbidimeter that measures the intensity of light scattered at right angles (90°) to the incident light. This lessens the difficulty of differentiating small changes against a large background. Standards for turbidity-measurement instruments specify the light source, angle, wavelength, beam width, and sample suspensions, among other factors. Many of today's commonly accepted procedures (e.g., Standard Methods, EPA, and ISO) apply to laboratory bench-top instruments.

THE TURBIDITY SENSOR

The optional turbidity sensor of the Multi-Parameter TROLL 9500 is permanently-installed and factory-calibrated. It may be a turbidity sensor alone or a pressure/turbidity sensor combination. If your MP TROLL 9500 was ordered without a turbidity sensor or a pressure sensor, there will be a permanently installed plug in the pressure/turbidity sensor slot. A turbidity sensor or combination pressure/turbidity sensor can be added at the factory.

The In-Situ turbidity sensor is comprised of a matched solid-state detector-emitter pair positioned at right angles. The light source is an infrared LED, optimized for operation at 870 nanometers (nm). The optical windows of the detector (photodiode) and emitter (LED) are scratch-resistant sapphire. ISO 7027 has set a detection angle of 90° and the light wavelength at 860 nm. The sensor uses active modulation for ambient light rejection.

The In-Situ sensor is an electronic nephelometer which compares the intensity of light scattered by the environmental fluid with intensity of light scattered by a standard reference suspension. The higher the intensity of scattered light, as measured in NTU's, the higher the turbidity. This measurement generally provides a very good correlation with the concentration of particles in the water that affect clarity. However, measurements of scattered light cannot be directly related to a gravimetric equivalent, such as suspended sediment load, unless a working curve for the specific sample is created.

THE TURBIDITY WIPER

The optional wiper accessory helps to keep the turbidity sensor optics free of bubbles and fouling.

The wiper installs in port 3 of the MP TROLL 9500 like other removeable sensors. A positional brace aligns it with respect to the turbidity sensor and keeps it stable in moving waters.

The wiper pad is adhesive-free, low-abrasion cotton material. The pad is easily replaced when it becomes too soiled to clean the sensor optics effectively.

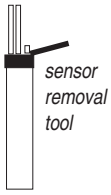
Use of the wiper will significantly impact battery life. Lithium batteries are recommended.

WIPER INSTALLATION

The MP TROLL 9500 may be shipped with the optional wiper already installed in port 3, as shown on the drawing below. If installation is necessary, unpack and install the wiper in port 3 as follows.

*The turbidity wiper will function properly only when installed in **port 3**.*

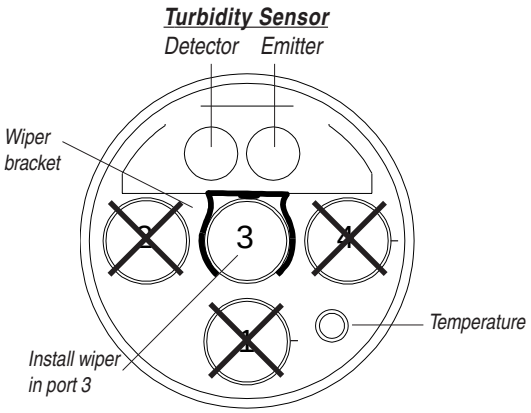
1. Remove the restrictor from the front end of the MP TROLL 9500. This allows access to the sensor block depicted in the drawing below.
2. Use the sensor removal tool to remove the sensor or plug from port 3. Retain the plug for future use. For best access to port 3, you may need to remove sensors or plugs from other ports as well.



3. Check lubrication of the o-rings on the connector end of the wiper.

TIP: The wiper o-rings require generous lubrication before installation. New wipers will be lubricated at the factory. If the o-rings appear dry, apply apply a silicone lubricant before installation.

4. Visually align the connector on the wiper with the connector at the bottom of port 3.
5. Press firmly until you feel the wiper dock with the port connector. When properly inserted a small gap (width of the sensor removal tool) remains between the wiper body and the instrument body.
6. Press the wiper into the bracket attached to the turbidity sensor.
7. After installing a new wiper, we recommend you access wiper control in the software while you can clearly see the wiper movement. Connect in software, select the wiper, and click **Wipe** to ensure the wiper passes over the turbidity sensor optics properly.



What does the wiper do, and when is wiping necessary?

The wiper helps keep the optical windows of the turbidity sensor clear of bubbles and debris during measurements. When the sensor is off, the wiper is parked in its "home" position over sensor port 4. When a turbidity measurement is called for—a manual reading, a scheduled reading during a test, while calibrating or profiling—the wiper makes a full 360 degree sweep to clean the optics.

Wiping is not needed when the instrument is hand-held for short periods (Profiling). Gently swishing the MP TROLL in the water should serve to dispel air bubbles.

WIPER MOVEMENT

When the turbidity sensor is off—not taking a measurement—the wiper head is "parked" over port 4. When a turbidity measurement is requested, the wiper head passes over the optics, sweeping them clean, and returns to its parking place. One "wipe" consists of a 360° counter-clockwise sweep (viewed from the sensor end), as shown in the drawing below. Wiping occurs automatically before turbidity readings—manual reads, profiling, calibration, and tests—that are more than 15 seconds apart. If readings are less than 15 seconds apart, the wiper will wipe once, before the first reading.

A single wipe may be initiated in the software when the instrument is idle to clear the turbidity optics of bubbles or debris. The wiper's movements are entirely software-controlled.

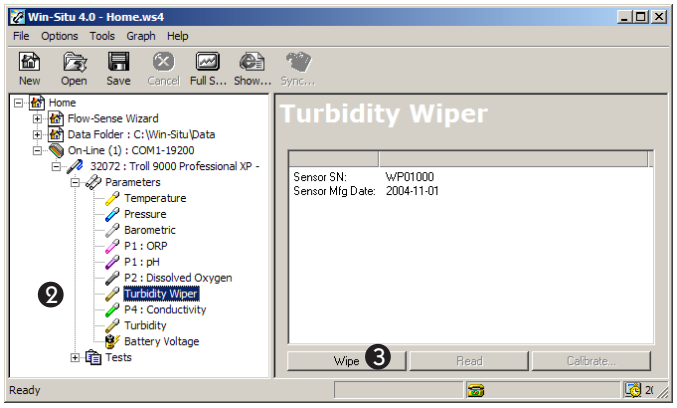
***TIP:** 15 seconds are alotted for a wipe cycle. This time is generous to allow for slower wiper movement at very low temperatures.*

If readings—test, calibration, profiling—are more than 15 seconds apart, the turbidity sensor will be wiped automatically before each reading. If readings are less than 15 seconds apart, the wiper will wipe the windows just once, before the first reading.

MANUAL WIPE

To wipe the turbidity sensor optics manually:

1. With the wiper installed in port 3, connect the MP TROLL 9500 to a PC and establish a connection in Win-Situ 4 or Pocket-Situ 4.
2. Select the Wiper in the Navigation tree.



3. Click **Wipe**. The wiper will pass once over the turbidity sensor optics and return to its home position.

WIPER GUIDELINES AND PRECAUTIONS

- If a wiper is installed during a Quick Cal of the Basic sensors (see Section 3, Getting Started), steps should be taken to insure the wiper pad material does not absorb the Quick Cal solution. There are two ways to do this.
  - Remove the wiper head before doing the Quick Cal. Refer to Wiper Maintenance guidelines later in this section for instructions on removing the wiper head.
  - Alternatively, soak the front end of the instrument in plain water before calibrating to allow the wiping pad to absorb sufficient water to prevent its absorbing any Quick Cal solution.
- **Do not attempt to move the wiper head by hand.** Wiper movement is software-controlled.
- The wiper pressure may be adjusted if necessary so that the pad is effectively cleaning the sapphire windows of the turbidity sensor during movement. Refer to Wiper Maintenance guidelines later in this section.
- The wiper pad or head may be replaced as needed. Refer to Wiper Maintenance guidelines later in this section.
- When an RDO optical dissolved oxygen sensor is installed, check to see that the RDO adapter cable is out of the way of wiper movement.

CALIBRATION

FACTORY CALIBRATION

The turbidity sensor has been factory-calibrated to achieve a sensor accuracy of ± 5% or 2 NTU (whichever is greater). The sensor is calibrated over its full range, 0 to 2000 NTU, using polymer standards. The resulting calibration coefficients are written to the sensor memory, where they are stored permanently. They may be overlaid by performing a field calibration as described below, or may be recalled from the sensor memory at any time.

The MP TROLL 9500's turbidity sensor is ready to measure turbidity without any user intervention. It is advisable to take a turbidity reading first in your own calibration solution(s) as a check to ensure the accuracy is within your operational standards and requirements. If this result is satisfactory, a field calibration is not required.

FIELD CALIBRATION

Field calibration (or "user calibration") is an overlay function that is applied after the factory calibration math is done. The factory calibration applies across the entire range of NTU, and can be altered in the field with a 1 to 4 point calibration procedure as described below to compensate for effects of sensor fouling and other factors. You may wish to perform a field calibration with standards other than polymer (i.e., Formazin).

For best results, calibrate as close to field temperature as possible.

CALIBRATION SOLUTIONS

A nephelometer such as the In-Situ turbidity sensor should be calibrated using standard reference suspensions having reproducible light-scattering properties. The sensor has been factory-calibrated with polymer suspensions, and the resulting calibration coefficients take into account the light-scattering properties of the suspensions and the sensor optics.

Q: Why do I need to calibrate the turbidity sensor if it has been calibrated in the factory?

A: A new turbidity sensor is ready to measure turbidity with reference to suspended polymer standards. If you prefer to reference turbidity measurements to Formazin rather than polymer, a field calibration with Formazin should be performed.

After cleaning the sensor, readings should be checked with standards and a field calibration performed if necessary.

Polymer-based standards are submicron, non-surface charged, solid spheres in matrixes of ultrapure water in homogeneous suspension; this homogeneity allows linear dilutions. EPA approved the polymer suspensions in 1984 as a calibration standard for turbidimeters. Polymer suspensions are very stable, can withstand temperature extremes, and have excellent lot-to-lot precision. A range of polymer suspensions are available individually from In-Situ Inc. for calibrating any expected turbidity range. They can be diluted with turbidity-free water to achieve other NTU values (but see the cautions below).

Avoid vigorous mixing or agitation, which will create air bubbles and lower the accuracy of the standards. It is advantageous to calibrate a nephelometric turbidimeter with a standard that most closely matches the size of the particulates you will be measuring.

Calibrating with Other Solutions

Formazin: If you wish to recalibrate with Formazin, keep these points in mind.

- Requires very careful handling.
- Must be shaken gently and allowed to settle for at least 5 minutes before use.
- Should not be diluted.

Diluting Polymer Suspensions: If you dilute polymer suspensions, keep these points in mind:

- Do not dilute more than 10:1. Use good laboratory techniques.
- Store carefully. PVC bottles are recommended.
- Diluting polymer suspensions takes them out of the category of "primary standards", they become "secondary standards."
- If not handled carefully, the dilutions can become unstable; the suspension of particles may be lost.

RECOMMENDED CALIBRATION FREQUENCY

Your own experience is the best guide to how often the turbidity sensor will benefit from recalibration. The need for recalibration depends on the condition of the optical windows, which in turn depends on the environment. In a biologically active environment, cleaning and calibration will be required more often. Periodic checks in calibration solutions of known turbidity can be beneficial in indicating how well the sensor is holding its calibration.

A field calibration is recommended

- if you wish to reference turbidity measurements to a standard other than polymer.
- after cleaning the sensor windows of contamination.
- when readings appear to drift, or show unexpectedly high or low results.

* if algal or other growth on the front end of the MP TROLL 9500 changes the reflective properties of the device.

TURBIDITY CALIBRATION PROCEDURE

You will need:

- MP TROLL 9500 with turbidity sensor (wiper optional), plugs in any unused sensor ports.
- The restrictor, nose cone, and removable sensors (if any) that will be installed when turbidity is measured.
- A laboratory beaker large enough to hold the instrument and calibration solution.
- One or more calibration standards for the region in which you wish to calibrate. Several ranges from Very Low to Full are suggested in the Calibration Wizard.

***TIP:** A 1-point to 4-point field calibration may be carried out in any range. When performing a multi-point calibration, begin with 0 NTU solution. For best measurement precision the highest NTU value should exceed the readings you expect in the field.*

1. Rinse the front end of the MP TROLL 9500 with clean water. Shake well to remove the rinse water; dry external surfaces (not the optical windows) with a clean tissue.
2. Pour the selected calibration standard into the beaker and insert the MP TROLL 9500 into the solution.

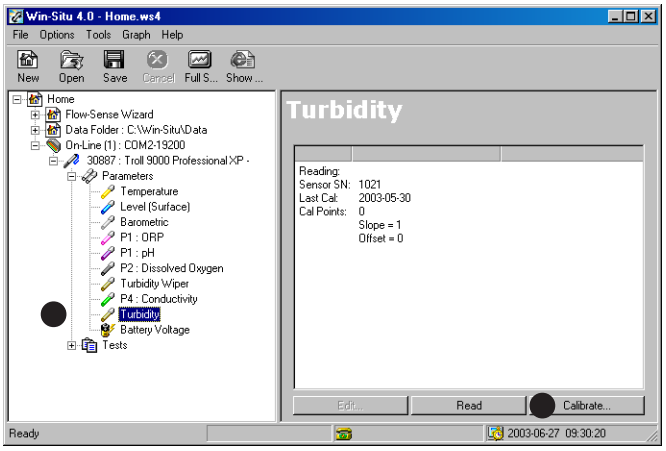
   The windows of the turbidity sensor should be immersed at least ¼" (a quarter of an inch) deep in the solution. If no wiper is present, gently agitate the instrument to dispel any air bubbles.

3. Connect the MP TROLL 9500 to a PC and establish a connection in Win-Situ 4 or Pocket-Situ 4. Win-Situ screens are illustrated here. The Pocket-Situ interface is similar, with the Navigation tree at the top of the screen and the Information pane below it.

4. Select the MP TROLL 9500 in the Navigation tree.

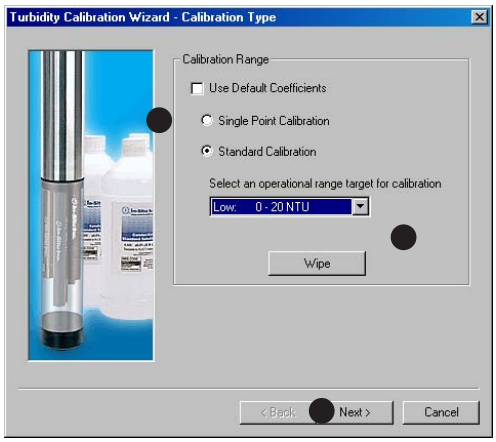
   The installed sensors will be displayed—including the turbidity wiper, if installed in port P3.

5. Click to select Turbidity in the Parameters list. The sensor serial number (S/N) and recent calibration information is displayed.



6. Select **Calibrate**.

   The Turbidity Calibration Wizard starts. A screen like the one below is displayed.



7. Select the type of calibration you wish to do:

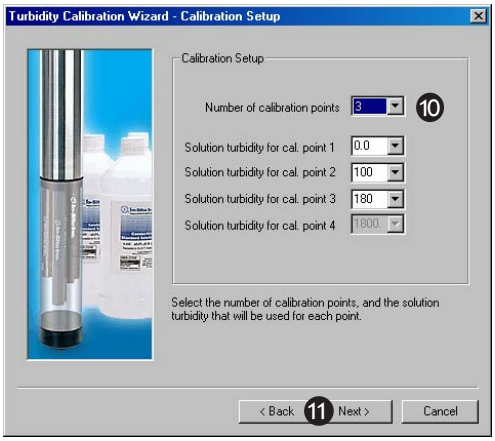
   - Use Default Coefficients resets the factory defaults. If you select this option, click **Next** and proceed to step 17.
   - Single-Point Calibration. Click **Next** and go to step 12.
   - Standard Calibration (default).

8. If you selected a Standard Calibration, select an operational range target. The ranges are suggestions only; a 1- to 4-point calibration may be performed in any range, using any standards

   Note: If the software detects a turbidity wiper accessory, pressing the **Wipe** button will result in one complete wipe cycle of the turbidity sensor optics.

9. Select **Next** to continue.

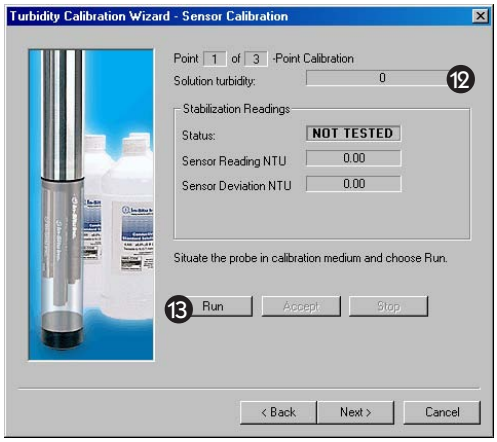
10. In the next screen, select the number of calibration points for this calibration, and the turbidity value (in NTU) of the calibration solution for each point. One to four points (solutions) may be selected for any operational range target selected in the previous screen.



   When performing a multi-point calibration, cal point 1 must be taken in a standard with a value of 0 NTU. Use clear water for this. Purchased distilled or deionized water will generally measure less than 0.5 NTU. Filtered water will have a lower NTU value.

11. Select **Next** to continue.

A screen similar to the one shown below is displayed.



12. If you are performing performing a single-point calibration, enter the value of the calibration standard (NTU). For a multi-point calibration, the value of the first solution will be displayed.

13. When the sensor is situated in the calibration medium, select **Run** to begin the stabilization.

    The display will continuously update as readings are taken and compared against the stabilization criteria.

- Status indicators:

  NOT TESTED is displayed until you begin the calibration by selecting Run.

  UNSTABLE indicates the sensor response does not meet the criteria for a valid calibration point.

  NOMINAL indicates the sensor deviation meets early stabilization criteria.

  The **Accept** button becomes available when nominal stability is achieved. You may accept the early value, or wait for complete stability. If you accept the early value, the calibration point will be designated "USER SET" in the calibration report. (For more on calibration reports, see "Calibration History" in Section 10.)

  STABLE is displayed when the readings have stabilized sufficiently to take a valid calibration point. The calibration proceeds automatically to the next screen.

- Sensor Reading: The current sensor response in NTU
- Sensor Deviation: Change in sensor response between the last two readings.
- Temperature

14. If doing a one-point calibration, go to step 17.

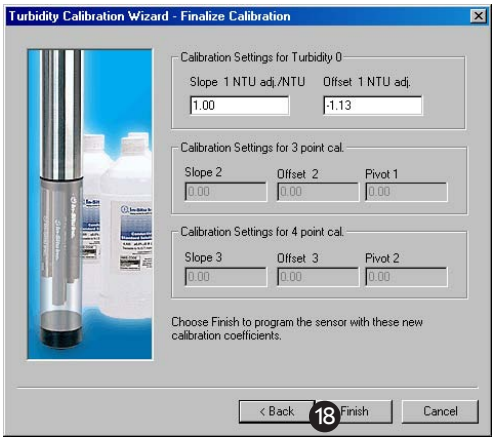
    For a multi-point calibration, the Wizard returns to the screen shown at step 13 and waits for you to situate the probe in the next calibration solution and click Run.

15. Discard the first solution, rinse the beaker and the front end of the instrument thoroughly, wipe off excess water, refill the beaker with the second solution, and insert the MP TROLL 9500 as before.

16. Select **Run** to begin the stabilization for the second calibration point. Status indicators and controls are the same as for the first calibration point (step 13).

    Again wait for stabilization, dump, rinse, dry, refill, Run, as many times as necessary to collect a stable calibration point in each solution.

17. The final screen shows the sensor slope and offset calculated during the calibration process (or the default settings if you selected that option at step 7). A slope and offset will be shown for each calibration point.



"Pivot" designates the point at which the slope characteristics change with a multi-point calibration. The correct slope for the turbidity values being monitored will automatically be applied.

18. Select **Finish** to program the sensor with the newly calculated calibration coefficients.

TIP: *You can look at the calibration report right after calibrating, or at any time. See "Calibration History" in Section 10 for details.*

RESETTING DEFAULT COEFFICIENTS

The sensor's calibration may be reset back to factory defaults at any time. As long as there is no contamination on the optical windows, this will restore the factory accuracy (± 5% or 2 NTU).

1. Establish a connection to the instrument in Win-Situ 4 or Pocket-Situ 4.
2. Select Turbidity in the Parameters list and click **Calibrate**.
3. In the first screen, select Use Default Coefficients, then **Next**.
4. In the final screen, click **Finish** to restore the sensor's factory calibration coefficients.

SENSOR SLOPE AND OFFSET

The offset is factory-set at 0 NTU. The zero offset may be recalculated for any appropriate value by performing a single-point calibration using a calibration standard of the desired NTU value. The sensor response is very linear up to 200 NTU.

UNITS AND CALCULATED MEASUREMENTS

Two units are available for readings from the turbidity channel:

- NTUs—Nephelometric Turbidity Units. Select NTU when the sensor has been calibrated with polymer suspensions.
- FNUs—Formazin Turbidity Units. Select FNU when the sensor has been calibrated with Formazin.

The operational pressure rating of the turbidity sensor is 150 psi. Do not submerge it deeper than 346 ft (105 m).

USAGE RECOMMENDATIONS AND CAUTIONS

Avoid use of the stirrer accessory (recommended for monitoring dissolved oxygen in stagnant water) when measuring turbidity.

When used without a wiper, dirty sensor optics can be compensated for to some extent by changing the offset.

Optical absorbancy ("color") will lessen the turbidity signal.

Turbidity readings are temperature-commpensated.

The optics need 5 seconds warm-up time to take the first reading later. Subsequent readings can be returned instantaneously.

COMMON INTERFERENCES

Light scattering depends upon the size, shape, refractive index, and other characteristics of the particles and the wavelength of the light.

Optically black particles, such as those of activated carbon, may absorb light and effectively decrease turbidity measurements. Nephelometers are relatively unaffected by small changes in design parameters and therefore are specified as the standard instrument for measurement of low turbidities. Nonstandard turbidimeters, such as forward-scattering devices, are more sensitive than nephelometers to the presence of larger particles and are useful for process monitoring. Reported turbidities are heavily dependent on the particulate matter contained in the suspensions that are used to prepare instrument calibration curves.

Due to current technological limitations, field turbidity measurement is "a snapshot of averages," Field measurements can be an excellent indicator of in-situ turbidity; final determination for reporting purposes should be conducted in a laboratory.

PROFILING TURBIDITY

The turbidity sensor's 5-second warmup will result in a slight delay before the first Profiler reading for all parameters. Subsequent readings can be taken within the Profiler's 2-second cycling.

If a turbidity wiper accessory is installed, it performs an initial wipe of the sensor optics—this takes about 15 seconds—then displays the first turbidity reading. If the profiling rate is longer than 15 seconds, this 15 second wipe will happen before each reading. To avoid this delay, set the profiling rate to less than 15 seconds. See Customizing the Profiler in Section 5 for details.

LOGGING TURBIDITY DATA

The wiper is activated automatically before turbidity readings during tests, so long as the readings are 15 seconds or more apart. To prolong battery life when running a wiper, we recommend the use of external power or two internal lithium D-cells installed in the MP TROLL 9500.

SENSOR CARE

INSPECTION/MAINTENANCE/CLEANING

The optical windows of the sensor are made of scratch-resistant sapphire. The optical components are not user-serviceable. Serious mechanical and temperature shock are about the only things that can damage the LED. If you feel the instrument has suffered such damage, contact In-Situ Technical Support.

However, the windows may need frequent cleaning, especially if used in a biologically active environment. A wiper accessory can help to prevent the accumulation of foreign material.

Cleaning may be necessary if the optical windows of the sensor become visibly contaminated by the gradual accumulation of foreign material. Because the sensor is not removable, we recommend gentle swabbing of the windows with a circular motion using plain water. Solvents are not recommended, although an ammonia solution (e.g., grocery-store ammonia) may be used with good effect to remove particularly stubborn materials.

A calibration check should be performed after cleaning, using calibration standards.

WIPER MAINTENANCE

The cotton wiper pad will require replacement periodically to maintain its effectiveness in cleaning the turbidity sensor optics. The entire head may be replaced, or just the pad. In either case, the wiper head will need to be removed. A hex wrench is supplied for this purpose. You do not need to remove the entire wiper; leave the wiper body installed in port 3.

Replacement pads and wiper heads are available from In-Situ Inc. or your distributor.

Removing the Wiper Head

With the wiper parked over port 4, loosen the set screw on the wiper head until you can grasp the wiper head and gently pull it out.

To remove the wiper head, use the supplied hex wrench to loosen the set screw

Replacing the Wiper Pad

1. Remove the wiper head as above. Remove and discard the used pad.
2. Insert a new pad into the slots with the smooth side facing out, and pull to eliminate slack. Excess material may be trimmed close to the wiper head.
3. Position the head on the motor shaft with the pad facing down toward the sensors. The button at the top of the shaft should be flush with the wiper head surface. Tighten the set screw against the flat of the motor shaft. ***Be very careful not to move the wiper head in a lateral direction by hand after tightening.***
4. If convenient, connect in software, select the wiper, and click **Wipe** to ensure the wiper passes over the turbidity sensor optics properly.

Adjusting Wiper Pressure

If necessary, loosen the set screw on the wiper head and gently pull the head up or press down lightly to ensure the pad just brushes the optical windows when it passes over the turbidity sensor. Then re-tighten the set screw. ***Be very careful not to move the wiper head in a lateral direction by hand when engaged with the motor shaft..***

TIP: *The wiper head is at the best height when it just brushes the optical windows of the turbidity sensor—too high and it will not clean effectively; too low and it may not be able to spin.*

If it is necessary to remove the entire wiper assembly, be sure to use the sensor removal tool and grasp the body of the wiper. Do not attempt to pull the wiper out by the head.

Wiper Replacement Parts	Catalog No.
Replacement wiper head	0044520
Wiper pad replacement kit	0044530

REFERENCES

ASTM method D1889-88(A)

Eaton, A.D., L.S. Clesceri, E.W. Rice, and A.E. Greenberg, eds., *Standard Methods for the Examination of Water and Wastewater,* 21st edition, Washington, D.C.: American Public Health Association, American Water Works Association, and Water Environment Federation, 2005. Section 2130, Turbidity.

EPA, Methods for Chemical Analysis of Water and Wastes, EPA/600/4-79-020, revised March 1983. Method 180.1, Turbidity, Nephelometric. Approved at 40 CFR Part 136.

EPA, Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93-100, August 1993. Method 180.1, Determination of Turbidity by Nephelometry, Revision 2.0. Approved at 40 CFR Part 141.

International Organization for Standardization (ISO), 1999. Water Quality—Determination of Turbidity, Method 7027.

Nollet, Leo M. L., ed. *Handbook of Water Analysis.* Marcel Dekker Inc., New York, 2000.

U.S. Geological Survey, Methods for Analysis of Inorganic Substances in Water and Fluvial Sediments, U.S. Department of the Interior, Techniques of Water-Resources Investigations of the U.S. Geological Survey, I-3860-85.

19 SDI-12 OPERATION

SDI-12 is a serial digital interface that operates at 1200 baud. In-Situ's SDI-12 Adapter enables processing of the MP TROLL 9500's sensor measurements by a standard SDI-12 data recorder.

SDI-12 REQUIREMENTS

- MP TROLL 9500 (firmware 1.54 or later)
- SDI-12 Adapter (for proper power management)
- SDI-12 data recorder (customer-supplied)

WIRING

Connect the stripped and tinned wires from the SDI-12 Adapter to the terminal block of an SDI-12 data recorder (or to an SDI-12 network) as follows.

- WHITE - serial data line
- BLACK - ground line
- RED - 12-volt supply line
- GREEN - shield

The data recorder or an external power supply may provide power (9.6 - 16 V) to the 12V line. The shield should be terminated (grounded) at the data recorder.

Minimum voltage supplied per the SDI-12 specification (9.6V) is sufficient to power a TROLL 9500 on 170 ft (52 m) of RuggedCable. Cables as long as 300 ft (91 m) may be used, depending on power supplied. Before using cables longer than 170 ft (52 m) we recommend that you measure the voltage at the Adapter. The table lists power requirements for specific submersible cable lengths.

CONNECTIONS

Attach the Twist-Lock Connector on the MP TROLL's RuggedCable to the matching connector on the SDI-12 Adapter.

The Adapter is weather-resistant but not completely waterproof. It is not designed to be exposed to the elements. Provide a weather-resistant enclosure for optimum operation.

Table 19-1. Cable length & power supply requirements

Cable length		Power supply
feet	meters	requirement
170	52	9.6 V
180	55	9.8 V
190	58	9.9 V
200	61	10.1 V
210	64	10.3 V
220	67	10.4 V
230	70	10.6 V
240	73	10.8 V
250	76	10.9 V
260	79	11.1 V
270	82	11.3 V
280	85	11.4 V
290	88	11.6 V
300	91	11.8 V

SDI-12 SUPPORT

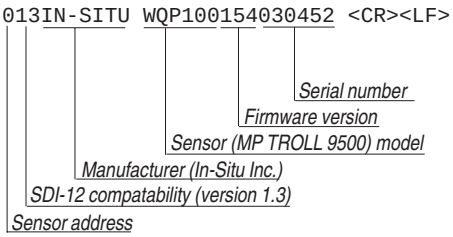
The MP TROLL 9500 supports the SDI-12 Version 1.3 commands. Data loggers that support SDI-12 Version 1.3 can usually send the Version 1.3 commands to an SDI-12 "sensor" like the MP TROLL automatically. These commands are listed later in this section. Additional information may be found in an SDI-12 reference, such as that listed at the end of this section. Or consult your SDI-12 data logger documentation for more specific information.

*Insure SDI-12 is **enabled** (factory default) on the 9500. In Win-Situ 4 or Pocket-Situ 4, select the TROLL, click **Edit...** select SDI-12 Mode Preferences.*

Calibration of the water-quality sensors will need to be done through Win-Situ 4 or Pocket-Situ 4 as SDI-12 protocols do not support calibration.

SENSOR IDENTIFICATION

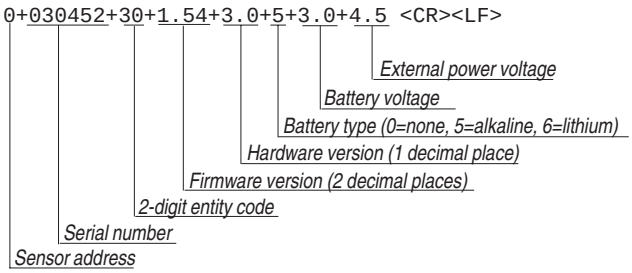
In response to the "send identification" command, the MP TROLL 9500 will respond as follows:



The default sensor address is 0. The device supports software-changeable addresses.

SENSOR VERIFICATION

In response to the Verification command, the MP TROLL 9500 will respond as follows:



MAKING SDI-12 MEASUREMENTS

When measurements are made they will be taken on all sensors installed in the MP TROLL 9500. "Derived" or calculated measurements, available in Win-Situ, are reported in SDI-12 for D.O. and conductivity. For example, the D.O. sensors can report oxygen concentration in milligrams per liter and saturation in percent. Specific conductance is reported as well as conductivity.

TIP: *SDI-12 protocols use the term "sensor" for a single SDI-12 device with an address. In this usage, the MP TROLL 9500 is a "sensor," even though it includes up to 11 installed "sensors" in the In-Situ usage. The "sensors" in the In-Situ usage cannot be addressed individually using SDI-12 protocols.*

The default order in which parameters are reported, and the units for each parameter, are listed in Table 19-2.

TIP: *You can change the default order of parameters reported in Win-Situ or Pocket-Situ like this:*

1. Select the MP TROLL in the Navigation tree
2. Select Edit
3. In the dialog box, select "SDI-12 mode preferences"

According to the SDI-12 specification the Start Measurement command "aM!" can take up to 9 measurements. Since the MP TROLL 9500 can potentially report more than 9 measurements there are two approaches to measuring all sensors:

- Use the Start Concurrent Measurement command ("aC!"). This command supports up to 20 measurements.
- Use the Start Additional Measurement commands ("aMn!"). The logger would first issue an "aM!" command. If the command responds with 9 measurements then the logger will send an "aM1!" command (after reading the initial measurements with the "aD0!" command), and read the measurements with the "aD0!" command. This process is repeated, progressing through the value of "n", until the "aMn!" command responds with less than 9 measurements.

When parameters are read back over the SDI-12 bus via one of the "aDn!" commands they will be reported in a fixed order (Table 19-2). If a unit has duplicate transducers, only one will be reported under this fixed-order reporting, by order of the port it is plugged into. For example, if two pH sensors are plugged into ports 1 and 3, the sensor in port 1 will be reported.

Note that the fixed reporting order can be changed as as described in the tip ✔ on this page.

A measurement is returned for all possible MP TROLL parameters.

Table 19-2. SDI-12 Parameter Reporting (Default Order)

Order	Parameter	Unit
1	Pressure	PSI
2	Temperature	degrees Celsius
3	Barometric Pressure	PSI
4	Turbidity	NTU
5	pH	pH
6	ORP	milliVolts
7	Conductivity (Actual)	µS/cm
8	D.O. (Polarographic)	mg/L
9	Battery Voltage	volts
10	Nitrate	ppm
11	Ammonium	ppm
12	Chloride	ppm
13	RDO (Optical D.O.)	mg/L
14	Conductivity (Specific)	µS/cm
15	Salinity	PSU
16	D.O. (Polarographic)	% saturation
17	RDO (Optical D.O.)	% saturation
18	Ammonia	ppm
19	Total Dissolved Solids	g/L
20	Resistivity	kOhm-cm

- If a sensor port is empty, the unit will report readings with values of 0.0.
- If you edit the device to set SDI-12 mode preferences, as described in the tip ✔ above, only the parameters you select will be reported.
- If a sensor is reading out of its range, a value of -999999.9 will be reported.

REDUNDANT LOGGING (WIN-SITU 4 AND SDI-12)

If your MP TROLL 9500 supports internal logging, the instrument is capable of running tests (programmed in Win-Situ) while participating in an SDI-12 network; however Win-Situ cannot communicate with the MP TROLL 9500 while it is transmitting SDI-12 data, and conversely, the instrument cannot receive or respond to SDI-12 commands while connected to a PC serial port.

This "redundant logging" feature means

- if the SDI-12 recorder somehow "loses" data, the MP TROLL 9500 data can be retrieved using Win-Situ.
* if the SDI-12 recorder ceases to function due to power loss, the MP TROLL 9500 will continue to collect new data using its own internal batteries and clock.

TIP: *Depending on the SDI-12 data recorder used, rapid sample schedules during a test may result in SDI-12 "retries."*

EXTENDED (ISCO) COMMANDS

Extended commands allow the data sampler to identify both the data channels and channel units that correspond to the ASCII formatted floating point data being returned. In response to the "aXPR0!" command, the response will be in the form: "aIxIxIx...<CR><LF>" where 'a' is the address, each 'I' is a parameter identifier, and each 'x' specifies the units for the preceding 'I'.

The data sampler will first issue either a measure or a concurrent measure command. These commands return the number of channels that will be reported in a subsequent read command. This number will correspond with the number of pairs returned by the extended commands.

If the expected number of "Ix" pairs is not returned in response to the "aXPR0!" command, additional "aXPRx!" commands will be issued until all pairs are received.

REFERENCE

SDI-12, A Serial-Digital Interface Standard for Microprocessor-Based Sensors, version 1.3. SDI-12 Support Group, Logan, Utah, April 7, 2000. Available at www.sdi-12.org.

SDI-12 V 1.3 COMMAND SET

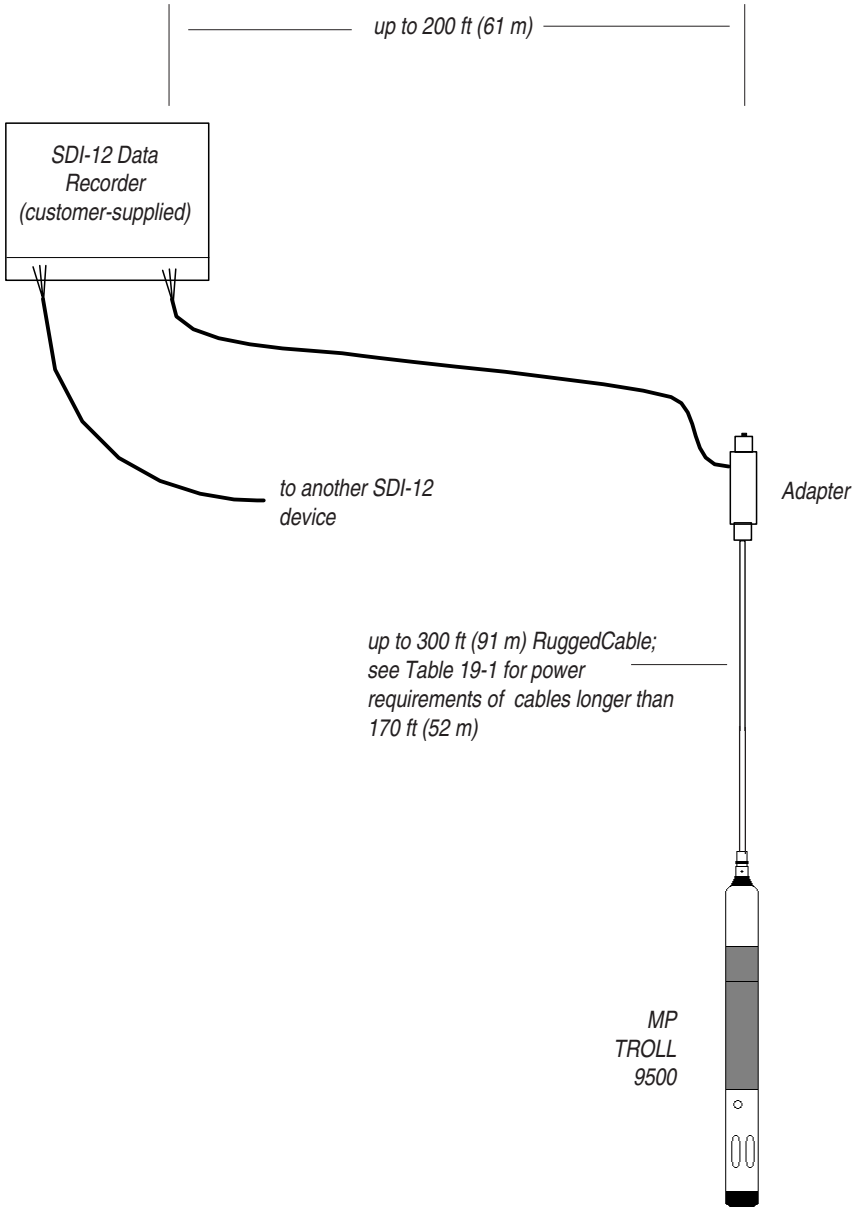
NAME	COMMAND	RESPONSE & COMMENTS
Address Query	?!	a<CR><LF> The wildcard address '?' character is supported only for the Address Query command. It is ignored as an invalid address for all other commands
Acknowledge Active	a!	a<CR><LF> Basic address characters in the range '0' to '9' and extended address characters in the ranges 'A' to 'Z' and 'a' to 'z' are supported. All other characters are ignored as an invalid address. The default address is '0'
Change Address	aAb!	b<CR><LF> Software changeable addresses and the Change Address command are supported
Send Identification	aI!	013IN-SITU WQP100vvvxxxxx<CR><LF> where vvv = device firmware * 100 (153 = 1.53) xxxxx = 5-digit device serial number
Start Verification*	aV!	00001<CR><LF> One result is available immediately for reading by the Send Data command
Send Data	aD0! . . . aD9!	0+030452+30+1.53+3.0+5+3.0+4.5 <CR><LF> Address + serial no. + 2-digit entity code + firmware version (2 decimal places) + hardware version (1 decimal place) + battery type (0=none, 5=internal alkaline, 6=internal lithium) + battery voltage (1 decimal place) + external power voltage (1 decimal place)
Start Measurement*	aM!	0001n<CR><LF>
Start Measurement with CRC	aMC!	n parameters will be available for reading by the Send Data command within 1 second. A service request (a<CR><LF>) will be sent when the parameters are ready. The number of parameters returned is determined by the SDI-12 defaults shown in Table 19-2 (or edit the SDI-12 mode preferences)
Send Data	aD0! . . . aD9!	a<values><CR><LF> or a<values><CRC><CR><LF>
Additional Measurements*	aM1! . . . aM9!	atttn<CR><LF>
Additional Measurements with CRC	aMC1! ... aMC9!	atttn<CR><LF>
Send Data	aD0! . . . aD9!	a<values><CR><LF> or a<values><CRC><CR><LF>
Start Concurrent Measurement	aC!	atttnn<CR><LF>
Start Concurrent Measurement with CRC	aCC!	atttnn<CR><LF>
Send Data	aD0! . . . aD9!	a<values><CR><LF> or a<values><CRC><CR><LF>
Additional Concurrent Measurements	aC1! . . .aC9!	atttnn<CR><LF>
Additional Concurrent Measurements with CRC	aCC1! ... aCC9!	atttnn<CR><LF>
Extended Commands		
ISCO Compatability	aXPR0! ... aXPR9!	aIxIxIxIx<CR><LF> where each Ix is a character pair identifying the parameter and units for each measurement. The number of Ix pairs equals the number of data values returned for the Start Measurement and Start Concurrent commands, limited to 19 per command. If the expected number of "Ix" pairs is not returned in response to the "aXPR0!" command, additional "aXPRx!" commands will be issued until all pairs are received

* This command may result in a service request.

a Sensor address ! Command terminator <CR><LF> Response terminator

ttt Time (seconds) until measurement is ready n, nn Number of measurement values

SDI-12 Schematic Installation Diagram



20 LOW-FLOW MONITORING

Groundwater that has sat in well casing for a period of time may not adequately represent the formation water. Well purging can ensure that fresh formation water is drawn into the casing for representative measurement of water temperature, pH, conductivity, and other water-quality parameters of interest. The well may be pumped to remove a predetermined number of volumes of stagnant water from the well.

A more cost- and time-effective method of purging involves pumping at very low flow rates with concurrent monitoring of water quality indicator parameters until it is determined that true formation water is being monitored. The Flow-Sense Wizard in Win-Situ 4 and Pocket-Situ 4 automates this process to help determine when a representative sample of formation water can be collected from a well for analysis. Based on user input, the software calculates the volume of the In-Situ flow cell and tubing, and the time to exchange one complete volume at the specified pumping rate. The frequency of measuring the water-quality indicator parameters is based on the time required to completely evacuate one volume of the flow cell and tubing. Meter and graphical views help to determine when the change in parameter readings falls within the specified target range.

Flow cell for TROLL 9500 without RDO sensor

Flow cell with TROLL 9500 and RDO sensor

PREPARATION

- Install Win-Situ 4 from the software CD or In-Situ website
- Install Pocket-Situ 4 to your desktop/laptop PC from the CD or website, connect the computers in ActiveSync®, launch the Win-Situ Software Manager, and follow the instructions to install Pocket-Situ 4 on the RuggedReader

TIP: *When using the RDO sensor for low-flow monitoring, be sure to install version 4.57 or higher of Win-Situ 4 and Pocket-Situ 4.*

- Calibrate the water-quality sensors
- Have the following site information ready to enter in the software when prompted by the Flow-Sense Wizard:
  - Well diameter and total depth
  - Screen length
  - Depth to water level, top of screen and placement of pump intake, referenced to a benchmark
  - Pump model & type
  - Tubing type
  - Tubing inner diameter
  - Tubing length

RDO SENSOR PREPARATION

Special preparation is in order if you plan to use an RDO® optical dissolved oxygen sensor for low-flow monitoring. You will need —

RDO Optical Dissolved Oxygen sensor, Delrin 0095160
or RDO Optical Dissolved Oxygen sensor, titanium 0095170
Flow Cell for use with RDO sensor 0057600

The RDO-ready flow cell includes hardware fittings for setting up the flow cell and installing the RDO sensor.

Follow the steps below to remove the RDO sensor from the adapter plate it ships with and install it in the sealing adapter plate that comes with the RDO flow cell.

TIP: *For low-flow monitoring without an RDO optical dissolved oxygen sensor, skip to Prepare the Flow Cell on page 138.*

Remove the RDO Sensor from the Original Adapter Plate

1. Pull the RDO cable and harness through the hole until it is on the side of the adapter plate opposite the sensor.

2. Firmly pull the RDO sensor out of the adapter plate. With sufficient force, it will "pop" out.

Set this adapter plate aside. The flow cell adapter plate may be used in all RDO applications.

Install the RDO Sensor in the Flow Cell Adapter Plate

1. To insure a good seal, replace the o-rings on the RDO sensor: Remove the old o-rings, lubricate the new o-rings and install on the "foot" of the sensor.

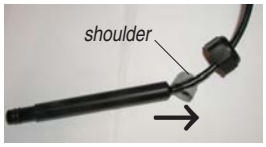
Slide lubricated o-rings over RDO cable harness and into grooves on RDO sensor

2. Remove top of flow cell (RDO adapter plate). Unscrew and remove the nut from the cable grip. Using the RDO cable harness as a tool, push the gray split seal out of the cable grip.

Remove nut and split seal from cable grip

3. Insert the RDO sensor (cable first) into the center hole of the adapter plate, on the side opposite the cable grip; press the sensor firmly until it clicks into place.

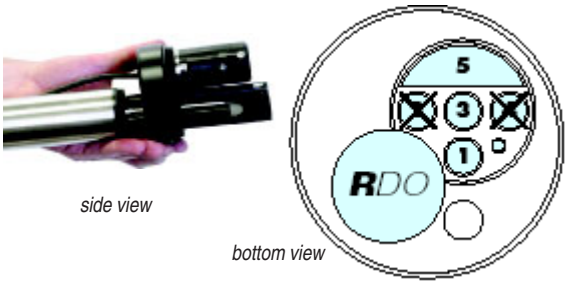
4. Place the nut and split seal (shoulder toward the nut) over the cable.



5. Feed the RDO cable through the cable grip. Work the split seal into the cable grip until almost flush, then pull the cable through to eliminate slack.

6. Partially tighten the nut on the cable grip.

7. Apply a small amount of lubricant to the orange o-ring inside the large opening in the adapter plate. Insert the sensor end of the TROLL 9500 through this opening, beside the RDO sensor. To avoid damage to the temperature sensor, orient the RDO sensor away from the temperature sensor. Align the RDO sensor between sensor ports 1 and 2, as shown below, and the cable beside port 1.



side view

bottom view

8. To insure a good seal, press firmly until the instrument's sensor block surface is flush with the adapter plate surface. When the pieces mate properly you will hear and feel them click together.

TIPS: *If the fit is tight, apply lubricant sparingly to the TROLL 9500 body between the label and the sensor block. Considerable force may be needed to insure a tight seal between the RDO adapter plate and the TROLL's sensor block*

9. Tighten the adapter plate screw with a Phillips head screwdriver, not overly tight.

10. Align the 3-pin connector on the RDO cable harness with the connector in port 1 or 3 of the TROLL 9500, and press it firmly into the port.

*The RDO sensor will function properly only when installed in **port 1 or 3**. Port 1 is normally easier to access. If installing in port 3, you may wish to remove the port 2 sensor temporarily (if installed). Replace the sensor o-rings if necessary.*

Tip: If you need a little more cable length, loosen the screw, slide the adapter off, and try steps 7 and 10 in reverse (plug in the sensor first, then attach the adapter). Lock into place by tightening the screw.

11. Tighten down the nut on the cable grip to insure a good seal.

RDO sensor installed in flow cell adapter plate and assembled to the MP TROLL 9500

PRIMING THE FLOW-SENSE WIZARD IN THE OFFICE

Text entry on a PDA in the field can be tedius. To simplify the task, we suggest you run the Flow-Sense Wizard using Win-Situ 4 on a full-sized PC in the office to prime the software with representative values. Then use Win-Situ Sync to copy the "templates" created in this way to the PDA.

A Connect the TROLL 9500 you will use in the field to your desktop PC. The device can be in air since the sampled data are not important.

B For each well you need to sample, execute the Wizard as described on the following pages. The more information you can enter in advance, the less you will have to tap in later with a stylus outdoors.

C Estimate any values you do not yet know (e.g., tubing length, pumping rate, final drawdown).

D Let the stabilization phase run for at least one reading, then **Accept**.

E When the Wizard asks if you want to save the file, give each one a meaningful name, for example:

"Well A template.flo"
"Well B template.flo"

F On your next ActiveSync connection, In-Situ's synchronization utility Win-Situ Sync will prompt you for Low Flow templates you wish to transfer to the PDA.

TIP: *If Win-Situ Sync does not launch automatically, select it from the In-Situ Inc. group in Programs on the Windows Start Menu. Be sure the option Transfer data files from Desktop to Field Unit is checked ☑. Click* *to transfer files.*

PREPARE THE FLOW CELL

Connect valves and tubing to flow cell body. Attach spike or base plate. Insert the calibrated MP TROLL into the flow cell. Turn on the pump.

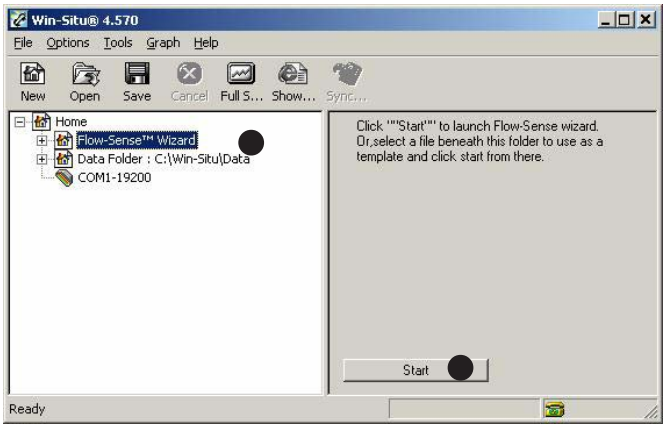
START THE SOFTWARE

Connect the MP TROLL to the PC or PDA. Launch Win-Situ 4 or Pocket-Situ 4. If you have not used the software before, take a moment to specify a connection type, COM port, and baud rate in the Connection Wizard.

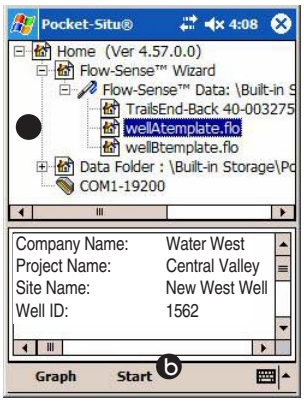
LAUNCH THE FLOW-SENSE WIZARD

1. Select one of the following ways to launch the Flow-Sense Wizard:

   - Tools Menu: Select the Flow-Sense Wizard (not available in Pocket-Situ)
   - Navigation Tree: (a) Select the Flow-Sense Wizard in the Navigation tree. (b) Click or tap **Start** in the Information pane.



   - If you've used the Flow-Sense Wizard before—or copied "template" files from a different PC—expand the Flow-Sense Wizard folder by clicking on the +, then expand the Flow-Sense Data folder. (a) Select a file or template. (b) Click or tap **Start**. Input values from that file or template will be copied in.



VERIFY UNIT PREFERENCES

Before the Flow-Sense Wizard starts, you may wish to verify the current unit selections. Length measurements in the Flow-Sense Wizard default to metric (meters, centimeters), but you can enter and display this data in English units (feet, inches) if you prefer. You may also wish to verify the units for Conductivity, Dissolved Oxygen, ORP, pH, Temperature, and Turbidity.

TIP: *Flow units in the Flow-Sense Wizard will always be in milliliters (mL). For best results, units should be consistent between the desktop application and the PDA application.*

To skip the settings verification, click Continue.

The Wizard will open the COM port and connect to the instrument. If you have used the Wizard before, or launched the Wizard from an existing .flo file, data entry values will be supplied.

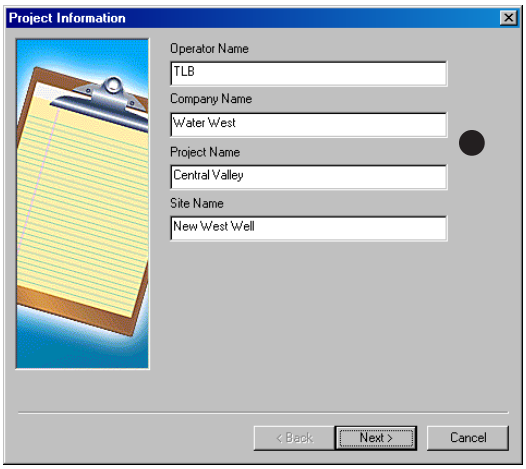
TIP: *The Wizard opens the COM port you used last (this is stored in the Wizards.ini file in the Config subfolder in the folder where Win-Situ is installed).*

If several connections have been used in the past, the Wizard uses the first "direct" connection it encounters in the tree.

If the Wizard is started without any connection information at all, it will attempt to connect using COM 1 at a baud rate of 19200.

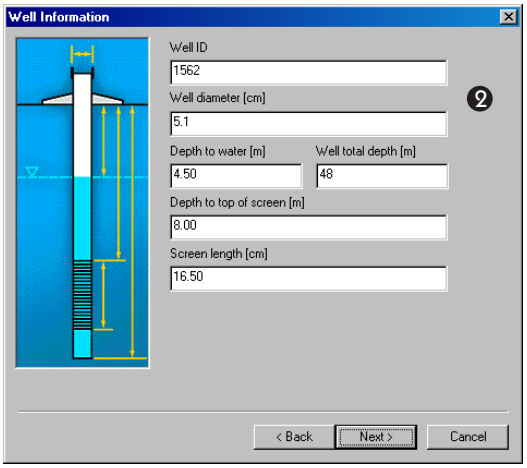
FLOW-SENSE WIZARD INPUT

1. The first input screen provides for entry of specific details about the project. This information will be included in the output report. The Project Name and Site Name will appear in the output file name.



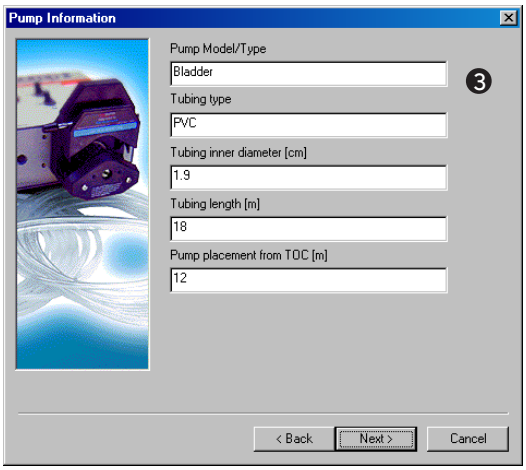
   Click or tap **Next** to continue.

2. In the next screen, enter information about the well. This information will be included in the output report. The Well I.D. will appear in the output file name.



Click or tap **Next** to continue.

3. In the next screen, enter details about the pump and tubing (tubing information is used in later volume calculations). If creating a template, estimate the tubing length and pump placement.

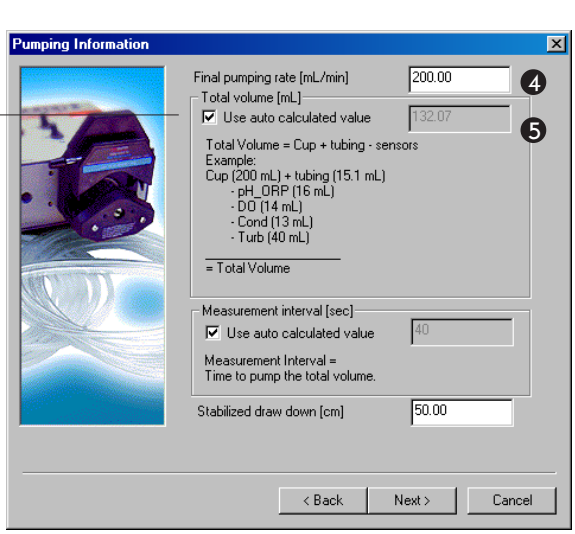


Click or tap **Next** to continue.

The next screen requests pumping information

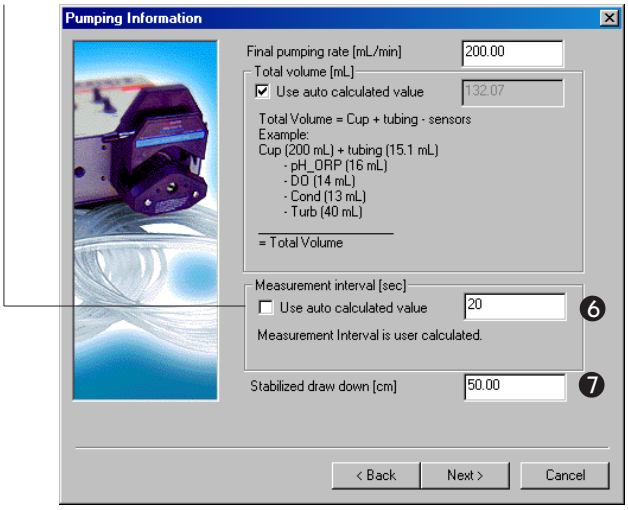
4. **Final pumping rate:** Enter in milliliters per minute. If creating a template, accept the default or estimate the pumping rate.

5. **Total volume—Auto Calculated Value:** This is the software-calculated volume of the cup (flow cell) and tubing, less the displacement of installed sensors.



To specify a different volume, clear the "Auto" check box, and enter the new volume (milliLiters).

6. **Measurement interval—Auto Calculated Value:** This is the software-calculated time (seconds) for one complete exchange of water in the calculated volume at the final pumping rate. In other words, this is the time required to completely evacuate one volume of the flow cell and tubing and draw in a new volume. Readings will be taken at this interval unless you specify a different interval.

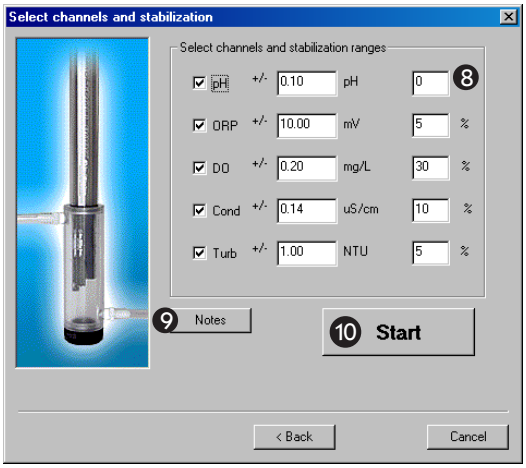


To specify a different interval, clear the "Auto" check box as shown above, and enter the desired measurement interval (seconds).

7. **Stabilized drawdown:** Final drawdown from the initial water level entered previously. (measured with tape after pumping starts). If creating a template, estimate the final drawdown.

   Click or tap **Next** to continue.

8. The final screen displays the available parameters. Choose the parameters to monitor and the target stability range for each parameter. You can enter absolute values in parameter units or percentage values



   The percentage range is calculated by the formula:

$$\frac{\text{max - min of last 3 readings}}{\text{last reading}} \times 100\%$$

   If no percentage ranges are entered, the software will monitor absolute values values to determine stabilization. If any percentage range is entered, the software will monitor percentage change.

9. If you wish to add comments, click the **Notes** button. They will be included in the output report.

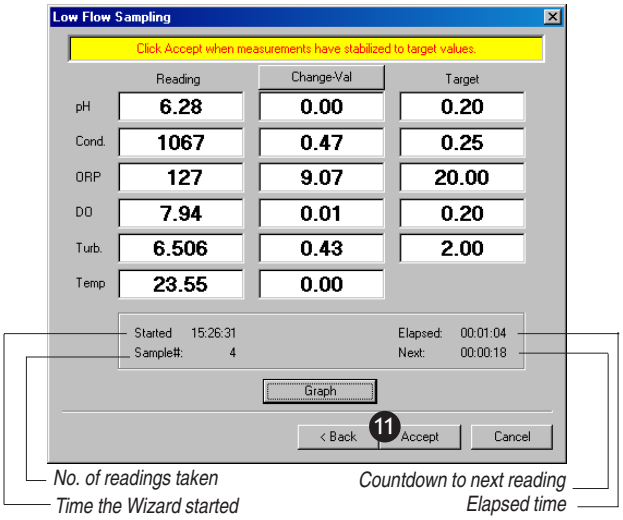
10. Ensure the pump is on (unless you are creating a template), then click or tap **Start** to begin the stabilization readings.

    The sidebar on this page describes the stabilization readings screen that is shown next.

11. When the readings appear stable, you are ready to save the data and exit the software. Click or tap **Accept**.

    If creating a template, let the stabilization phase run for at least one reading, then click **Accept**.

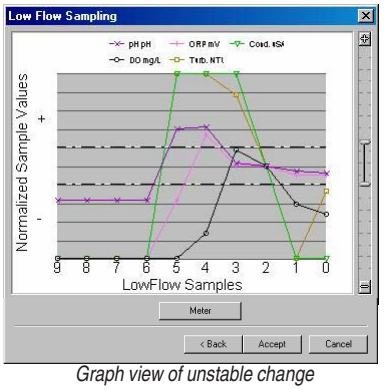
STABILIZATION READINGS—METER AND GRAPH



- **Reading:** the current reading
- **Change - Val:** difference between the maxium and minimum over the last 3 readings *OR*
- **Change - %:** difference between the current reading and the third reading back, expressed as a percentage
- **Target** specified earlier in the Wizard (shown for Values)

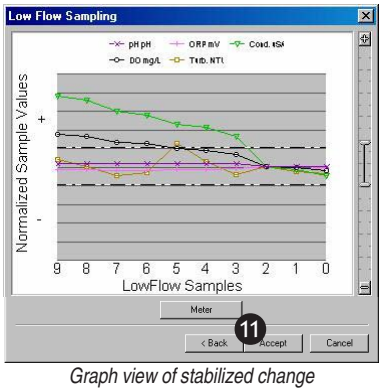
To view this data in graphical form, click **Graph**.

The graph shows the change and stabilization ranges of all parameters. The "change band," between the heavy dotted lines, represents a composite target of all specified stability ranges. You can drag the range finder on the right up or down, or expand the stability region to zoom in.



Graph view of unstable change

The most recent readings are shown on the right, earlier readings on the left. 0 marks the latest reading. The change band is centered on the third point as a reference. The graph can show up to 10 sets of readings. Change is recalculated with each reading.



Graph view of stabilized change

SAVING THE LOW-FLOW DATA OR TEMPLATE

Click Save when a suggested output file name is displayed. You may change this name if you like. After it is saved, the file will be displayed in the Data Folder branch of the Navigation tree and will open in the Information pane, like other test files extracted in Win-Situ 4 or Pocket-Situ 4.

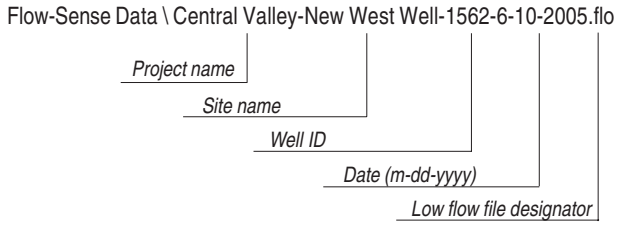
The file may be displayed in report format or as a graph in both Win-Situ 4 and Pocket-Situ 4. (If you can't see much on the PDA screen, try scrolling to the right.) The top of the file presents well, site, and project information. At the end of the file are the measurement data.

Additional functions are available through Win-Situ 4 (desktop/laptop PC).

- Print (file menu)
- Graph (button in Information pane) However, note that better graphical report output is available if you export to Excel
- Save as text file (file menu)
- Export to Excel (file menu)

OUTPUT

Low-Flow files are saved as files of type .flo in a folder named Flow-Sense Data under the Flow-Sense Wizard folder, and are accessible



in the Navigation tree. By default they are named as shown below:

EXPORT TO EXCEL OPTION

To automatically create an output report in Microsoft® Excel® from Win-Situ 4:

1. In the Win-Situ Navigation tree, select a low-flow data file. If it opens in Graph view, select the Report button.
2. On the Win-Situ File Menu, select Export to Excel.
3. The report will open in an Excel spreadsheet.

USING A CUSTOM EXCEL TEMPLATE

The Win-Situ 4 installation includes an Excel template for creating an output report (shown on the following page). This template is named InSituLowFlow.xlt, and is automatically installed to the Templates directory of the Microsoft operating system. Brief instructions for using this template are included in the spreadsheet that opens when you select Export to Excel.

To format an output report using the custom template,

1. After exporting a low flow data file to Excel, insert a new sheet based on a template by right-clicking the tab at the bottom of the screen in Excel.
2. Click Insert, then select the template InSituLowFlow.xlt.
3. When prompted by Excel, select "Enable Macros."

   An example of low flow data formatted in Excel using this template is shown on the following page.
4. If desired, save the report as an .XLS file.

In-Situ Inc.

Troll 9000 **Low-Flow System**
04/23/04 **ISI Low-Flow Log**

Project Information:		**Pump Information:**	
Operator Name	TCR	Pump Model/Type	Bladder
Company Name	Princeton	Tubing Type	PVC
Project Name	AAA	Tubing Diameter	0.8 [cm]
Site Name	Code3	Tubing Length	29.99 [m]
		Pump placement from TOC	12.01 [m]

Well Information:		**Pumping information:**	
Well Id	Percentage	Final pumping rate	200 [mL/min]
Well diameter	5 [cm]	Flowcell volume	132.07 [mL]
Well total depth	50 [m]	Calculated Sample Rate	40 [sec]
Depth to top of screen	8.01 [m]	Sample rate	10 [sec]
Screen length	16.5 [cm]	Stabilized drawdown	12 [cm]
Depth to Water	4.49 [m]		

Low-Flow Sampling Stabilization Summary

	Time	Temp [C]	pH [pH]	Cond [uS/cm]	Turb [NTU]	DO [mg/L]	ORP [mV]
Stabilization Settings			+/-1 +/-10 %	+/-0.14 +/-20 %	+/-1 +/-5 %	+/-0.2 +/-15 %	+/-10 +/-10 %
Last 5 Readings	15:05:49	19.83	7.77	1.34	1.23	-3.18	141.63
	15:06:00	19.83	6.75	1.34	1.23	-3.18	-297.05
	15:06:09	19.83	4.99	1.34	1.23	-3.18	371.14
	15:06:19	19.83	2.98	1.34	1.21	-3.17	646.73
	15:06:30	19.85	-0.48	1.34	1.20	-3.17	717.62
Variance in last 3 readings	15:06:09	0.00	-1.75	0.00	0.00	0.00	668.19
	15:06:19	0.00	-2.02	0.00	-0.02	0.00	275.60
	15:06:30	0.01	-3.46	0.00	-0.01	0.00	70.89

Notes: ORP is all over the place

Sample of a Low-Flow output report using the Export to Excel function and the In-Situ template InSituLowFlow.xlt Normalized data = change in indicator parameters mapped from 0 to 1. A graph may be generated using Win-Situ 4 and inserted manually into the report, if desired.

21 CARE & MAINTENANCE

REPLACING BATTERIES

The MP TROLL 9500 uses—

- two standard 1.5V alkaline D cells, or
- two 3.6V lithium D cells—recommended for use with an RDO optical dissolved oxygen sensor, and with a turbidity wiper

Use only Saft LSH-20 3.6V lithium D cells. Use of any other lithium battery will void the product warranty.

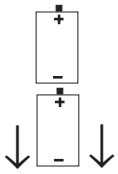
Battery voltage and approximate percentage remaining is displayed in the software interface when the instrument is connected to a PC. *Note:* Due to the voltage supplied by two lithium D cells, the software may report that the TROLL 9500 is operating on external power.

To replace batteries:

1. Unscrew and remove the white battery compartment cover. If the cable is attached, slide the battery compartment cover up onto the cable.

2. Press down slightly on the top battery to remove it, or knock it out gently into your hand.
3. Tip the unit to slide the bottom battery out.

4. Insert the new batteries according to the diagram on the inside of the battery compartment (positive up for both).



Insert batteries negative side first, positive side up

5. Slide the white cover back down over the battery compartment and hand-tighten to thread it to the instrument body.

Screw the cover down firmly to compress the o-rings and create a waterproof seal. When properly assembled, the o-rings will not be vsible.

6. At your next software connection in Win-Situ 4 or Pocket-Situ 4, edit the device to update the battery information. (See “Editing the Device Properties” in Section 4.)

O-RING SEALS

LUBRICATION

The Viton® o-rings used in the MP TROLL 9500 and other submersible In-Situ instruments are crucial to insure the integrity of the water-tight seal. We recommend that you inspect them each time they are stressed (insertion/removal of sensors, attachment/removal of the restrictor, battery replacement, etc.) for any indication of dirt, cracks, tears, splitting, shredding, desiccation, and other damage. If the o-rings are in good condition, apply silicone lubricant before re-assembling the instrument. Remove excess lubricant with a lint-free tissue. If the o-rings are damaged, they should be replaced, as described below.

When lubricating the sensor o-rings, take special care to keep grease away from the area around the connector at the bottom of the sensors. Should lubricant get into this area, remove it with a clean cotton swab.

REPLACEMENT

If the o-rings become damaged to the extent that no longer provide an effective seal, they should be replaced. If there is any doubt whether the o-rings should be replaced, it is best to err on the side of safety and replace them.

Before replacing o-rings, clean all mating surfaces, including the o-ring grooves.

O-rings and lubricant are included in the MP TROLL 9000 Maintenance kit available from In-Situ Inc. or your distributor.

GENERAL CLEANING

Rinse the instrument body well, especially if it has been in contact with contaminated media. Air-dry or wipe with a lint-free tissue.

Ultrasonic cleaning is not recommended.

STORAGE

Store the TROLL 9500 clean and dry. Place the protective red dustcap on the cable end, or store with cable attached to protect the connector pins and o-ring.

Store the instrument where it will be safe from mechanical shocks that may occur, such as rolling off a bench onto a hard surface.

Protect the instrument from temperature extremes. Store within a temperature range of -40°C to +80°C (-40°F to +176°F).

If the sensors are removed for storage, place plugs in the dry sensor ports as protection from dust and dirt.

SENSOR STORAGE

For long-term storage, return the water-quality sensors to their original packaging. Protect the lubricated o-rings from dust and dirt.

For up to a week, the sensors may be left in the instrument, with a moist sponge in the bottom of the Cal Cup to provide a moist environment for those sensors that require it.

TWIST-LOCK CONNECTORS

Keep the pins on all connectors free of dirt and moisture by using the soft protective dustcap when cable is not attached.

22 TROUBLESHOOTING

TROUBLESHOOTING CONNECTIONS

Problem: Win-Situ or Pocket-Situ cannot "find" (connect to) the MP TROLL 9500. Error 6146 may be displayed.

Probable Cause: Wrong COM port selected, loose cable connections, device is taking a measurement as part of a test, batteries are low, elastomer is worn

Suggested Remedy: Check the following:

- all cable connections are tight
- the back end is securely attached to the instrument
- the correct COM port is selected
- the internal battery has voltage remaining; attach external power
- If a test is running, try connecting again—several times if necessary to "sneak" in between test data points.

Problem: Readings are in the wrong units

Probable Cause: Default units are being used

Suggested Remedy: Select the desired units on the Win-Situ Options menu, or select the Home site in Pocket-Situ and tap Setup in the command bar

Problem: Pocket-Situ hangs

Suggested Remedy: Reset the PDA; see your PDA documentation for details on hard and soft reset

Q: The MP TROLL 9500 rolled out of the back of my truck and hit the ground pretty hard. It still talks. Is it OK to use?

A: The instrument is pretty rugged, and can survive a few drops and rolls. We hope the restrictor was on to protect the sensors! First, check the joint between the body and the restrictor. It should appear smooth and tight to preserve the integrity of the water seal. Next, remove the restrictor and insure the pressure sensor is snug against the sensor block. Push it firmly into the sensor block if you see a gap. If the temperature sensor is bent, straighten it gently but firmly by hand (no tools, please).

If the instrument is dropped repeatedly on the nose cone, check for damage to the batteries.

TROUBLESHOOTING DATA COLLECTION (TESTS)

Problem: Test ABENDed (came to an "ABnormal END")

Probable Cause: Device lost power or ran out of memory

Suggested Remedy: None; indication of ABEND in software cannot be reversed. but data collected up until the time the test ABENDed is likely to be fine

Check clock, check memory free, check device power

Problem: Scheduled test did not start

Probable Cause: Incorrect device clock, full memory, power removed at time of first scheduled data point

Suggested Remedy: Synchronize device clock and reschedule test; insure device has sufficient battery power and free memory; insure device is powered at time of first scheduled data point

TROUBLESHOOTING SENSORS

Problem: Sensor will not go into port

Probable Cause: (1) Insufficient lubrication on sensor o-rings. (2) Incorrect sensor alignment.

Suggested Remedy: (1) Generously lubricate sensor o-rings with a good silicone lubricant. Remove excess lubricant with a tissue, and take care to keep grease away from the area around the connector at the bottom of the sensor. (2) Align the mark on the side of the sensor (it looks like a small white "V") with the tic mark on the sensor port. If you have trouble locating these marks, visualize the sensor block as a clock face, with the pressure/turbidity sensor or plug at 12:00. The port alignment marks are at the 3:00 position for each port.

Problem: Sensor will not come out of port

Probable Cause: Inability to grasp sensor

Suggested Remedy: Try the sensor removal tool. Insert it between the widest part of the sensor and the instrument body and press down on the handle, prying the sensor up until it pops out.

Problem: Software does not recognize sensor in port

Probable Cause: (1) Sensor is not firmly seated in port. (2) Excess lubricant or dirt in port. (3) Sensor is in a wrong port for its type.

Suggested Remedy: (1) Re-insert the sensor: Align the mark on the side of the sensor (it looks like a small white "V") with the tic mark on the sensor port. Use sensor insertion tool to press sensor firmly into port until you feel it dock with the connector. When properly inserted a only a very small gap (0.060-0.075 inch, the width of the sensor removal tool) remains between the widest part of the sensor and the instrument body. (2) Remove excess lubricant and/or dirt from the connector on the sensor and from the connector in the port.

(3) Insure the sensor is in the correct port for its type. Some sensors will function properly in any port, others will work only in specific ports. Refer to diagrams in section 3 or specific sensor section of this manual. Remove sensor and re-install in correct port, if necessary, then refresh device information in the software.

TROUBLESHOOTING CALIBRATION

Problem: The Cal Cup leaks when rinsing sensors

Probable Cause: Cal Cup is not tightened to probe body sufficiently to seat against the o-ring

Suggested Remedy: Carefully align threads on Cal Cup with threads on instrument body. Thread the Cal Cup onto the body until it is seated against the o-ring, then back off slightly to avoid overtightening.

Problem: The DO readings stabilized during the Quick Cal but now the readings are off (too high or too low)

Probable Cause: (1) Too much solution in Cal Cup during the Quick Cal to expose the DO sensor to air. (2) Cal Cup is too tightly sealed during calibration.

Suggested Remedy: (1) The DO membrane must be exposed to air for a valid 100% DO calibration. If the membrane is submerged when you invert the Cal Cup during the Quick Cal, remove the end cap and pour out some of the calibration solution until the membrane is in air. (2) Loosen the end cap of the inverted Cal Cup during DO calibration to avoid pressurizing the chamber.

APPENDIX

ELECTRONIC DRIFT AND DEVICE RECALIBRATION

The electronics of the Multi-Parameter TROLL 9500 will experience accuracy drift over time. This drift applies to all channels and is additive to the initial calibration accuracy. Electronic drift does not apply to user-calibrated sensors because the drift is compensated for during calibration.

The system wide long-term drift is dominated by the stability of the voltage reference used in the device. Other components exhibit long-term drift of a much smaller magnitude.

The equation used to calculate drift over time is:

$$D = K * \sqrt{(t / 1000 \text{ hours})}$$

where:

D is the drift in ppm

K is the long term stability coefficient listed as ppm / 1000 hours but actual units are ppm

t is the time expressed in hours

Using this information, the maximum drift over time is shown in the table on this page.

Time Period		Drift	
Years	1K Hours	ppm	%
0.00	0.00	0	0.000
0.25	2.19	178	0.018
0.50	4.38	251	0.025
0.75	6.57	308	0.031
1.00	8.76	355	0.036
1.25	10.95	397	0.040
1.50	13.14	435	0.043
1.75	15.33	470	0.047
2.00	17.52	502	0.050
2.25	19.71	533	0.053
2.50	21.90	562	0.056
2.75	24.09	589	0.059
3.00	26.28	615	0.062
3.25	28.47	640	0.064
3.50	30.66	664	0.066
3.75	32.85	688	0.069
4.00	35.04	710	0.071
4.25	37.23	732	0.073
4.50	39.42	753	0.075
4.75	41.61	774	0.077
5.00	43.80	794	0.079

TIP: *The recommended frequency of factory recalibration of the MP TROLL 9500 depends upon the amount of drift a user is willing to tolerate. For example, if a drift of 0.025% is acceptable, then the recalibration period is 6 months; if a drift of 0.05% is acceptable, then the recalibration period is 2 years.*

DETERMINING DENSITY

The density of water in a well can be determined using an accurate tape measure and a pressure transducer. A change in pressure is recorded between two points as the transducer is lowered into the water and the corresponding change in depth is recorded using the measuring tape. Density is then calculated using a simple formula. This method is valid if the pressure and depth measurements are accurate and the water within the well is homogeneous throughout the entire depth of the well.

Note: Density can also be measured using a hydrometer if it is possible to withdraw a water sample from the well. We recommend an accuracy of ±0.0005.

Procedure

There are two possible methods for measuring the change in water depth. Choose the method that is the most convenient and accurate.

- Attach the tape measure to the transducer cable using an adhesive (e.g., duct tape). The tape measure can be attached to the transducer itself or to a segment of the cable that will be adjacent to the top of the well casing. Read the cable positions directly from the measuring tape. The measuring device must have a resolution of at least 1 mm or 1/16 in.
- Alternatively, mark the positions of the cable with an indelible felt tip pen. The distance between marks is then determined with a tape measure after the corresponding cable segment is removed from the well.

1. Lower the transducer into the well until it is submerged under about one meter of water.
2. Secure the transducer at a fixed depth using the cable at the top of the well casing. Wait an hour or so for the system to equilibrate.
3. Take an electronic pressure reading, manually, from the transducer and record this measurement in PSI. This is measurement P_1.
4. Read the tape measure relative to some fixed reference point (e.g., top of well casing) or mark the position on the cable with an indelible pen. This is measurement L_1.
5. Lower the transducer at least three meters deeper into the water and repeat steps 3 and 4. These are measurements P_2 and L_2.
6. Density (ρ) in g/cm^3 is calculated using the following:

$$\rho = \frac{(P_2 - P_1) \times 6.894757}{g \times (L_2 - L_1)}$$

where g is the gravitational acceleration for the location of the well in m/s^2. P must be in PSI units and L must be in meters. If using a tape measure calibrated in feet, 1 ft = 0.3048 m (exactly).

An error of 0.001 m (1 mm) in the depth measurement translates into an error of 0.00085 g/cm^3 for density.

GLOSSARY

ABend: Indication in the software interface that a test has come to an "ABnormal END"—usually because the device memory is full, or power was lost.

ABS: Acrylonitrile Butadiene Styrene, a plastic material.

Absolute pressure sensor: Non-vented pressure sensor that measures all pressure forces detected by the strain gauge, including atmospheric pressure. Fluid levels measured with an absolute pressure sensor must be corrected through subtraction of the atmospheric pressure to obtain accurate fluid level measurements. *Compare* Gauged pressure sensor.

AC: Absolute or Actual Conductivity.

Accuracy: Closeness of agreement between the result of a measurement and the true value. Usually expressed as a deviation from 100% accuracy.

A/D (analog to digital) converter: Converts an electrical signal to a numeric value that can be interpreted by a computer.

Ambient pressure (temperature): The pressure (temperature) of the medium surrounding the sensor or instrument.

Ammonia (NH_3): A toxic, colorless gas with a pungent odor, highly water-soluble.

Ammonium (NH_4^+): Solvated ammonium cation produced when ammonia gas is dissolved in water.

Ammonium chloride (NH_4Cl): A salt used to make ammonium and chloride calibration standards.

Anion: Negatively charged ion (e.g., Cl^-, NO_3^-).

Atmospheric pressure: Pressure due to the atmosphere, altitude-dependent.

Barometric pressure, *see* Atmospheric pressure

Bithermal: At two temperatures, e.g., a three-point calibration of an ammonium, chloride, or nitrate sensor conducted at two different temperatures.

Basic sensor set: pH, pH/ORP, conductivity, and polarographic (Clark cell) dissolved oxygen; *compare* Extended sensor set.

Boxcar filtering: A smoothing scheme that looks at the 5 most recent data points.

Cable, *see* Comunication cable, Network cable, RuggedCable, TROLL Com, Vented cable

Calibration: The process of determining the response of a measurement system to a known amount of the measured component in order to permit the measurement of unknown samples.

Calibration, out-of-box: Use of new Basic sensors for the MP TROLL 9500 directly from the box, with factory-supplied calibration coefficients. Sensors should be calibrated after they are used and begin to drift.

Calibration, Quick Cal: A rapid calibration procedure available for the Basic sensors, using a single solution.

Calibration, traditional: Single- or multi-point methods for calibrating water-quality sensors individually to gain higher accuracy.

Calibration coefficients: Sensor slope and offset that convert analog measurements to user units; calculated during calibration.

Calibration cup: Clear PVC vessel that attaches to the front end of the MP TROLL 9500 in place of the restrictor and holds the recommended amount of calibration solution during calibration of the water-quality sensors.

Calibration kit: Boxed set of standards for calibrating a specific water-quality sensor for operation in a specific range.

Calibration solution, Calibration standard: A solution whose concentration is accurately known.

Cation: Positively charged ion (e.g., NH_4^+, Na^+).

Cell constant: A value that describes a conductivity cell which is determined by electrode area and electrode separation.

Chloride (Cl^-): Common anion in water that gives it a salty taste.

Chlorophyll: Green pigment in plants that transforms light energy into chemical energy during photosynthesis.

Clone: Copy all elements of a selected test definition to a new test.

Combination electrode: A combination of a sensing or measurement electrode and a reference electrode in one unit.

COM port: RS232 serial communication port on a PC.

Communication cable: see TROLL Com

Conductivity, electrical: A measure of the ability of an aqueous solution to carry an electric current. Increases with increasing temperature.

Connection node: Node in the Win-Situ or Pocket-Situ Navigation tree, representing the COM port on the host PC.

Data folder: Node in the Win-Situ or Pocket-Situ Navigation tree, providing a view of tests that have been extracted from the device memory to the host PC. The Data Folder can be expanded to show the device type, device serial number, and test name.

Data point: In logged data, one reading from every channel being sampled.

Density: Mass of a substance per unit volume (e.g., grams per liter, g/L; grams per cubic centimeter, g/cm^3). Water is most dense at 4° Celsius.

Depth: The distance between the water surface and the pressure sensor of the MP TROLL 9500. Converted from pressure units using values selected by the user during pressure parameter setup.

Derived measurement: Value calculated in software from the output of more than one sensor; e.g., salinity is derived from conductivity and temperature.

Device node: Node in the Win-Situ or Pocket-Situ Navigation tree, representing the connected MP TROLL 9500.

Digital DO: Proprietary method of powering the dissolved oxygen sensor; digital pulsing eliminates the need to stir the sample to avoid oxygen depletion.

Dissolved oxygen (DO): The amount of oxygen present in water and available for respiration.

DO: Dissolved Oxygen.

Downhole cable, *see* RuggedCable

Drift: Gradual change in sensor response with time.

DSP: Digital signal processor.

Electrode: An electric conductor through which an electric current enters or leaves a medium (such as an electrolyte).

Electrolyte: A chemical compound which when dissolved in water will conduct an electric current; sensor filling solution.

Event test, Event sampling: Test measurement schedule in which the selected parameters are measured at the same regular, unvarying linear interval, but the data are logged only if the measurements on the designated event channel exceed a user-specified value. Conserves storage memory while logging all meaningful data.

Extended sensor set: Ammonium, chloride, nitrate, turbidity, and optical dissolved oxygen sensors; *compare* Basic sensor set.

Extract: Copy test data from the MP TROLL 9500 memory to a host PC. Initiated by the ***Extract*** button when a test is selected in the Navigation tree.

FEP: Fluorinated ethylene propylene; the generic equivalent of DuPont Teflon®.

Firmware: Software program that resides in the memory of the MP TROLL 9500; firmware can be field-upgraded.

Flow cell: Clear

vessel with input and output ports for routing flow past the sensors of the MP TROLL 9500; alternative to in-situ installation of the instrument where in-place installation is not possible or practical.

Flow-Sense Wizard: Low-flow application in Win-Situ software for monitoring water-quality indicator parameters in a flow cell during low-flow pumping.

FNU: Formazin Turbidity Units; compare NTU

FS: Full scale.

Gauged pressure sensor: Pressure sensor that is vented to the atmosphere; measures only pressure exerted by the water column, excludes the atmospheric pressure component. *Compare* Absolute pressure sensor; *see also* Vented cable.

HDPE: High-density polyethylene.

HIF: U.S. Geological Survey's Hydrological Instrumentation Facility.

Home site: Default site node (top node) in the Win-Situ or Pocket-Situ Navigation tree, representing the host computer.

Host PC: Desktop computer running Win-Situ, or PDA running Pocket-Situ, connected to the MP TROLL 9500 via TROLL Com or other communication interface.

Interference: The presence of a species in a sample other than the species being measured that causes erroneous values.

Ionic strength: A measure of the total effect of all the ions, both positive and negative, present in a solution.

ISA (Ionic Strength Adjustor): Solution of high ionic strength which can be added to both sample and calibration solutions in equal proportions before measurement to minimize differences in ionic strength.

ISE (Ion-Selective Electrode): An electrode which responds selectively to the ions of a particular species in solution.

Isopotential point: The ion concentration at which changes in temperature do not cause a change in ISE sensor response (voltage).

Isothermal: At constant temperature.

Kcell, *see* Cell constant

KCl: Potassium chloride.

LED: Light-emitting diode, used in turbidity and Optical DO sensors.

Level reference: User-specified starting point for level readings; entered during pressure parameter setup.

Level—Surface: A mode for displaying logged pressure measurements; readings are positive up; useful for measuring surface water; permits use of zero or other user reference.

Level—Top of Casing: A mode for displaying logged pressure measurements; readings are positive down, as the water level draws down from the top of the well casing; permits entry of zero or other user reference.

Limnology: The science of the life and conditions for life in lakes, ponds, and streams.

Linear average: Test measurement schedule in which each measurement stored to the data file is the average of multiple closely-spaced measurements.

Linear test, Linear sampling: Test measurement schedule in which the selected parameters are measured at the same regular, unvarying sample interval and all measurements are logged.

Log test, Log sampling: Test measurement schedule in which measurements begin closely spaced and the interval between measurements continuously increases. Short for Logarithmic sampling.

LSZH: Low smoke zero halide

µM, µmol/L: micro Molar, unit of dissolved oxygen concentration; to convert to mg/L, divide by 31.25.

mg/L: Milligram per liter; equivalent to one part per million (ppm).

miniTROLL: In-Situ's 0.72" diameter downhole pressure/temperature smart probe.

Molarity (M): A unit of measure indicating concentration in moles of solute per liter of solution.

Multi-ISE: An ion-selective electrode that measures more than one parameter.

$NaNO_3$: Sodium nitrate.

Na_2SO_3: Sodium sulfite.

Navigation tree: Left side of the Win-Situ application interface, or top of the screen in Pocket-Situ, showing selectable nodes: Site, Data Folder, Connection, Device, Parameters, Tests.

Nernst equation: The fundamental equation that relates the electrode potential to the activity of measured ions in a solution.

Network: Instrument network consists of Multi-Parameter TROLL 9500 (up to 32) with submersible cable connected to a network box, connected to additional network boxes via network cable, 12 V power supplied by externally applied AC line power.

Network box (T-box, Quad box, Mid-line tap box): Vented environmental enclosure with a regulated power supply and lightning suppression; ties multiple MP TROLLs into an instrument network.

Network cable: Insulated non-vented PVC cable for connecting networks of MP TROLL 9500s or other instruments.

NH_4Cl: Ammonium chloride.

N.I.S.T.: National Institute of Standards and Technology, a non-regulatory federal agency within the U.S. Department of Commerce. Formerly known as the National Bureau of Standards.

Nitrate (NO_3^-): Oxidized form of nitrogen that is highly soluble in water, present in soils, fertilizer, wastewater, etc.

Node: Element in the Navigation tree on the left side of the Win-Situ interface, or at the top of the screen in Pocket-Situ. When a node is selected, the remainder of the screen displays details about the node. Nodes include the Site, Data Folder, Connection, Device, Parameters (group node), single Parameter, Tests (group node), single Test.

Non-vented pressure sensor, *see* Absolute pressure sensor

Nose cone: Detachable threaded protective stainless steel piece at the front end of the MP TROLL 9500.

Nose cone stirrer, *see* Stirrer

NTU: Nephelometric turbidity unit, a measure of the intensity of light scattered by a water sample. From nephelometer, a type of turbidimeter. Comparable to previously reported Formazin Turbidity Unit (FTU), and Jackson Turbidity Unit (JTU).

Optode: optical electrode.

ORP, *see* Oxidation-reduction potential

Oxidation-reduction potential (ORP), also called "redox" potential (from "reducing" and "oxidizing"): Voltage difference at an inert electrode immersed in a reversible oxidation-reduction system; measurement of the state of oxidation of the system.

Parameter node: Node in the Win-Situ or Pocket-Situ Navigation tree, representing a single parameter (pressure, temperature, pH, conductivity, etc.).

Parameters node: Node in the Win-Situ or Pocket-Situ Navigation tree, providing a view of all parameters the device can measure.

Partial pressure: In a mixture of gases, the pressure a single gas would exerted if it occupied the entire volume.

Pascal: Unit of pressure equal to the pressure resulting from a force of 1 newton acting uniformly over an area of 1 square meter.

PC: Desktop or laptop computer.

PDA (Personal Data Assistant): Generic term for a hand-held personal computer.

pH: Term used to describe the hydrogen-ion activity of a system; the negative logarithm of the activity of the hydrogen ions (H^+) in the solution.

Pocket PC: A type of PDA with an ARM processor and Pocket PC (Windows Mobile) operating system.

Pocket-Situ: Win-Situ 4 software for supported PDAs.

PocketSync for Pocket-Situ: Synchronization utility that runs on a desktop/laptop PC; automatically installs or updates Pocket-Situ on a connected PDA; synchronizes data and other files between the PDA and the PC where Win-Situ is installed

Polarization: Application of a direct or alternating current to a sensor.

Potassium chloride (KCl): A salt used to make conductivity calibration standards.

ppm: Part-per-million; equivalent to a milligram per liter (mg/L).

Precision: The closeness of agreement between independent test results obtained under stipulated conditions. A measure of the reproducibility of a method.

Pressure: A type of stress which is exerted uniformly in all directions. Its measure is the force exerted per unit area; e.g., pounds per square inch (psi), newtons per square meter (pascals).

Pressure transducer: Instrument or component that detects a fluid pressure and produces an electrical signal related to the pressure.

Professional: MP TROLL 9500 model containing memory; able to log data; accommodates the Basic sensor set.

Professional XP: MP TROLL 9500 model with all features of the Professional model and in addition allows use of the Extended sensor set.

Profiler: MP TROLL 9500 model without memory; must be used with a PC or PDA; accommodates the Basic sensor set.

Profiler XP: MP TROLL 9500 model with features of the Profiler and in addition allows use of the Extended sensor set.

Profiling: Taking continuous real-time readings of all enabled parameters.

PRT: Platinum resistance thermometer, a type of resistance temperature detector (RTD).

psia: A pressure unit, pounds per square inch absolute, measured with respect to zero pressure. All forces detected by the strain gauge are measured, including atmospheric pressure.

psig: A pressure unit, pounds per square inch gauge, measured with respect to atmospheric pressure. Thus the atmospheric pressure component is excluded.

PSU: Practical Salinity Units, based on the Practical Salinity Scale.

Pulsing: Periodic low-frequency polarization of a dissolved oxygen sensor.

Pump test, Pumping test: Aquifer characterization test that involves pumping out a known volume of fluid from a well and measuring the time of recovery to stable conditions.

Quick Cal: Rapid calibration procedure available for the MP TROLL 9500 Basic sensors that uses a single solution.

Quick Cal solution: A calibration standard of an appropriate chemical composition to calibrate four parameters simultaneously (pH, ORP, Dissolved Oxygen, Conductivity).

Quinhydrone: Dark green water-soluble compound, a 1:1 complex of benzoquinone and hydroquinone used as an ORP calibration standard when dissolved in pH buffer solution.

Reading: Measurement from a single channel (parameter).

Redox potential, *see* Oxidation-reduction potential

Reference (water level measurements), *see* Level reference

Reference electrode: A standard electrode of known potential against which the measurement or sensing electrode is compared.

Repeatability: Closeness of the agreement between the results of successive measurements carried out under the same conditions.

Reproducibility: Closeness of the agreement between the results of measurements of the same measurand carried out under nearly identical conditions but after an intermediate change was made and removed.

Resistance thermometer: Temperature sensor that changes electrical resistance with temperature.

Resistivity: The reciprocal of conductivity; calculated from conductivity.

Resolution: The smallest unit that can be measured by a device over its full range.

Response time: Time required for the MP TROLL to power a sensor and the sensor to return an accurate reading.

Restrictor: Perforated stainless steel area of the MP TROLL 9500 between the nose cone and the body; protects the sensors and allows free circulation of environmental fluid.

RDO: Rugged optical dissolved oxygen sensor

RS-485: Communications protocol using Recommended Standard 485 of the Electronic Industries Association (EIA-485) for the orderly transfer of electrical data signals; a balanced (differential), multipoint Interface Standard that uses two lines to transmit/receive data and can operate at 100 Kbps with cable lengths up to 4000 feet.

RTD: Resistance temperature detector, a type of resistance thermometer that has nominally 100 Ω at 0°C.

RuggedCable™: Waterproof, submersible, TPU-jacketed vented or non-vented cable for a Multi-Parameter TROLL 9500; carries power and communication signals; provides strain relief and a means to anchor the instrument to a stationary object; Twist-Lock connectors on both ends, Rugged (titanium) or Standard (carbon-filled ABS plastic); halogen-free version available.

S, *see* Siemens

Salinity: A measure of the amount of salts dissovled in water, usually expressed in parts per thousand (ppt); calculated from conductivity and temperature.

Saturation: The point at which a substance contains a maximum amount of another substance at a given temperature and pressure.

SC: Specific Conductance, conductivity corrected to 25°C.

SDI-12: A serial-digital interface operating at 1200 baud.

Sensor kit: Package containing an In-Situ sensor, along with necessary installation items and instructions for installing in the Multi-Parameter TROLL 9500.

SI: International System of Units.

Siemens (S): SI unit for conductivity, reciprocal of the ohm; this unit was formerly known as the “mho” (ohm spelled backwards).

Site node: Topmost node in the Win-Situ or Pocket-Situ Navigation tree, representing the host computer.

Slope: Sensor response vs. concentration (quantity). Slope and offset are the coefficients calculated during calibration that convert analog measurements to user units.

Slug test: Aquifer characterization test that involves “slugging” a well with a known volume of fluid or solid and measuring the time of recovery to stable conditions.

Soak time: Length of time a sensor is immersed in a calibration solution or sample, ideally at the same temperature at which measurements will be taken.

Sodium nitrate ($NaNO_3$): A salt used to make nitrate calibration standards.

Specific conductance: Conductivity of a solution at 25°C.

Standard Methods: Approved methods of analyzing for water-quality parameters, as specified in the reference work *Standard Methods for the Examination of Water and Wastewater,* published jointly by the American Public Health Association, American Water Works Association, and Water Environment Federation.

Stirrer: Battery-powered motorized low-power stirring mechanism with magnetic stirring bar for use during calibration and/or in stagnant waters.

Submersible cable: Waterproof, quick-connect cable designed for submersion; Instrument backshell located at downhole end; surface connector at surface end.

Surface connector: Multi-function vented nylon connector at the surface end of the MP TROLL's submersible cable; accommodates a variety of top-of-well devices for communications, networking, and power supply.

TDS, *see* Total Dissolved Solids

Temperature, Solution temperature: Amount of heat present in the solution in which the instrument is submerged.

Test: Instructions to the MP TROLL's internal logger for collecting data; the logged data from one set of instructions.

Test node: Node in the Win-Situ or Pocket-Situ Navigation tree, representing a single test.

Tests node: Node in the Win-Situ or Pocket-Situ Navigation tree, providing a view of all tests currently stored in the device memory.

TOC (Top of Casing), *see* Level—Top of Casing

Torr: A unit of pressure, equal to 1/760 atmosphere.

Total Dissolved Solids (TDS): The amount of dissolved substances, such as salts or minerals, in water remaining after evaporating the water and weighing the residue. Calculated from conductivity.

TPU: Thermoplastic Polyurethane, a cable jacket option.

TROLL Com: Vented RS485/RS232 converter with a short length of cable attached; connects the MP TROLL 9500's RuggedCable to a PC serial port.

Turbidity: A measure of the transparency of water.

Twist-Lock Hanger: Back end hanger without venting or communication capabilities; allows use of inexpensive hanging cable while taking absolute (non-vented) pressure data with a preprogrammed instrument.

Units: Measurement units; user-selectable in software interface.

Vented cable: RuggedCable with a vent tube that applies reference atmospheric pressure to the back of the pressure sensor diaphragm.

Vented pressure sensor, *see* Gauged pressure sensor

Vertical profile: Characterization of a water column from surface to bottom (or vice-versa) through multiple real-time readings of the water-quality parameters of interest taken at varying depths.

Win-Situ 4: Instrument control software for instrument setup, calibration, profiling, data logging, data retrieval and display.

ZoBell's: A redox standard solution with a known state of oxidation-reduction potential (measured in milliVolts) used to calibrate ORP.

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Declaration of Conformity

Manufacturer: In-Situ, Inc.
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USA

Declares that the following product:

Product name: Multi-Parameter TROLL 9500
Model: WQP-100
Product Description: The Multi-Parameter Troll 9500 provides real-time readings for and logs up to 9 water-level and water-quality parameters 7 of which are multi-configurable in addition to the built-in temperature and barometric pressure parameters.

is in compliance with the following Directive

89/336/EEC for Electromagnetic Compatibility (EMC)

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

- **Emissions**
  Class A requirements of EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directive 89/336/EEC, and the CE mark is affixed accordingly.

Todd Campbell

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
October 28, 2005

FC CE

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Declaration of Conformity

Manufacturer: In-Situ, Inc.
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Fort Collins, CO 80524
USA

Declares that the following product:

Product name: TROLL Com
Model: USB TROLL Com
Product Description: RS485 to USB converter

is in compliance with the following Directive

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326, Electrical Equipment for Measurement, Control and Laboratory Use, Industrial Location

- **Emissions**
  Class A requirements of EN 61326, Electrical Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
June 17, 2006

CE FC

APPENDIX C

APPENDIX C

Field Sampling Plan

DRAFT

FIELD SAMPLING PLAN

Surface Water Monitoring
Industri-Plex Superfund Site Operable Unit 2
(including Operable Unit 3 of the Wells G&H Superfund Site)
Woburn, Massachusetts

Prepared by:

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January 23, 2009

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FIGURES

C-1 Surface Water Monitoring Stations North of Route 128
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ATTACHMENTS

C-1 Operating Manual for Marsh-McBirney Flo-Mate™ Model 2000 Flowmeter
C-2 USGS General Procedure for Gaging Streams
C-3 Roux Associates' Standard Operating Procedures

1.0 INTRODUCTION

Pursuant to the Remedial Design/Remedial Action (RD/RA) Statement of Work (SOW) for Operable Unit 2 (OU 2) at the Industri-Plex Superfund Site (including Operable Unit 3 of the Wells G&H Superfund Site) in Woburn, Massachusetts (hereinafter, "Industri-Plex OU 2"), and on behalf of Pharmacia Corporation by its Attorney-in-Fact Monsanto Company and Stauffer Management Company LLC as litigation agent for Bayer CropScience Inc. (Settling Defendants), this Field Sampling Plan (FSP) has been prepared to provide guidance for all fieldwork during implementation of the Surface Water Monitoring Plan (SWMP). The FSP constitutes the second part of the Sampling and Analysis Plan (SAP) for the SWMP and was prepared in accordance with Attachment A of the RD/RA SOW and the U.S. Environmental Protection Agency (EPA) guidance document titled "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA" (EPA/540/G-89/004). Accordingly, this FSP contains the following sections:

- Section 2.0 – Sampling Objectives
- Section 3.0 – Sample Locations and Frequency
- Section 4.0 – Sample Designations
- Section 5.0 – Sampling Equipment and Procedures
- Section 6.0 – Sample Handling and Analysis

Background information regarding Industri-Plex OU 2 is provided in the Quality Assurance Project Plan (QAPP), which constitutes the first part of the SAP for the SWMP.

2.0 SAMPLING OBJECTIVES

In the RD/RA SOW (page 21), the SWMP is described as follows:

> *"The [SWMP] shall consist of monthly baseflow surface water sampling and quarterly storm flow sampling. The location and frequency of sampling shall be consistent with the monitoring conducted during the Remedial Investigation. The [SWMP] shall include all monitoring and analyses necessary to satisfy the surface water monitoring outlined in the [Record of Decision] and shall be generally consistent with the monitoring conducted during the [Remedial Investigation/Feasibility Study]. It shall continue until the implementation of the Operation & Maintenance Plan, which shall include Long-Term Environmental Monitoring (much of the surface water monitoring will continue under Operation and Maintenance). The data shall be utilized to monitor surface water trends and demonstrate compliance during implementation of the remedy."*

3.0 SAMPLE LOCATIONS AND FREQUENCY

Surface water will be the only environmental medium sampled during implementation of the SWMP. Sampling will occur at each of the ten surface water monitoring stations shown in Figures C-1 and C-2, under both baseflow and storm conditions. Baseflow samples will be collected monthly, while storm samples will be collected during four storms per year, on a roughly quarterly basis. Additional sampling may be conducted if large storms occur after any of the quarterly storm samples have already been collected. Samples collected at the three tributaries to the Halls Brook Holding Area (HBHA) Pond and at the HBHA Pond outlet will be analyzed for total and dissolved arsenic, total and dissolved iron, benzene, ammonia, nitrate, nitrite, total kjeldahl nitrogen (TKN), and total suspended solids (TSS). Samples collected at the remaining stations will be analyzed for the same suite of analytes, minus total and dissolved iron.

The number of field samples to be collected during each sampling event, including quality control (QC) samples, is shown below.

Analyte	Field Samples	Field Duplicate	Trip Blank	Total Samples
Total Arsenic	10	1	N/A	11
Dissolved Arsenic	10	1	N/A	11
Total Iron	4	1	N/A	5
Dissolved Iron	4	1	N/A	5
Benzene	10	1	1	12
Ammonia	10	1	N/A	11
Nitrate	10	1	N/A	11
Nitrite	10	1	N/A	11
TKN	10	1	N/A	11
TSS	10	1	N/A	11

In addition, on a quarterly basis, extra sample volume will be collected during baseflow sampling events for preparation and analysis of a matrix spike and matrix spike duplicate (for benzene) and matrix spike/duplicate (for all inorganic analytes except TSS).

Continuous monitoring will also be performed for stream depth and velocity, as well as general water chemistry parameters including temperature, specific conductance, dissolved oxygen concentration, pH, oxidation-reduction potential [ORP], and turbidity. These measurements will be made with dedicated, data-logging field instruments mounted at each sampling location.

4.0 SAMPLE DESIGNATION

During implementation of the SWMP, sample containers for field samples will be labeled with the following information:

- a unique sample identifier
- analysis requested
- date and time of collection

The unique sample identifier will contain the sample location and the sampling date separated by an underscore, as follows:

Sample Location_Date

There must be no dashes or spaces in the sample location when used as part of the sample identifier (e.g., SW-01-TT should be written SW01TT), and the date must be written in the format YYYYMMDD. Therefore, a sample collected at SW-01-TT on June 12, 2008 would be identified as SW01TT_20080612. Note that one-digit months and dates must be entered as two digits (e.g., June must be entered as 06).

Trip blanks and field duplicates will be given unique identifiers containing a two-character code based on the type of sample (TB for trip blank, FD for field duplicate), the sample date (entered as described above), and a two-digit number (generally 01 for the SWMP), each separated by an underscore. The two-digit number at the end of the QC sample identifier will indicate if more than one of any particular type of QC sample was collected on a given day, and would therefore be sequentially assigned as 01, 02, 03, etc.[1] For example, the second trip blank collected on June 12, 2008 would be designated as follows:

TB_20080612_02

The time of collection must not be recorded on the sample container for any QC sample to avoid introducing any potential bias to the analytical process (e.g., identifying the field duplicate pair). Therefore, it is important that all QC sampling information (e.g., location of field duplicate) be recorded in the field notebook.

[1] It is not anticipated that more than one of any particular type of QC sample will be collected on a given day during implementation of the SWMP.

For the quarterly matrix spikes/matrix spike duplicates/matrix duplicates, rather than identifying the samples as such, field staff should simply collect triple the normal volume of sample required at the location selected, labeling each sample container as a single field sample according to the convention described above. The laboratory is to be instructed that the extra volume is for the matrix spike and matrix spike or laboratory duplicate by indicating such in the comments column of the chain-of-custody form (see Section 6.3).

5.0 FIELD SAMPLING AND DATA-GATHERING PROCEDURES

This section defines in detail the manual (i.e., non-automated) sampling and data-gathering procedures to be followed during implementation of the SWMP. Manual sampling and data gathering activities will be conducted as part of Water-Quality Monitoring (SWMP Task 3) and Weekly and Monthly Operation and Maintenance (O&M) activities (SWMP Tasks 4 and 5).

5.1 Water-Quality Monitoring

Baseflow surface water samples will be collected manually as grab samples in accordance with Roux Associates' standard operating procedure (SOP) for surface water sampling, provided in Attachment C-3. Most samples will be collected by lowering laboratory-supplied sample containers to a depth nominally equal to 60% of the depth of the stream and allowing the containers to fill. The sample containers must not be opened until the appropriate sampling depth is reached and must be re-sealed prior to withdrawing from the stream to prevent mixing with water from shallower depths. Sample containers with preservative should not be lowered directly into the stream, as this may cause loss of preservative; instead, a non-preserved container of adequate size (i.e., sufficient to fill the final [preserved] sample container using only one dip) shall be used, with the collected sample carefully and immediately decanted into the final container. In the particular case of samples being collected for total metals (arsenic and iron) analysis, the sample collected from the stream must be vigorously re-mixed prior to decanting into the final laboratory sample container to avoid any potential for bias associated with retention of suspended matter in the sampling device. Aliquots for the analysis of dissolved arsenic and iron will be field-filtered using a peristaltic pump with dedicated tubing and 0.45-micron in-line filters, in general accordance with Roux Associates' SOP for Filtration of Groundwater and Surface Water Samples for Dissolved Metals Analysis (see Attachment C-3).

If surface water at a given station is covered in ice, baseflow samples may be collected by drilling a hole in the ice and inserting dedicated tubing into the stream to a depth nominally equal to 60% of the depth of the stream, and then filling sample bottles directly using a portable, variable speed peristaltic pump. A peristaltic pump may also be used if the stream is too shallow to immerse a sampling device to the appropriate (i.e., six-tenths) depth. In either case, the peristaltic pump will be operated at the lowest practicable setting (50-100 milliliters per minute) during collection of samples for benzene analysis to minimize potential loss of volatiles during the sampling process.

Surface water samples representative of storm conditions will be, for the most part, collected using Isco Model 6712 automated samplers, in accordance with the operating instructions provided in Attachment B-3 of the Quality Assurance Project Plan (Appendix B of the SWMP). Dedicated sample tubing will be used for each storm, and field staff will add ice to the base of the Isco units as soon as possible following the onset of automated sampling. Once sampling has been completed, the sample rosette from the primary Isco unit at each station will be removed and inspected to determine if adequate sample volume has been collected in each sample container. If any containers are found to contain more or less than the programmed amount (800 milliliters [mL]), those containers will be replaced with the equivalent sample containers from the backup Isco unit (i.e., those filled at corresponding times), assuming the backup containers contain the appropriate amount. If both containers for a given time (flow) interval contains more or less than 800 mL, the container with the volume closest to 800 mL will be used.[2] If the selected container contains less than 800 mL, the volume of sample in all other retained sample containers (i.e., those with appropriate volumes) will be reduced accordingly so that all containers have the same volume of sample.[3] However, if the sample volume in the "light" container is less than 250 mL, that container will be excluded entirely from the composite sample.

Once it is determined that an adequate and representative sample volume is contained in the rosette (see QAPP [Appendix B] for basis), the retained sample containers will be emptied into an appropriately sized compositing vessel, the composite sample adequately remixed, and aliquots drawn off for the schedule analyses. The aliquots will be drawn off using a portable peristaltic pump and dedicated sample tubing lowered to a depth nominally equal to 60% of the depth of the liquid contained in the compositing vessel. Remaining sample will be returned to the stream and the compositing vessel will be decontaminated with soap and water between each station, in accordance with Roux Associates' SOP for Decontamination of Field Equipment (see Attachment C-3). Aliquots for the analysis of dissolved arsenic and iron will be field-filtered using dedicated (i.e., disposable), 0.45-micron, in-line filters, in general accordance with Roux Associates' SOP for Filtration of Groundwater and Surface Water Samples for Dissolved Metals Analysis(see Attachment C-3).

---

[2] The Isco sample log will also be consulted to see if the cause of the under/overfill can be determined, as this may also factor into the decision on which container to use.

[3] The retained samples will all be thoroughly mixed prior to decanting excess volume.

Due to the potential for volatilization during sampling and compositing, all storm samples for benzene analysis will be collected as discrete grab samples rather than as flow-weighted composites. These samples will be collected during the rising limb of the storm hydrograph by interrupting the automated sampling protocol on the primary Isco unit at each station and using that Isco unit's sample tubing and a portable, variable-speed peristaltic pump to fill the sample containers. To minimize potential loss of volatiles, the peristaltic pump will be operated at the lowest practicable setting (50-100 milliliters per minute). Upon collection of the grab samples, which will be stored on ice pending collection of the flow-paced composite storm samples, the sample tubing will be reconnected to the primary Isco unit and the automated sampling program re-started.

During the first year of sampling, manual measurements of stream flow will be made at the time of baseflow sampling. For the monitoring station established at the Mishawum Road culvert (SW-04-TT), manual stream flow measurements will entail measuring the depth of flow in the culvert (which is then converted to area of flow using standard geometric tables) and the velocity. Depth readings will be taken using a standard measuring device with 0.01-foot gradations, inserted with the face parallel to the direction of flow. Velocity readings will be taken at a depth nominally equivalent to 60% of the depth of flow in the culvert, using a Marsh-McBirney Flo-Mate Model 2000 flow meter attached to a top-setting rod (depth permitting). Directions for operating the Marsh-McBirney Flo-Mate Model 2000 flow meter are provided in Attachment C-1.

For all other stations, manual stream flow measurements will be made using the "partial-section" method recommended by the U.S. Geological Survey (USGS), in which depth and velocity measurements are made (as above) at regular intervals across a profile perpendicular to the flow of the stream. Each depth and velocity measurement, recorded on a USGS Discharge Measurement Form (an example of which is provided in Attachment C-2) or equivalent, is used to calculate discharge (flow) through the section of the stream represented by those measurements. The total flow for the profile is the sum of the flows for each partial section. A more detailed discussion of the partial-section method, including the means of calculating stream flow for each partial section based on the depth and velocity measurements, is provided in Attachment C-2.

During both baseflow and storm sampling, depth-to-water measurements will be made at the piezometers located at the various monitoring stations using an electronic water-level meter with an accuracy of +/- 0.01 foot. Measurements will be made from the top of the piezometers' casing.

5.2 Weekly and Monthly O&M

During weekly O&M of the surface water monitoring stations, manual stage readings will be taken using the same methodology as that employed for the manual stream flow measurements taken during baseflow sampling (see Section 5.1). Manual velocity readings will be taken as part of monthly O&M, also using the methodology employed for the manual stream flow measurements.

6.0 SAMPLE HANDLING AND ANALYSIS

This section of the FSP describes field sample handling and documentation requirements.

6.1 Field Sample Handling and Preservation

Upon collection, all samples will be handled in accordance with Roux Associates' SOP for Sample Handling (Attachment C-3). The types of containers, preservation techniques, and holding times for the analyses to be performed during implementation of the SWMP are presented in the table below.

Analyte	Container	Preservation	Holding Time
Arsenic and iron (total)	1 x 250 milliliter (mL) plastic container	Nitric acid to pH<2, 4° C	6 months
Arsenic and iron (dissolved)	1 x 250-mL plastic container	Nitric acid to pH<2, 4° C	6 months
Benzene	2 x 40-mL amber glass vials with Teflon septa	Hydrochloric acid to pH<2, zero headspace, 4° C	14 days
Ammonia and TKN	1 x 500-mL plastic container	Sulfuric acid to pH<2, 4° C	28 days
Nitrate and Nitrite	1 x 500-mL plastic container	4° C	48 hours
TSS	1 x 1000-mL plastic container	4° C	7 days

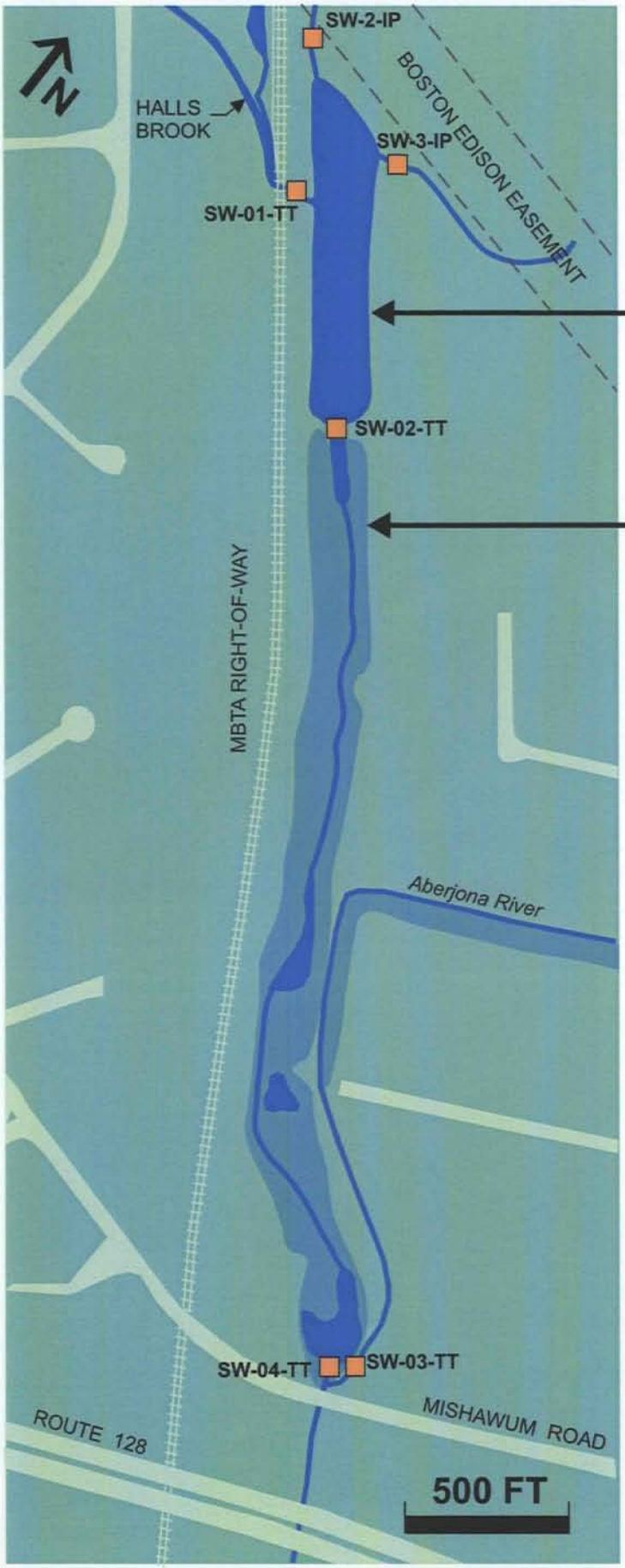
All samples must be placed in chilled coolers immediately upon collection and delivered to the analytical laboratory within 24 hours of collection, due to the short holding time for the analysis nitrate and nitrite.

6.2 Field Documentation

Accurate field documentation is essential to providing a clear and complete record of all field activities which can be used for reference and information retrieval at a later date. All field documentation will be recorded in bound logbooks and/or pre-generated activity-specific forms using indelible ink. The types of information and level of detail required for logbook recording are described in Roux Associates' SOP for Field Record Keeping and Quality Assurance/Quality Control, a copy of which is provided in Attachment C-3.

6.3 Sample Custody Documentation

Sample custody will be maintained from the point of sampling through analysis (and storage/disposal of unused sample portion, if any). Each individual collecting samples is personally responsible for the care and custody of the samples until custody of the samples is formally transferred to another party, such as a sample custodian in the field or office or a laboratory courier. Custody is documented with a properly completed chain-of-custody form listing the samples, date and time of collection, requested analyses, and any other information deemed relevant. When transferring the possession of samples, individuals relinquishing and receiving will sign, date, and note the time on the chain-of-custody form.



LEGEND

SW-01-TT ■ APPROXIMATE LOCATION AND DESIGNATION OF SURFACE WATER MONITORING STATION

Title:

SURFACE WATER MONITORING STATIONS NORTH OF ROUTE 128

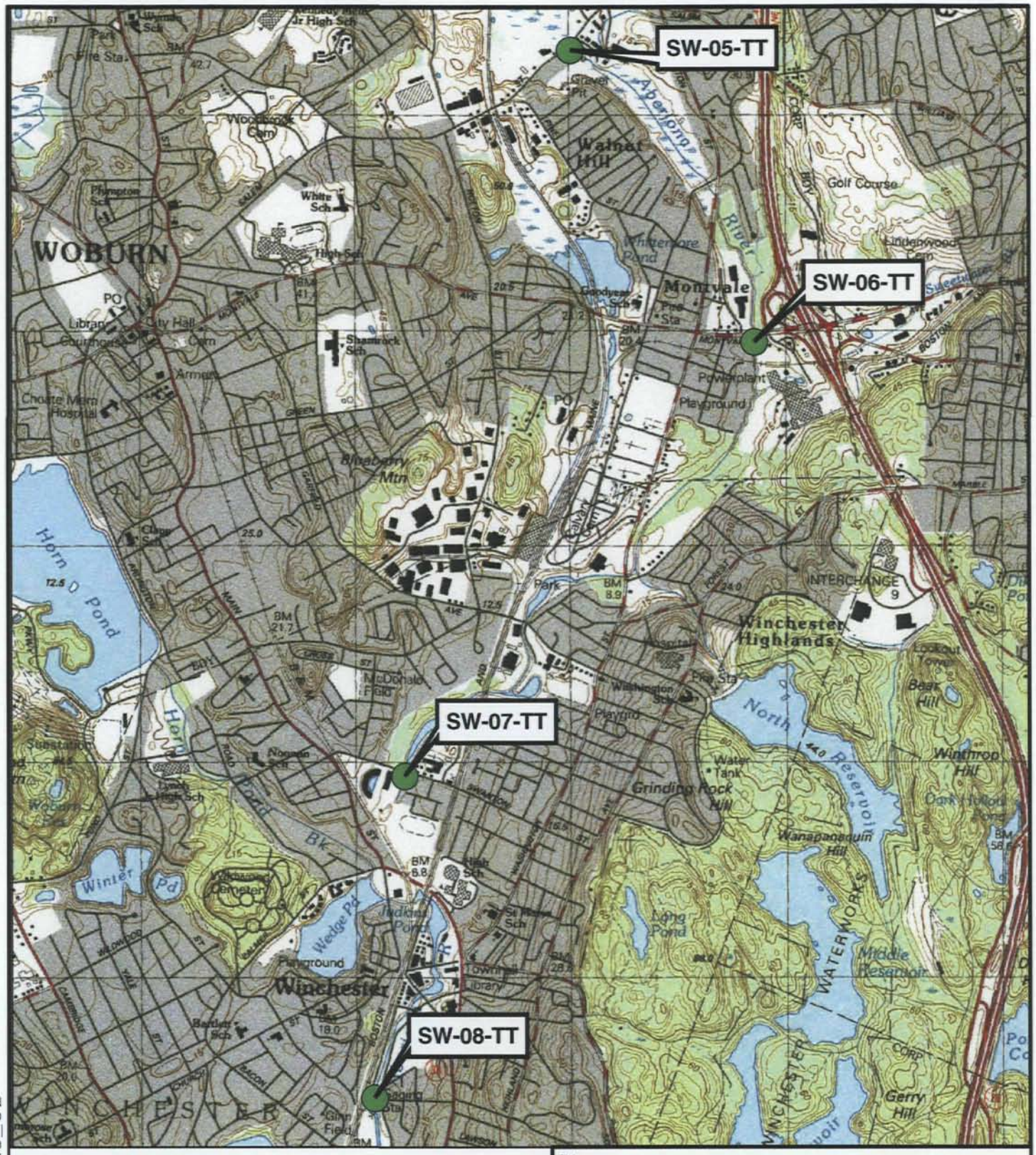
Prepared for:

INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES INC.
Environmental consulting & Management

Compiled by: LM	Date: 1/10/09	FIGURE	
Prepared by: CRS	Scale: AS SHOWN	C-1	
Project Mgr.: LM	Office: MA		
File No.: FIGUREC-1	Project No.: 119407M07		

N:\PROJECTS\I-PLEX\119401M07\1100\NEWFIGURES5-15-08\C FIGURES\FIGUREC-1.cdr



■ QUADRANGLE LOCATION

SOURCE:
USGS, 1987.
Reading (Massachusetts) Quadrangle
1:25,000–scale Topographic Map

N

0 1,000 2,000 Feet

Title:

SURFACE WATER MONITORING STATIONS SOUTH OF ROUTE 128

Prepared For:

INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled By: LM	Date: 1/13/09	FIGURE
Prepared By: CRS	Scale: AS SHOWN	C-2
Project Mgr.: LM	Office: MA	
File No. IPS0110005_C2	Project: 119401M	

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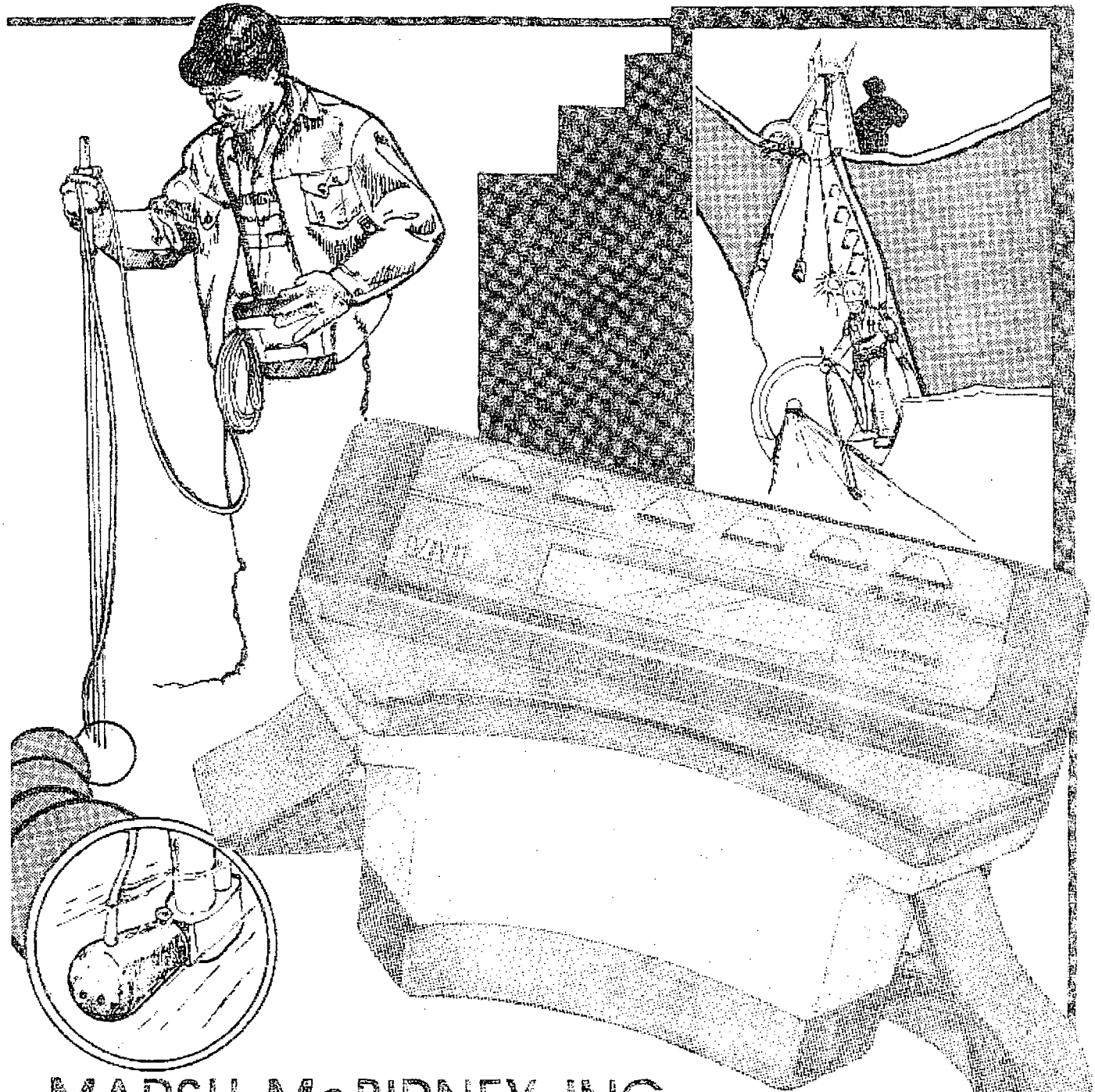
ATTACHMENT C-1

Operating Manual for Marsh-McBirney FloMate™ Model 2000 Flowmeter



MARSH-McBIRNEY, INC.

FLO-MATE™

MODEL 2000 PORTABLE FLOWMETER
INSTRUCTION MANUAL

MODEL 2000

INSTALLATION AND OPERATIONS MANUAL

DECEMBER 1990

Marsh-McBirney Inc.
4539 Metropolitan Court
Frederick, Maryland 21704-9452

(301) 874-5599 • (800) 368-2723 • FAX (301) 874-2172 • www.marsh-mcbirney.com

PN 105 0003 01, Rev. D, 11/00

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SPECIFICATIONS

Velocity Measurement

Method
Electromagnetic

Zero Stability
± 0.05 ft/sec

Accuracy
± 2% of reading + zero stability

Range
-0.5 to +19.99 ft/sec
-0.15 m/sec to +6 m/sec

Power Requirements

Batteries
Two D Cells

Battery Life Continuous ON hours
Alkaline 25-30
NiCad 10-15 per charge

External Power Supply (Optional)
120 V, 1 W or 220 V, 1 W

Water Resistant Electronic Case

Submersible
One Foot for 30 Seconds

Outputs

Display
$3\frac{1}{2}$ Digit

Signal Output Connector (Optional)
Analog 0.1 V = 1 ft/sec or 1 m/sec
2 V = Full Scale

Materials

Sensor
Polyurethane

Cable
Polyurethane jacket

Electronic Case
High Impact Molded Plastic

Weight

3 lb 9 oz with case and 20 ft of cable

2 lb 10 oz without sensor and cable

Temperature

Open-Channel-Velocity Sensor
32° F to 160° F (0° C to 72° C)

Full-Pipe Sensor (S/S Insertion Tube)
32° F to 160° F (0° C to 72° C) @ 250 psi

Electronics
32° F to 122° F (0° C to 50° C)

GENERAL DESCRIPTION

The Marsh-McBirney Model 2000 Flo-Mate is a portable flowmeter designed for use in both the field and the laboratory. The unit uses an electromagnetic sensor to measure the velocity in a conductive liquid such as water. The velocity is in one direction and displayed on a digital display as feet per second (ft/s) or meters per second (m/s).

A watertight case protects the electronics from wet weather and accidential submersions. The unit is powered by two D-size batteries in the bottom of the case. A shoulder strap and 20 feet of sensor cable are standard. Excess sensor cable is coiled and secured to the shoulder strap by the sensor cable retainer.

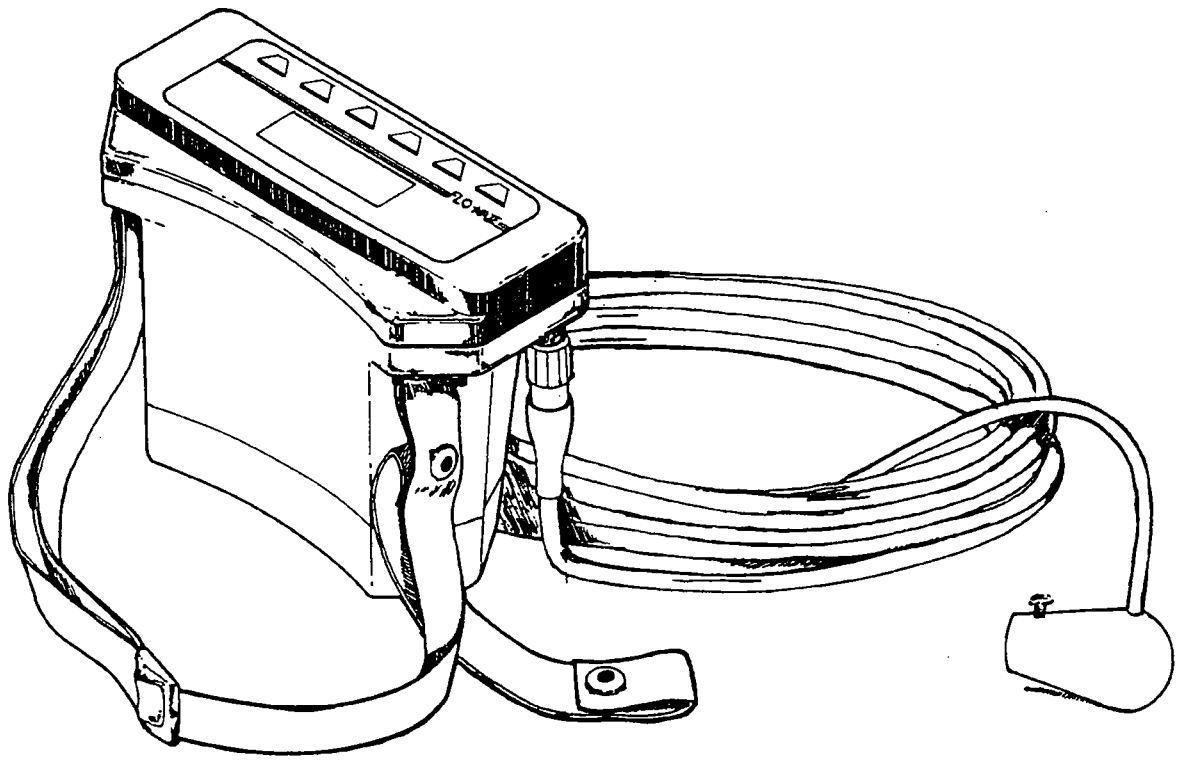


Figure 1. Model 2000 Flo-Mate

THEORY OF OPERATION

The Flo-Mate measures flow using the Faraday law of electromagnetic induction. This law states that as a conductor moves through a magnetic field, a voltage is produced. The magnitude of this voltage is directly proportional to the velocity at which the conductor moves through the magnetic field.

When the flow approaches the sensor from directly in front, then the direction of the flow, the magnetic field, and the sensed voltage are mutually perpendicular to each other. Hence, the voltage output will represent the velocity of the flow at the electrodes.

The sensor is equipped with an electromagnetic coil that produces the magnetic field. A pair of carbon electrodes measure the voltage produced by the velocity of the conductor, which in this case is the flowing liquid. The measured voltage is processed by the electronics and output as a linear measurement of velocity.

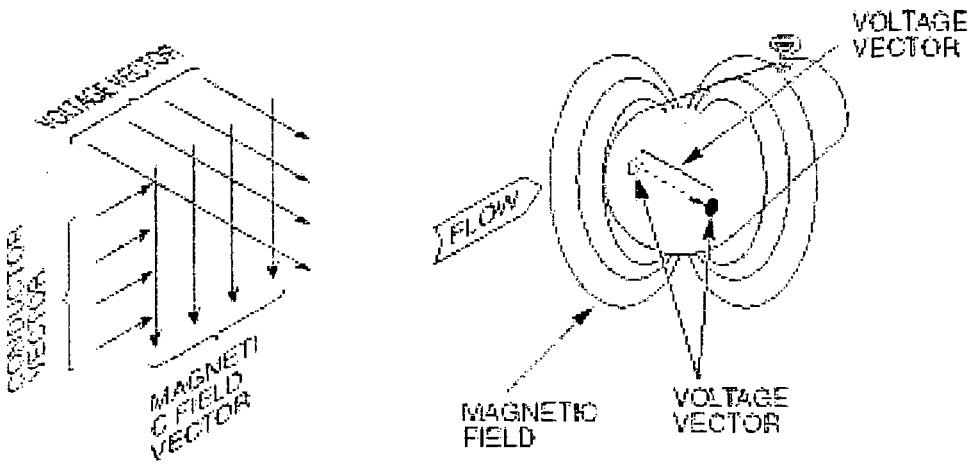


Figure 2. Theory of Operation

DESIGN FEATURES

The Model 2000 design features are as follows:

- Lightweight (3 lb 9 oz with sensor and 20 ft of cable), water resistant, and rugged. The case is made of a high impact molded material which protects the electronics from wet environments and accidental submersions.
- Digital filtering. The sensor electronics uses digital filtering. This does a better job than analog filtering in rejecting electrical noise that may be present in the flow.
- Noise flag. If there is enough electrical noise present in the flow to interfere with normal operation, the display will blank out and the noise flag is displayed.
- Conductivity lost detection. A conductivity lost flag is displayed and the velocity readings are blanked out when conductivity lost is detected. Conductivity lost is usually caused by the sensor being out of the water.
- Dry sensor power down. The unit stops driving the sensor five seconds after conductivity lost is detected. This results in a 66% reduction in power consumption, which conserves battery life. If the sensor is dry for more than 5 minutes, the unit will turn itself OFF.
- Automatic shut off. After five minutes of conductivity lost, the unit will shut itself off thus conserving battery life.
- Low battery flag. A low battery flag is displayed when the battery voltage drops below a certain value. The amount of time the batteries will last after the flag is displayed can vary from an hour (alkaline) to 15 minutes (nicads). The unit will shut itself off if the voltage drops too low.
- Clear display function. The clear display function clears the display and restarts the filtering.
- Data storage and recall ability. There are 19 memory locations in which to store and recall velocity measurements.
- Unit of measurement selection. The meter can be switched between English (ft/s) and metric (m/s) units of measurement.
- Selectable filtering modes for display output. Fluid dynamics near the sensor electrodes may cause slightly noisy readings. The output can be stabilized by averaging the velocities over a fixed time period or by a software algorithm that mimics an RC time constant.

OPERATION

The Model 2000 has two operating modes: Real-Time and Recall. In the Real-Time operating mode, Real-Time velocities from the sensor are displayed. In the Recall operating mode, velocities from memory are displayed.

Comment

In the Recall mode, the time bar will be stationary.

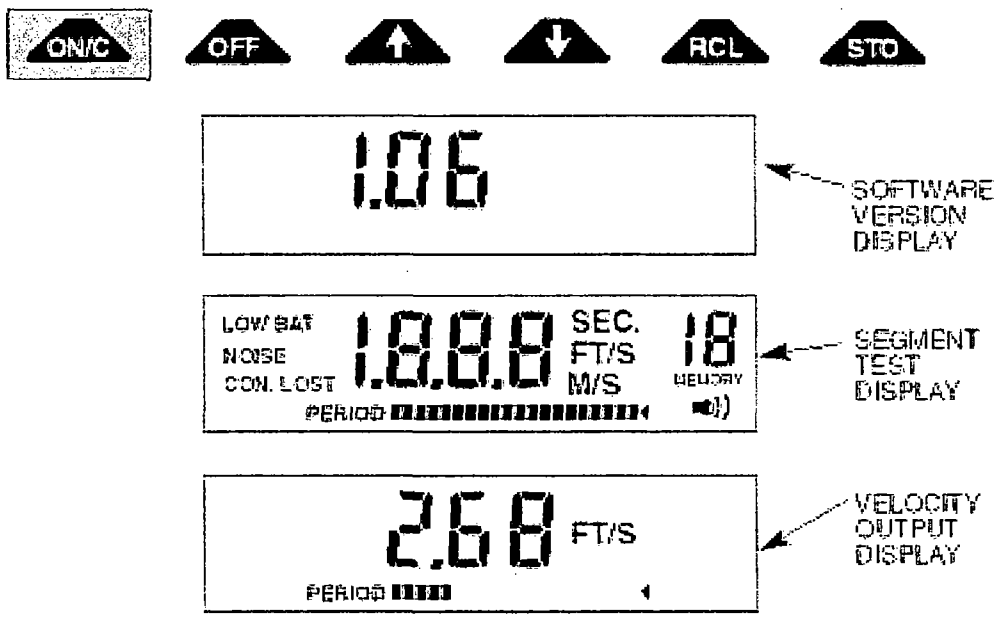
Real-Time Operating Mode

The unit will always power up in the real-time operating mode. From the real-time mode you can change the filter value, store readings in memory, turn the beeper on or off, alternate between feet per second (ft/s) and meters per second (m/s), alternate between fixed point averaging and time constant filtering, and switch to the recall operating mode.

Display ON Sequence

When the unit is turned ON, the display output sequence is as follows:

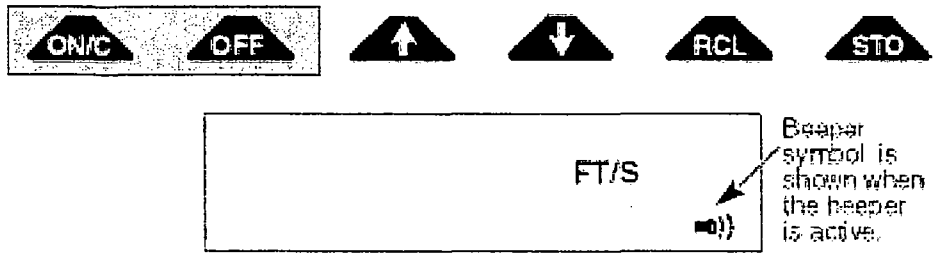
- Software version number. This is the Model 2000 operating software that was burned into the electronics at the factory.
- Display segment test. The unit will light all display segments.
- Velocity output. The first few readings are not filtered; however, they are accurate.



Units of Measurement/Beeper

The Model 2000 can output velocity in ft/s or m/s. When the beeper symbol is shown, the beeper is active. Press down on the ON/C and OFF keys simultaneously to cycle between:

- FT/S no beeper
- M/S no beeper
- F/S with beeper
- M/S with beeper



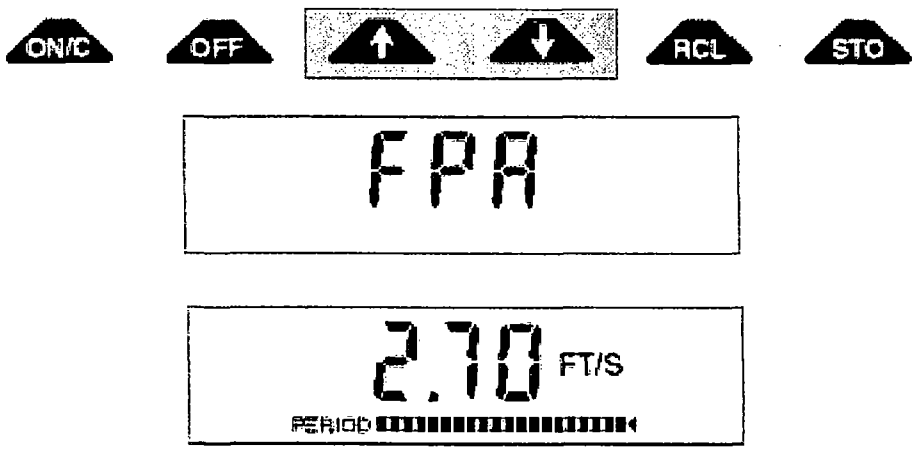
Fixed Point Average/Time Constant Filtering

The fluid dynamics around the sensor electrodes may cause the readings to bounce around. To stabilize the readings, the output to the display is dampened. The display can be dampened by Fixed Point Averaging (FPA) or by time constant filtering (rC).

Fixed Point Averaging is an average of velocities over a fixed period of time. Time constant filtering is a software algorithm that mimics an RC analog circuit. Press the ↑ and ↓ keys simultaneously to alternate between the FPA and rC displays.

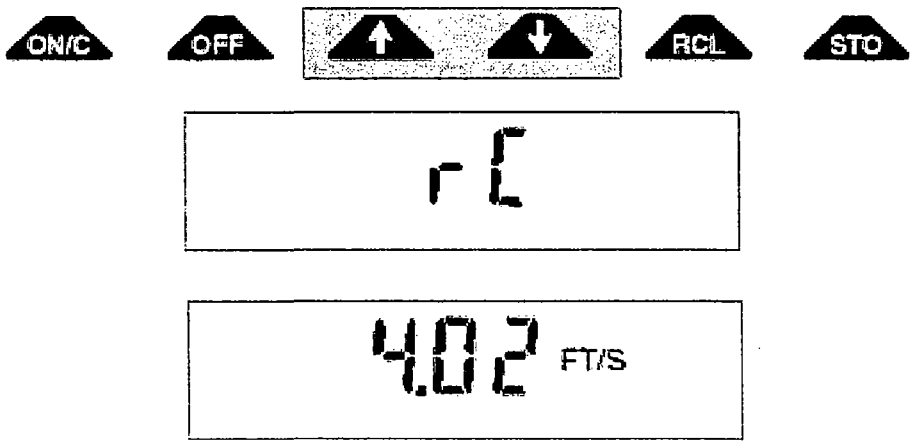
FPA

The display will show the letters FPA when you first switch to the FPA display. Except for the first period, the display is updated at the end of each averaging period. For example, if the FPA is set to 10 seconds, the display is updated once every ten seconds. The FPA display will have a horizontal time bar under the velocity output. The time bar provides an indication as to the amount of time left until the display is updated.



rC

The display will show the letters rC when you first switch to the time constant mode. The display will start with unfiltered full scale velocities. These readings are accurate but may bounce around slightly. As the filtering takes effect, the readings will settle out. It takes five time constants to get to maximum filtering. There is no time bar on the rC display because the display is continually updated.

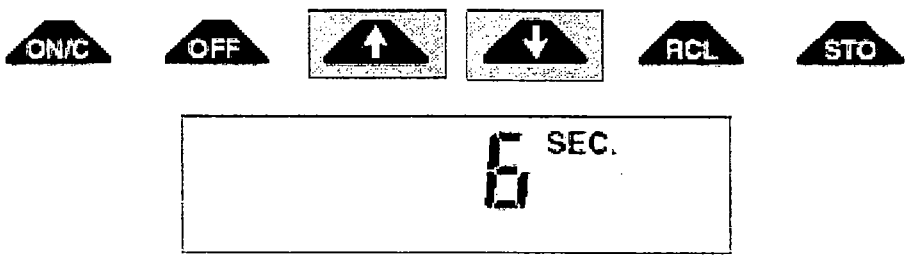


FPA/rC Time

The FPA and rC time is specified in seconds. The ↑ key increments time and the ↓ key decrements time. The display will show the FPA/rC length in seconds. After you have reached the desired setting, wait and the display will automatically switch to velocity.

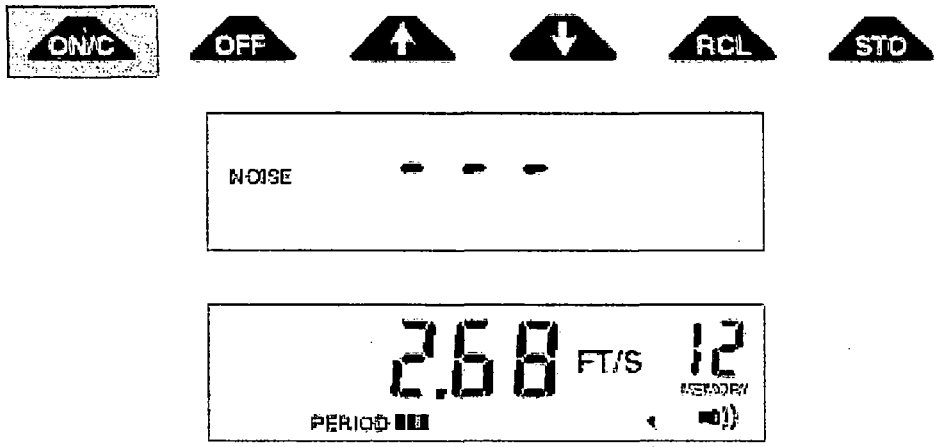
Comment:

Limits are 2-120 seconds for FPA and 2-30 seconds for rC. Changing FPA and rC time restarts the filtering.



Clearing the Display

The clear function will clear the display and restart the filtering. To clear the display, press the ON/C key. The display will blank out for a second and then restart to output velocity readings.



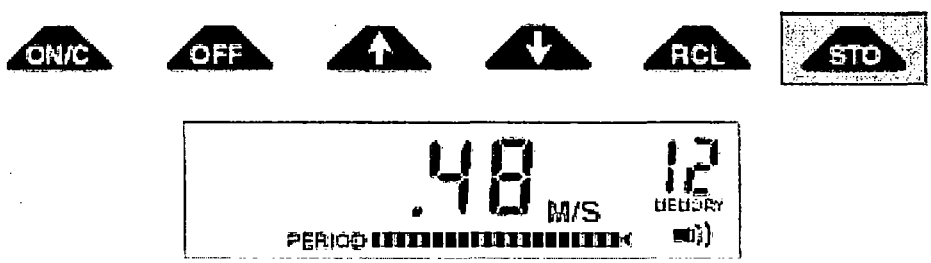
Storing Velocity Readings

There are 19 memory locations in which velocity readings can be stored. To store a reading, press the STO key when the desired velocity is displayed. The unit will store the reading and automatically increment to the next empty location. The memory location shown on the display is where the present reading will be stored. No memory locations are shown until after the first reading has been stored.

Comment:

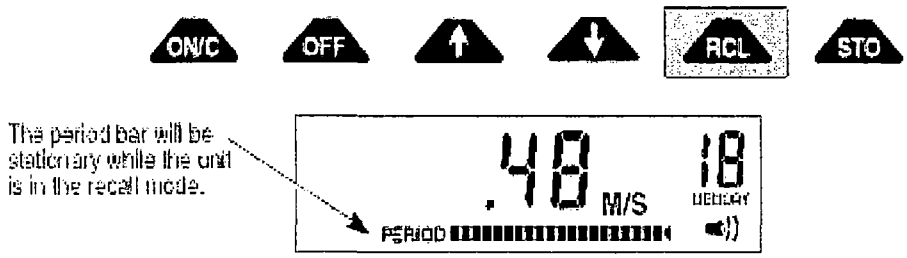
Except for the beeper symbol, the STO function will store the display as you see it. Turning the unit off or changing batteries will not affect the memory.

If you want to measure a prior location again, you need to switch to the recall mode with the RCL key. Go back to the prior location with the ↑ key. Switch to the real-time mode with the RCL key and when you get a good velocity reading store it with the STO key. The reading is stored, and the unit advances to the next empty memory location.



Recall Operating Mode

The recall operating mode outputs the velocity readings that have been stored in memory. The recall mode is indicated by a blinking memory location number and always starts at location one. To switch to the recall mode, press the RCL key. The memory location and the velocity stored in that location is shown on the display. Increment and decrement through the locations with the ↑ and ↓ keys respectively. With the exception of the first empty location, only the locations that have stored readings can be recalled.



To clear memory, press the ON/C and STO keys simultaneously. Memory can be cleared from both the the Recall and Real-Time operating modes.

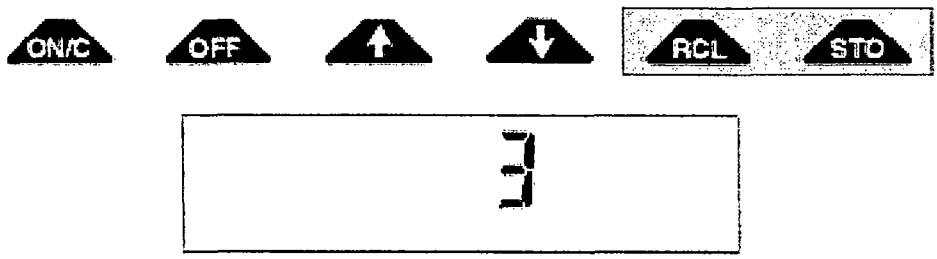
ZERO ADJUST

Zero Check

First clean the sensor (Page 12) because a thin film of oil on the electrodes can cause noisy readings. Then place the sensor in a five gallon plastic bucket of water. Keep it at least three inches away from the sides and bottom of the bucket. To make sure the water is not moving, wait 10 or 15 minutes after you have positioned the sensor before taking any zero readings. Use a filter value of 5 seconds. Zero stability is ± 0.05 ft/sec.

Zero Adjust

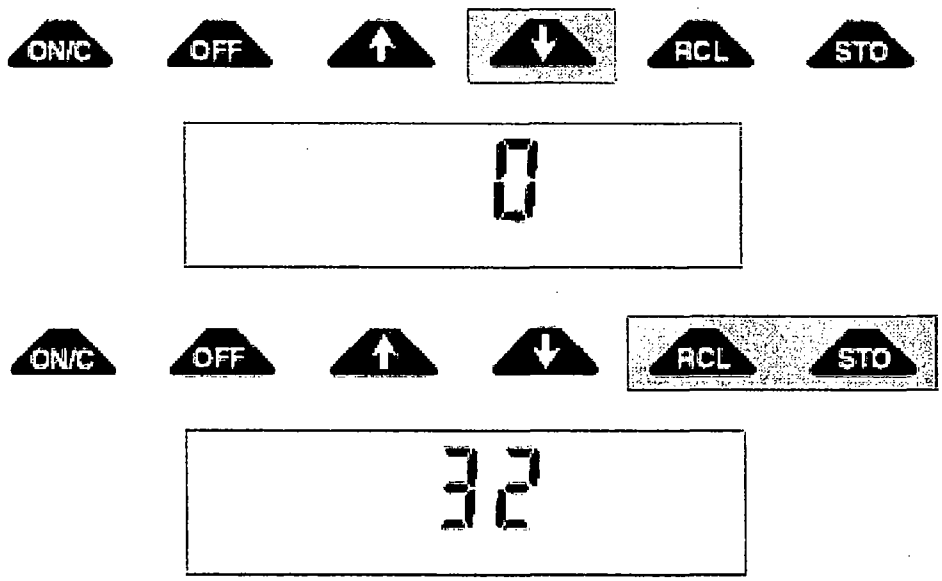
- Position the sensor as described in the zero check procedure.
- To initiate the zero start sequence, press the STO and RCL keys at the same time. You will see the number 3 on the display.
- Decrement to zero with the ↓ key.



- The number 32 will be displayed.
- The unit will decrement itself to zero and turn off. The unit is now zeroed.

Comment:

Each key in the zero adjust sequence must be pressed within 5 seconds of the previous key. If the time between key entries is longer than 5 seconds or if a wrong key is pressed, the unit will display an ERR 3. Turn the unit OFF then back ON and try again.



ERRORS

The purpose of displaying errors is to alert the user of possible problems with either the unit or application. Errors can be displayed as messages or numerical codes. There are three error messages and five numerical codes.

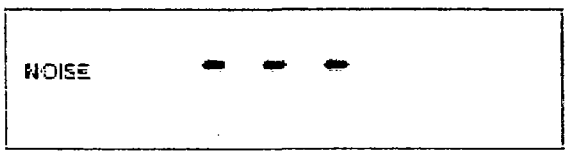
Comment:

With the exception of Err 2, error codes freeze the display. Turn the unit OFF then back ON to clear the display. If after corrective action the error still exists, call the factory.

Error Messages

Low Bat — Indicates low batteries (Page 13). Replace the batteries (Page 12).

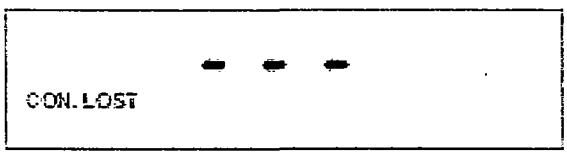
Noise — Indicates excessive electrical noise is present in the flow which will interfere with normal operation. This will cause the display to blank out.



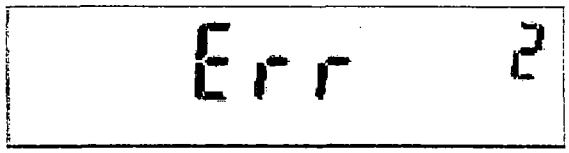
Comment:

The noise flag usually comes on for few a seconds after the sensor is submerged even though there is no noise present. This is normal.

Con Lost — Indicates that either the sensor electrodes are out of the water or they have become coated with oil or grease. After 5 minutes, the unit will turn itself OFF. If the electrodes are coated, clean them (Page 12).



Error Codes



Error #1 Problem with sensor drive circuit. Check sensor disconnect.

Error #2 Memory full error. Memory must be cleared before another reading can be stored.

Error #3 Incorrect zero-adjust-start sequence. Reinitiate zero-adjust-start sequence.

Error #4 Zero offset is greater than the zero adjust range. Repeat the zero-adjust procedure. If the error is still displayed, the unit needs servicing.

Error #5 Conductivity lost or noise detected during zero adjust. Usually caused by the sensor being out of the water.

KEY FUNCTION SUMMARY

One-Key Functions

- Turns Unit ON. Clears the display and restarts the meter.

- Turns Unit OFF.

- Increments FPA, TC, and Memory Location.

- Decrements FPA, TC, and Memory Location.

- Alternates Between Recall and Real-Time Operating Modes.

- Stores Values In Memory.

Two-Key Functions

- Change Units, Turns Beeper ON/OFF.

- Alternates Between FPA and rC Filtering.

- Clears Memory.

- Initiates zero adjust sequence. Zero stability is ± 0.05 ft/sec.

MAINTENANCE

Routine maintenance of the unit is confined to cleaning the sensor and changing the batteries.

Cleaning the Sensor

Nonconductive coatings (oil and grease) can cause noisy readings or conductivity lost errors. Clean the sensor with soap and water. If a problem still persists, clean the electrodes with a very fine grit (600) sandpaper. Do not use hydrocarbon solvents.

Changing Batteries

A low battery flag is displayed when a low battery voltage is detected. Check the battery change guide (Page 13) for battery-life estimates.

The battery compartment (Figure 3) is located in the bottom of the meter. To change the batteries, unscrew the three captive screws on the bottom cover. Remove cover and replace the batteries (two D size). Reinstall the bottom cover.

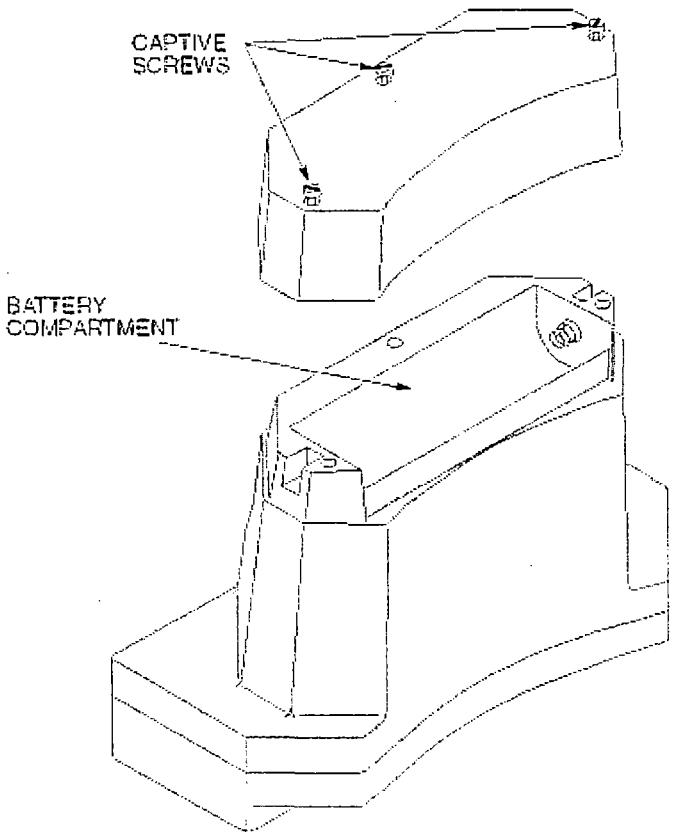


Figure 3. Battery Compartment

BATTERY LIFE

The battery life will vary from unit to unit because of different battery types, different ambient temperatures and different applications. The battery change guide below will help you to determine when to change the batteries until you gain experience in using your flowmeter in your application.

Battery Change Guide

The hours shown in the battery life table are estimates based upon a continuous ON at an ambient temperature of 72° F (22° C).

Battery Life Table

BATTERY TYPE	HOURS OF CONTINUOUS ON
Alkaline	25 - 30
Carbon Zinc	5 (Not Recommended)
NiCad*	10 - 15 (Per Charge)

* *Sanyo KR4400-D*

Typically the flowmeter is not continuously on and the ambient temperature varies from application to application. The effect this will have on battery life is as follows.

- Alkaline-battery life will be increased by as much as 30% when cycled on and off.
- At 32° F (0° C) alkaline-battery life will be reduced by 20%.
- At 110° F (40° C) alkaline-battery life is increased by 10%.

Comment:

The power-in-signal-out option is required for charging the NiCad batteries in the battery compartment. See Caution on Page 14 before using NiCad batteries.

Self Discharge in Storage

Alkaline batteries will lose approximately 5% to 10% of their charge per year. NiCad batteries will lose about 1% to 2% of their charge per day. Therefore, NiCad batteries should be charged shortly before use.

Low Battery Flag

A low battery flag is displayed when the battery voltage drops below a certain value. The amount of time the batteries will last after the flag is displayed can vary from an hour (alkaline) to 15 minutes (NiCad batteries). The unit will shut itself off if the voltage drops too low.

OPTIONS

Sensor Disconnect

The sensor cable can be disconnected from the flowmeter with the sensor disconnect option. To disconnect the sensor, pull the latch release (Figure 4) toward the sensor cable.

To connect the cable, align the latch alignment marks and push the connector together.

Comment:

If you change sensors, check the zero (Page 9).

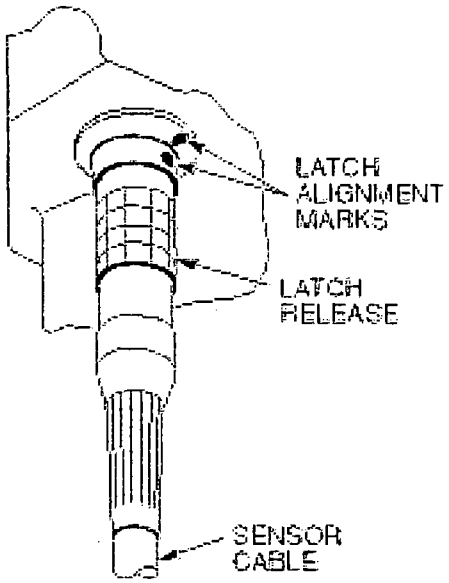


Figure 4. Sensor disconnect

Power-In-Signal-Out Connector

Except for being smaller in size, the power-in-signal-out connector (Figure 4) operates the same as the sensor disconnect. The connection to the output signal is made on a terminal strip that is attached to the AC power adapter.

The signal can be output to external recording devices.
Output impedance = 1.1 Ký
Output signal is 0.1 V = 1 ft/sec or 0.1 V = 1 m/sec.
Maximum scale is 2 volts.

[CAUTION]

Only use the NiCad batteries that are supplied with the AC power option. If batteries other than 4.4 Ah nicads are used, they may rupture and damage the unit or present a hazard to the operator.

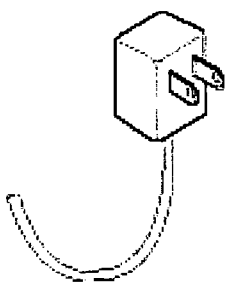


Figure 5. AC Power Adapter

The flowmeter is shipped with 2 D-Size Sanyo KR4000-D NiCad batteries installed that should be left in the unit when external power is being used. They serve as a filter and provide backup power if the main power fails. A well isolated AC power adapter (Figure 5) serves as a battery charger and external power source. The NiCads take about 14 hours to charge. Power requirements are 300 mA, 3 V for wet sensor; 100 mA, 3 V for dry sensor.

Carrying Case

The carrying case for the Model 2000 (Figure 6) is a padded nylon case with two compartments and a shoulder strap. The back compartment is for the meter, and the front compartment is for the sensor and cable. The sensor compartment is made of nylon mesh which lets air circulate through the sensor compartment.

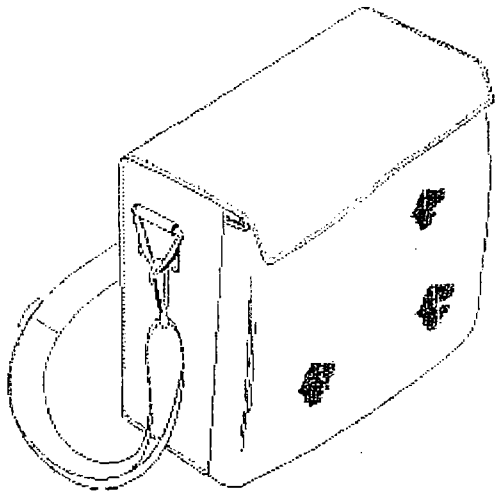


Figure 6. Carrying Case

SENSORS

The Model 2000 can be configured with an open-channel-velocity sensor, a one-inch full-pipe-velocity sensor, or a two-inch full-pipe-velocity sensor. The open-channel-velocity sensor is the standard configuration.

Open-Channel-Velocity Sensor

The front of the open-channel-velocity sensor is round with three electrodes. A mounting hole is in back, and a thumbscrew is on top (Figure 7). The front of the sensor must be pointed upstream and the electrodes must be in contact with the flow to get good readings.

Comment:

The electrodes on all sensors must be kept free from nonconductive coatings such oil and grease.

The open-channel-velocity sensor shape produces a cosine response which greatly reduces errors due to sensor positioning. For example, if the front of the sensor is pointed away from the flow at a 10° angle, the cosine of 10° is 0.98480. This is only 1.5% lower than the actual velocity.

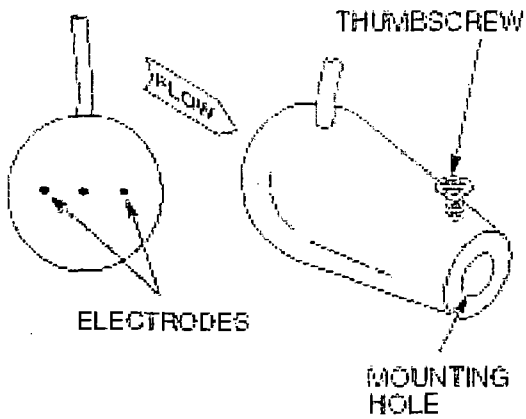
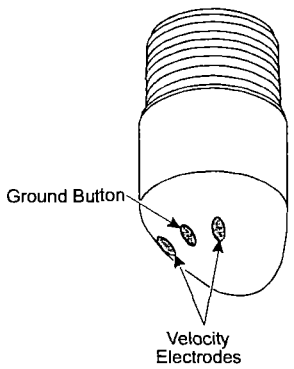


Figure 7. Open-Channel-Velocity Sensor



Full-Pipe-Velocity Sensor

The Model 2000 can be configured with either a one-inch full-pipe-velocity sensor or a two-inch full-pipe-velocity sensor (Figure 8). The installation instructions for the full-pipe sensors are contained in the manuals titled "One-Inch Full-Pipe Sensor Installation" and "Two-Inch Full-Pipe Sensor Installation. The sensor disconnect is required when the unit is configured with a full-pipe sensor.

Figure 8. Full-Pipe Velocity Sensor

SENSOR MOUNTING CONFIGURATIONS

Universal-Sensor Mount

The sensor can be attached to different size poles with the universal-sensor mount (Figure 9). Mounting instructions are as follows:

- Insert the mounting shaft on the universal mount into the hole at the back of the sensor. The thumbscrew needs to be seated in the groove, so make sure the shaft is completely inserted into the hole.
- Hand tighten the thumbscrew.
- Slide a pole one inch or less in diameter through the clamp and tighten.

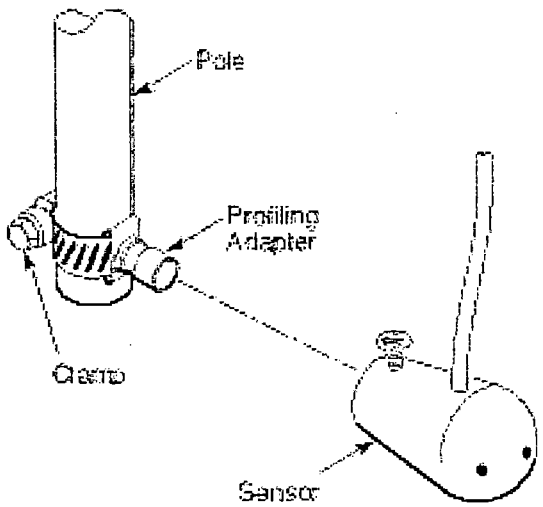


Figure 9. Universal Sensor Mount

[CAUTION]

Do not over tighten the thumbscrew on the sensor. Excessive force on the thumbscrew could damage the sensor.

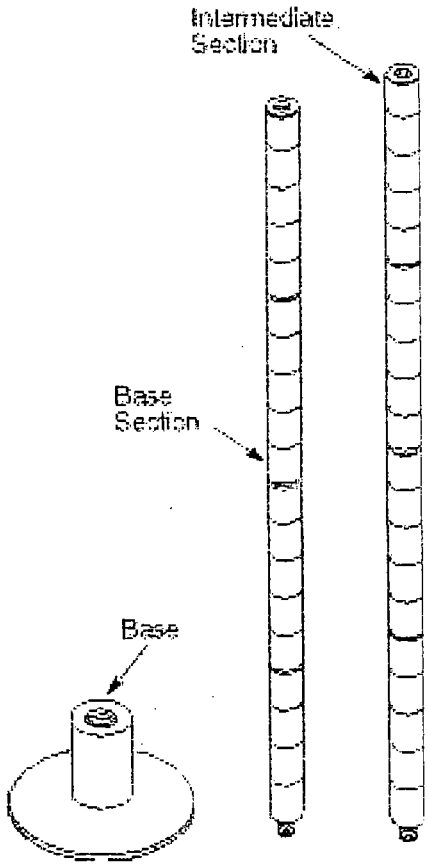


Figure 10. Standard Wading Rod

Standard Wading Rod

Both the metric and English standard wading rods have a base, a bottom section, a double end hanger, and three intermediate sections (Figure 10). Each intermediate section is two feet in length (English), or one half meter in length (metric). The bottom section is shorter; but when it is screwed to the base, the overall length is equal to the intermediate sections. Each section is divided into 0.10 foot (single marks), 0.50 foot (double marks) and 1.0 foot (triple marks) increments (English), or 5 cm (single marks) and 10 cm (double marks) increments (metric).

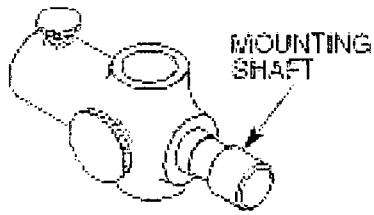


Figure 11. Double-End Hanger

Double-End Hanger

The sensor is mounted to the standard wading rod with a double-end hanger (Figure 11). Slide the wading rod through the hole in the hanger and hand tighten the locking screw on the side. Insert the mounting shaft on the hanger into the hole in back of the sensor. Then hand tighten the thumbscrew on top of the sensor. The thumbscrew must be seated in the groove on the shaft so make sure the mounting shaft is completely inserted into the hole on the sensor.

Top-Setting-Wading Rod

Two accepted methods for determining mean velocities of flows are as follows:

1. Measure the velocity at 60% of the depth (from the top) and use this as the mean.

2. Measure the velocity at 20% and 80% of the depth (from the top). Use the average of these velocities as the mean.

The purpose of the top setting wading rod (Figure 12) is to conveniently set the sensor at 20%, 60%, or 80% of total depth. The total depth can be measured with the depth gauge rod. Each single mark represents 0.10 foot, each double mark represents 0.50 foot, and each triple mark represents 1.00 foot.

To set the sensor at 60% of the depth, line up the foot scale on the sliding rod with the tenth scale on the top of the depth gauge rod. If, for example, the total depth is 2.7 feet, then line up the 2 on the foot scale with the 7 on the tenth scale.

To set the sensor at 20% of the depth, multiply the total depth by two and repeat the above procedure. In the above example this would be 5.4 feet. Line up the 5 on the foot scale with 4 on the tenth scale.

To set the sensor at 80% of the depth, divide the total depth by two and repeat the above procedure. In the above example, this would be 1.35 feet. Line the 1 on the foot scale with 0.35 on the tenth scale.

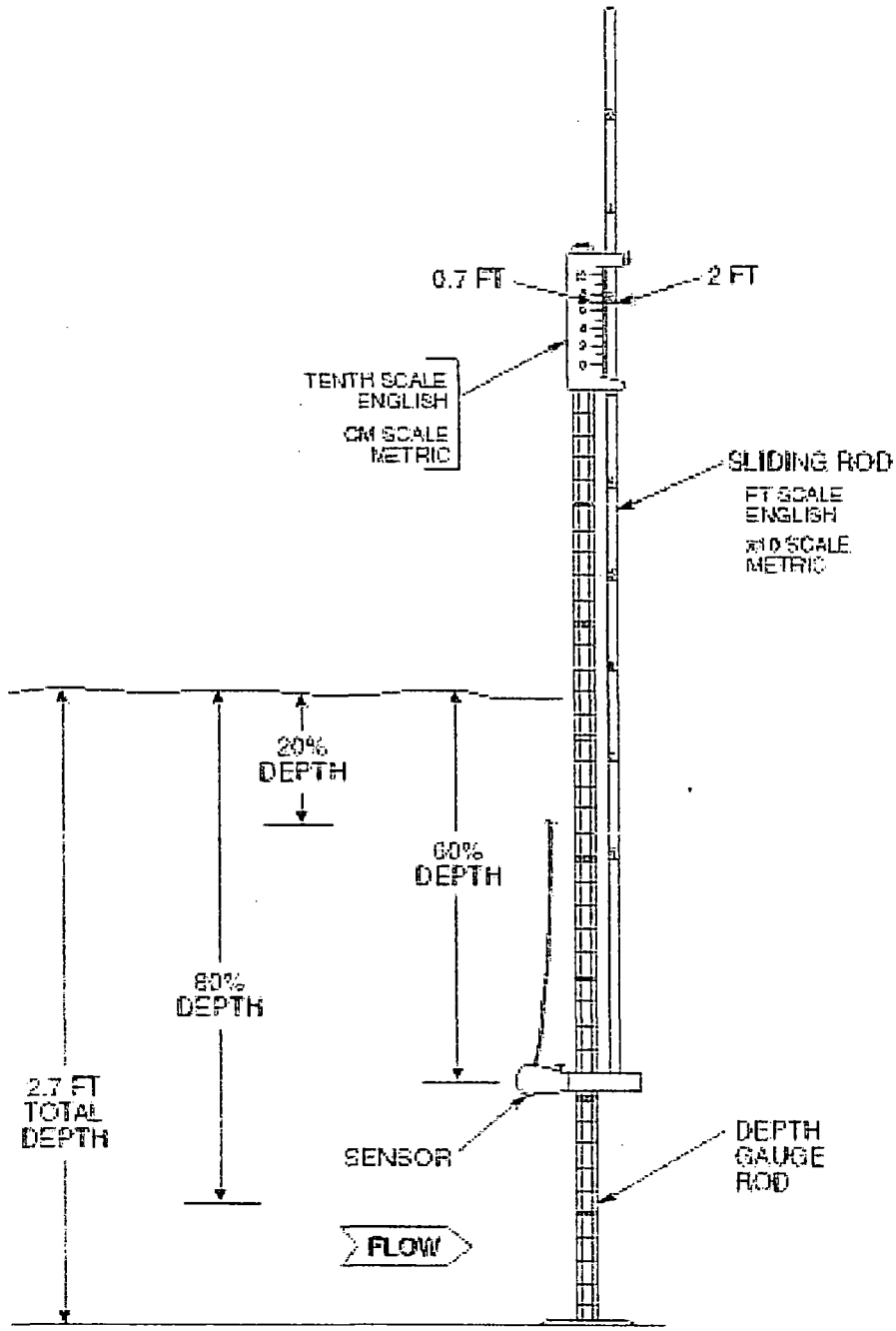


Figure 12. Top-Setting-Wading Rod

Suspension Cable

The suspension cable (Figure 13) makes it possible for the sensor to be lowered into the water from boats or bridges. To attach the sensor to the suspension cable, insert the mounting shaft on the sensor mount into the hole at the back of the sensor. The thumbscrew needs to be seated in the groove on the shaft, so make sure the shaft is completely inserted into the hole. Hand tighten the thumbscrew.

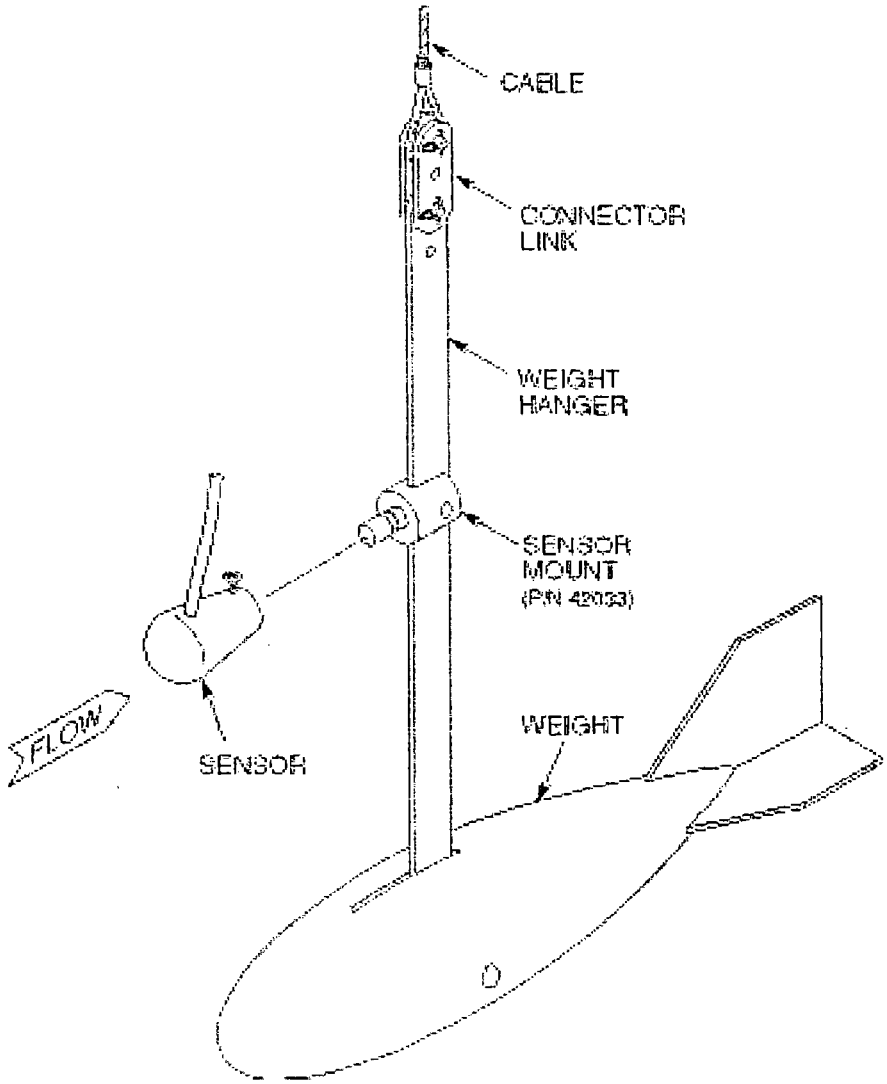


Figure 13. Suspension Cable

ATTACHMENT C-2

USGS General Procedure for Gaging Streams

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Techniques of Water-Resources Investigations
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Chapter A6

GENERAL PROCEDURE FOR GAGING STREAMS

By R. W. Carter and Jacob Davidian

Book 3

APPLICATIONS OF HYDRAULICS

DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

First printing 1968
Second printing 1969
Third printing 1977
Fourth printing 1989

UNITED STATES GOVERNMENT PRINTING OFFICE : 1968

For sale by the
Books and Open-File Reports Section
U.S. Geological Survey
Federal Center, Box 25425
Denver, CO 80225

PREFACE

The series of manuals on techniques describes procedures for planning and executing specialized work in water-resources investigations. The material is grouped under major subject headings called books and further subdivided into sections and chapters; section A of book 3 is on surface-water techniques.

The unit of publication, the chapter, is limited to a narrow field of subject matter. This format permits flexibility in revision and publication as the need arises.

Provisional drafts of chapters are distributed to field offices of the U.S. Geological Survey for their use. These drafts are subject to revision because of experience in use or because of advancement in knowledge, techniques, or equipment. After the technique described in a chapter is sufficiently developed, the chapter is published and is sold by the U.S. Geological Survey Books and Open-File Reports Section, Federal Center, Box 25425, Denver, CO 80225 (authorized agent of Superintendent of Documents, Government Printing Office).

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GENERAL PROCEDURE FOR GAGING STREAMS

By R. W. Carter and Jacob Davidian

Abstract

This chapter briefly describes the objectives and procedures used in obtaining streamflow records. It is considered an introduction to other chapters on surface-water techniques which treat individual procedures in greater detail.

Introduction

Measurement of the flow of streams was begun by the U.S. Geological Survey in 1888 as part of special studies relating to the irrigation of public lands. Since that time systematic records of streamflow have been obtained at more than 16,000 places in the United States by the Geological Survey. In 1967 the stream-gaging network comprised about 9,000 continuous-record stations. In addition, there were about 7,200 partial-record stations where data on only floodflow or low flow were obtained.

Stream gaging is the largest operation among the various hydrologic networks. Streamflow is the only part of the hydrologic cycle in which moisture is so confined as to permit reasonably accurate measurements of the volumes involved. All other measurements in the hydrologic cycle are at best only inadequate samples of the whole.

Water in streams serves man in many ways; it provides water supply for man and animals, irrigation water for plants, dilution and transport for removal of waste, energy for production of power, channels for water transport, and a medium of recreation. Records of streamflow are important in each of these uses.

Water in streams can also be a hazard. Floods cause extensive damage and hardship. Records of flood events obtained at gaging stations serve as the basis for the design of highway bridges and culverts, dams, and flood-control reservoirs and for flood-plain delineation and flood-warning systems.

The network of stream-gaging stations is designed to meet the various needs for information on streamflow. Many stations are operated to provide current information for use in the day-by-day management of water supplies or for use in forecasting flood events. Most of the stations, however, are operated as a part of the hydrologic network. Records for these stations reflect the natural hydrologic characteristics of the basins and can thus be used as samples of the variations of streamflow in time and space.

The design of streamflow networks is governed to some extent by the ability to measure stage and discharge at a given site to the required degree of accuracy. The continued development of new instrumentation and analytical techniques has improved the capability of obtaining streamflow records under difficult conditions.

This chapter describes in general terms the techniques used in obtaining continuous streamflow records—from selection of site to publication of records. It is considered an introduction to four other chapters in book 3, section A, surface-water techniques, which describe in detail the instruments and techniques used in making specific measurements. This series of chapters may be considered an updating of Water-Supply Paper 888, "Stream Gaging Procedure."

General Objective and Procedures

The objective in operating a gaging station is to obtain a continuous record of stage and discharge at the site. The exact location of the station is chosen to take advantage of the best

available condition for stage and discharge measurements and for developing discharge ratings.

A continuous record of stage is obtained by installing instruments that sense and record the water-surface elevation in the stream. Discharge measurements are initially made at various stages to define the relation between stage and discharge. Discharge measurements are then made at periodic intervals, usually monthly, to verify the stage-discharge relation or to define any change in the relation owing to changes in channel geometry.

At many sites the discharge is not a unique function of stage; variables other than stage also must be continuously measured to obtain a discharge record. For example, stream slope is measured by the installation of an auxiliary stage gage downstream if variable backwater occurs. At other sites a continuous measure of stream velocity at a point in the cross section is obtained and used as an additional variable in the discharge rating. The rate of change of stage can be an important variable at sites having considerable unsteadiness of flow.

Low weirs and dams are constructed at some stations to stabilize the stage-discharge relations in the low-flow range. These control structures are calibrated by stage and discharge measurements in the field.

The data obtained at the gaging station are reviewed and analyzed by engineering personnel at the end of the water year. Discharge ratings are established, and the gage-height record is reduced to mean values for selected time periods. The mean discharge for each day and extremes of discharge for the year are computed. The data are then prepared for publication.

Selection of Gaging Site

The selection of gaging sites is dictated by the needs of water management or by the requirements of the hydrologic network. In fulfilling water-management needs there is little or no freedom of choice in selecting gaging sites, and frequently records must be obtained under very adverse hydraulic conditions. For example, many of the principal streams in the United States have been converted into a series of pools by the construction of dams; yet, very precise records are needed for operation. Records are also needed in tidal reaches of stream channels in connection with water supply, salinity contamination, or waste disposal.

Hydrologic network requirements allow more choice in selecting good sites for gaging, although in some places gaging conditions are poor throughout an entire region. For example, all streams in a given region may have unstable beds and banks, which result in continually changing stage-discharge relations. However, before a stream-gaging station is constructed, a general reconnaissance is made in order that the most suitable site for the gage may be selected. This reconnaissance is facilitated by an examination of geologic, topographic, and other maps of the area. Tentative sites for gaging stations may be indicated on the maps, each site being subject to critical examination of the physical characteristics of the stream channel. In selecting a site consideration should be given to the following items:

1. Channel characteristics relative to a fixed and permanent relation between stage and discharge at the gage. A rock riffle or falls, as shown in figure 1, indicates an ideal site. If a site on a stream with a movable bed must be accepted—for example, a sand-channel stream—it is best to locate the gage in as uniform a reach as possible, away from obstructions in the channel such as bridges.
2. Opportunity to install an artificial control.
3. Possibility of backwater from downstream tributaries or other sources. If a site

Figure 1.—Gage and natural control, Little Spokane River at Elk, Wash.

where backwater occurs must be accepted, a uniform reach for measurement of slope should be sought, in addition to the proper placement of an auxiliary gage. Unsteady flow such as occurs in tide-affected stream channels requires similar consideration but, in addition, line power must be available to insure simultaneous recording of stage at the two gages.

4. Availability of a nearby cross section where good discharge measurements can be made.
5. Proper placement of a stage gage with respect to the measuring section and to that part of the channel which controls the stage-discharge relation.
6. Suitability of existing structures for use in making high-flow discharge measurements, or the proper placement of a cableway for this purpose.
7. Possibility of flow bypassing the site in ground water or in flood channels.
8. Availability of line power or telephone lines where needed, for special instrumentation or for Telemark units.
9. Accessibility of the site by roads, particularly during flood periods.

The gage on Kaskaskia River at Bondville, Ill., shown in figure 2, satisfies several of the above requirements. Low-flow measurements are made by wading upstream from the artificial control, and high-flow measurements are made from the bridge. The bridge site provides accessibility, convenience to power lines, and a good location for an outside gage, shown on the downstream handrail.

Artificial Controls

Artificial controls are structures built in a stream channel to stabilize the stage-discharge relation and thereby simplify the procedure of obtaining accurate records of discharge. They may be low dams, broad-crested weirs conforming to the general shape and height of the streambed, or flumes similar in design to the Parshall flume. The adverse effects of unstable conditions due to shifting bed or banks, the formation of ice in winter, progressive growth of aquatic vegetation during the summer, and other phenomena which at times affect the stage-discharge relation at low stages may generally be eliminated or alleviated by the construction of an artificial control. The structure is seldom designed to function as a complete control throughout the entire range of stage. Generally it is impracticable to build it high enough to eliminate the effects of downstream conditions at high stages unless there is a steep fall below the gage. If the downstream slope is flat, so that with an increase in discharge the water below the control rises faster than the water above it, the control may be completely effective only for low and medium stages. Figure 3 shows the artficial control on Mill Creek near Coshocton, Ohio. A differently shaped artificial control is shown in figure 4, for the gage on the Delaware River near Red Bluff, N. Mex. Note the shallow V-notch in the broad-crested weir, to improve sensitiveness.

Although the artificial control is usually constructed in the form of a dam or a weir, it is seldom if ever desirable to attempt the use of a weir formula as its rating. The rating for each station should be determined by a current-meter or other method of measuring discharge. The conditions or facilities for the accurate measurement of small streams and for the measurement of the low-water flow of larger streams commonly can be improved by the use of artifical controls.

In the design of artificial controls the following four major points should be considered:

1. The shape of the structure should permit the the passage of water without creating undesirable disturbances in the channel above or below the control.
2. The structure must be of sufficient height to eliminate the effects of variable downstream conditions.
3. The profile of the crest of the control should be designed so that a small change in discharge at low stages will cause a measurable change in stage, and the relation of changes in stage to changes in discharge should produce a rating curve of a shape that may be extended to peak stages without serious error.
4. The control should have structural stability and should be permanent.

The artificial control should be self-cleaning and

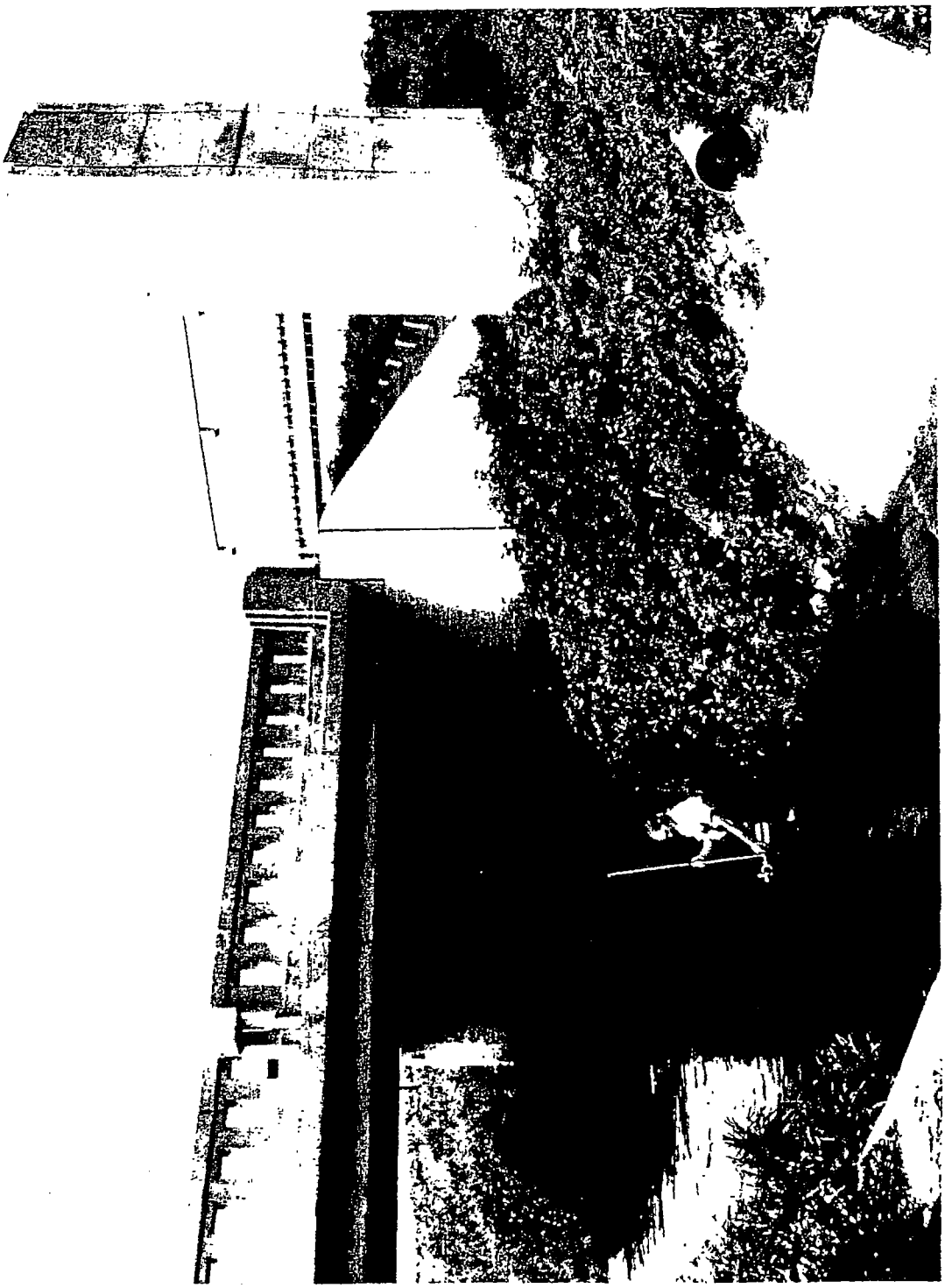

Figure 2.—Gage, concrete control, outside gage on bridge, and an engineer making a wading measurement, Kaskaskia River at Bondville, Ill

Figure 3.—Concrete artificial control on Mill Creek near Coshocton, Ohio.

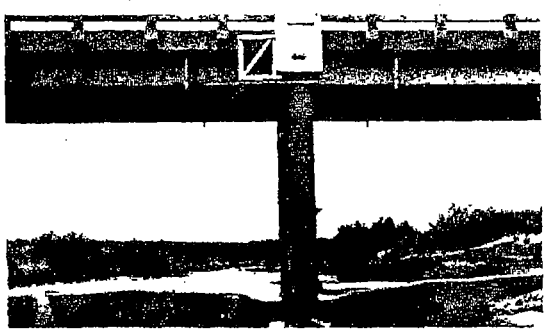

Figure 4.—Artificial control on Delaware River near Red Bluff, N. Mex., with shallow V-notch in the broad-crested weir.

should not be subject to obstruction by debris and ice or to deposits of sand, gravel, or silt in its immediate vicinity, either upstream or downstream.

Measurement of Stage

The stage of a stream is the height of the water surface above an established datum plane. Measurements of stream stage are used in determining records of stream discharge. In addition, records of stream stage are useful in themselves, such as in the design of structures affected by stream elevation or in the planning of the use of flood plains.

A record of stage can be obtained by systematic observations of a nonrecording gage. In the early days of the Geological Survey, this was the means generally used, but now the water-stage recorder is used at practically all gaging stations. The advantages of the nonrecording gage are the low initial cost and the ease of installation. The disadvantages are the need for an observer and the lack of accuracy of the estimated continuous stage graph sketched through the points of observation. For long-term operation the advantages of the recording gage far outweigh those of the nonrecording gage, and thus the use of the nonrecording gage is no longer considered a feasible method of obtaining a stage record.

Methods of sensing stage

Stage is usually sensed by a float in a stilling well that is connected to the stream by intake pipes. The stilling well protects the float and dampens the fluctuation in the stream caused by wind and turbulence. Stilling wells, though usually placed in the bank of the stream, are often placed directly in the stream as in figure 4, attached to a bridge pier or abutments. The bottom of the stilling well should be below the minimum anticipated stage and its top above the maximum anticipated stage. The intake to the well must be of proper size and location to prevent lag during periods of rapid change in stage and to prevent velocity-head effects at its end.

Stage may also be sensed by a gas-purge system known as a bubble gage. This system does not require a stilling well. A gas is fed through a tube and bubbled freely through an orifice that is permanently mounted in the stream. The gas pressure in the tube is equal to the piezometric head on the bubble orifice at any gage height. The pressure in the tube is measured by a zero-displacement mercury manometer with the associated electrical components to drive a stage recorder.

The bubble gage is used primarily at sites where it would be expensive to install a stilling well. It is also used on sand-channel streams because the gas tends to keep the orifice from being covered with sand and the tube may be easily extended to follow a stream channel that shifts its location. However, the float stilling-well installation is cheaper to install at most sites, and its performance is more reliable than is that of the bubble gage. The two systems have about the same accuracy—$\pm$0.01 foot. The

choice of systems thus depends on the characteristics of the site.

Water-stage recorders

Both strip-chart and digital-tape water-level recorders are in general use. Either recorder may be actuated by the float or bubble-gage system. Figure 5 shows a bubble-gage digital-punch arrangement.

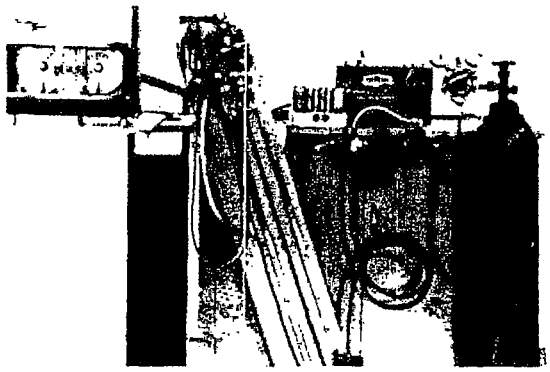

Figure 5.—Bubble-gage digital-recorder arrangement. Gas tank on right; digital-punch recorder on left.

A strip-chart recorder produces a graphic record of the rise and fall of the water surface with respect to time. A gage-height scale of 1:6 and a time scale of one day being equal to 2.4 inches are commonly used. Continuous recorders such as the Stevens A–35 will operate unattended for periods of 60–90 days and provide a very satisfactory record of stage.

A digital stage recorder punches coded values of stage on paper tape at preselected time intervals. A time interval of 15 minutes is normally used. The Fischer-Porter recorder is battery operated and will run unattended for periods of 60–90 days. The code consists of four groups of four punches each; the four punches represent 1, 2, 4, and 8 in each group. The punching of a stage requires only a 0.1-inch advance of paper tape. The recorder is actuated by a cam on a battery-driven mechanical clock.

Digital recorders are gradually replacing strip-chart recorders at gaging stations in the United States. The two recorders are about equal in accuracy, reliability, and cost, but the digital recorder is compatible with the use of electronic computers in computing discharge records. This automated system as developed by the Geological Survey offers greater economy and flexibility in the computation-publication process than do manual methods associated with graphical recording. However, the use of graphical recorders will be continued at those sites where a graphical record is necessary to detect ice effects, backwater, or frequent malfunctions of the recording system.

Reference gages

Because of the possibility of plugged intakes or other malfunctions, a nonrecording gage is installed so that the water level in the stream can be directly measured. Comparative readings on the inside and outside gages are taken during each visit to the station by engineering personnel. Datum of all gages is checked at periodic intervals—usually every 2 or 3 years. In figure 2, the outside gage is on the bridge. Outside staff gages are visible in figures 3 and 4 in the pools near the gage structures.

Discharge Measurements

Discharge measurements are made at each gaging station to define the discharge rating for the site. The discharge rating may consist of a simple relation between stage and discharge or a more complex relation in which discharge is a function of stage, slope, rate of change of stage, or other factors.

Discharge measurements are normally made by the current-meter method, which consists of determinations of velocity and area in the parts of a stream cross section. However, indirect methods are frequently used in determining flood peak discharges. These methods utilize hydraulic equations in conjunction with the information on channel characteristics and floodmarks obtained in a field survey after the flood event.

Discharge measurements may also be made by the dilution method. This method depends on determination of the degree of dilution of an added tracer solution by the flowing water.

Current-meter measurements

In the making of a discharge measurement the cross section is divided into 20–30 partial sections, and the area and mean velocity of each is determined separately. A partial section is a rectangle whose depth is equal to the sounded depth at a meter location (a vertical) and whose width is equal to the sum of half the distances to the adjacent verticals. At each vertical the following observations are made: (1) The distance to a reference point on the bank, (2) the depth of flow, and (3) the velocity as indicated by current meter at one or two points in the vertical. These points are at either the 0.2 and 0.8 depths (two-point method) or the 0.6 depth (one-point method) from the water surface. The average of the two velocities, or the single velocity at 0.6 depth, is taken to be the mean velocity in the vertical. The discharge in each partial section is computed as the product of mean velocity times depth at the vertical times the sum of half the distances to adjacent verticals. The sum of the discharges in all the partial sections is the total discharge of the stream.

The measurement can be made by wading the stream with a current meter which slides on a graduated depth rod as shown in figures 2 and 6, or it can be made from a supporting structure such as a bridge (see fig. 7), cableway, or boat, the meter being suspended by a cable.

The Price current meter is used to observe velocity, except in shallow depths where the pygmy current meter is used. The rotor on both these meters has a vertical axis and six cone-shaped cups. Each meter is individually calibrated in the rating flume at the National Bureau of Standards. Figure 8 shows a velocity-azimuth-depth assembly, which has been in use since 1958, primarily on large rivers and in estuarine studies.

These methods and the associated equipment have been developed by the Geological Survey over a period of 60 years. Satisfactory results have been obtained in measuring discharges ranging from the trickle of a small stream to the 7,500,000-cfs flow of the Amazon River. Methods and equipment used in making discharge measurements by the current-meter method are described in detail in book 3, chapter A8, of this series, by Buchanan and Somers.[1]

Indirect discharge measurements

During floods, it is frequently impossible or impractical to measure the peak discharges when they occur, because of conditions beyond control. Roads may be impassable; structures from which current-meter measurements might have been made may be nonexistent, not suitably located, or destroyed; knowledge of the flood rise may not be available sufficiently in advance to permit reaching the site near the time of the peak; the peak may be so sharp that a satisfactory current-meter measurement could not be made even with an engineer present at the time; the flow of debris or ice may be such as to prevent use of a current meter; or limitations of personnel might make it impossible to obtain direct measurements of high-stage discharge at numerous locations during a short flood period. Consequently, many peak discharges must be determined after the passage of the flood by indirect methods such as slope-area, contracted-opening, flow-over-dam, or flow-through-culvert, rather than by direct current-meter measurement.

To evaluate the accuracy of indirect methods, comparisons have been made at every opportunity. When it has been possible to compare peak discharge computed by indirect means with peak discharge measured by current meter or other direct means, the agreement, in general, has supported confidence in the auxiliary methods.

Indirect measurements make use of the energy equation for computing discharge. The specific equations differ for different types of flow, such as open-channel flow, flow over dams, and flow through culverts. These equations relate the discharge to the water-surface profile and the geometry of the channel. A field survey is made after the flood to determine the location and elevation of high-water marks and the geometry of the channel.

[1] Buchanan, T. J., and Somers, W. P., Discharge measurements at gaging stations: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. A8, unpub. data.

Figure 6.—Measuring discharge with current meter by wading.

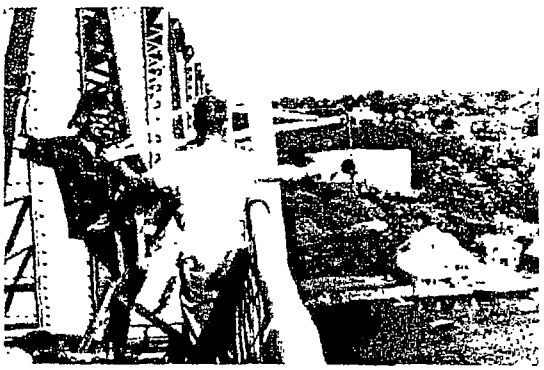

Figure 7.—Measuring discharge with current meter from bridge over the Hudson River at Poughkeepsie, N.Y

Detailed descriptions of the procedures used in collecting field data and in computing the discharge are given in Benson and Dalrymple (1967), Dalrymple and Benson (1967), Bodhaine (1968), Matthai (1967), and Hulsing (1967), which are book 3, chapters A1–A5, of this series. The use of electronic computers in these computations is explained by Anderson and Anderson [2] and by Somers and Selner.[3]

Dilution method

Measurement of discharge by this method depends on determination of the degree of dilution of an added tracer solution by the flowing water. A solution of a stable or radioactive chemical is injected into the stream as either a constant rate or all at once. The solution becomes diluted by the discharge of the stream. Measurement of the rate of injection, the concentration of the tracer in the injected solution, and the concentration of the tracer at a cross

[2] Anderson, D. B., and Anderson, W. L., Computation of water-surface profiles in open channels; U.S. Geol. Survey Techniques Water-Resources Inv., unpub. data.

[3] Somers, W. P., and Selner, G. I., Computation of stage-discharge relationships at culverts and Computer technique for slope-area measurements: U.S. Geol. Survey Techniques Water-Resources Inv., unpub. data.

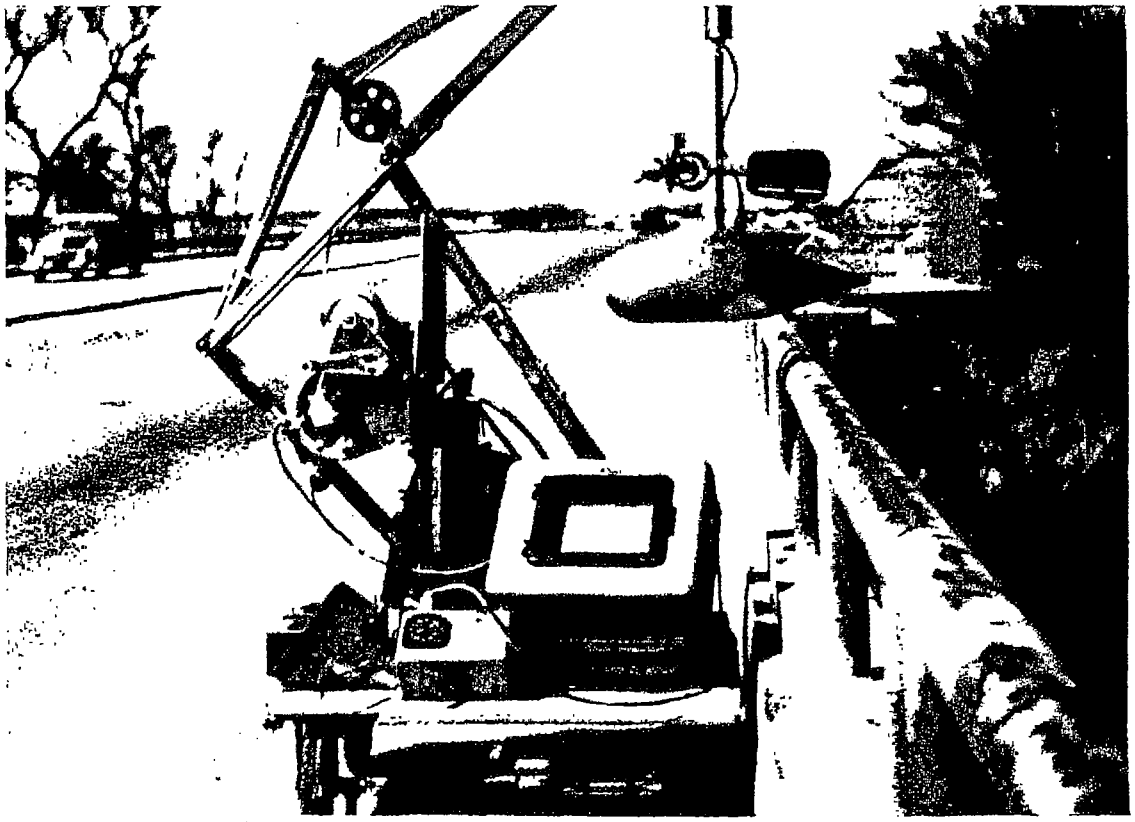

Figure 8.—VADA (velocity-azimuth-depth-assembly) equipment in use for measurement from bridge.

section downstream from the injection point permits the computation of stream discharge. The accuracy of the method critically depends upon complete mixing of the injected solution through the stream cross section before the sampling station is reached and upon no adsorption of the tracer on stream-bottom materials. The method is recommended only for those sites where conventional methods cannot be employed owing to shallow depths, extremely high velocities, or excessive turbulence. A detailed description of the procedures and equipment used in measuring discharge by a dye-dilution method is given by Cobb and Bailey.[4] Figure 9 shows the pressurized constant-rate tanks used to inject fluorescent dye solutions into the streams, and figure 10 shows collected sample bottles ready for field testing with a fluorometer on the tailgate of a vehicle.

Discharge Ratings

The computation of continuous records of discharge at gaging stations depends on definition of the discharge rating for the channel. Discharge ratings may be simple or complex. The rating may consist of a simple relation between stage and discharge or of several relation curves which define discharge as a function of stage, slope, rate of change of stage, or other variables. The expression "discharge rating" is an all-inclusive term to describe the one or more relations used to determine the discharge from measured parameters of flow.

Stage-discharge relations

Discharge ratings at a large majority of gaging stations consist of relations between stage and discharge. These stage-discharge relations are rarely permanent, particularly at low flow, because of changes in the stream channel such as scour and fill, aquatic growth, ice, or debris or because of changes in bed roughness. Frequent discharge measurements are necessary to define the stage-discharge relation at any time.

[4] Cobb, E. D., and Bailey, J. F., Measurement of discharge by dye-dilution methods: U.S. Geol. Survey Techniques Water-Resources Inv., unpub. data.

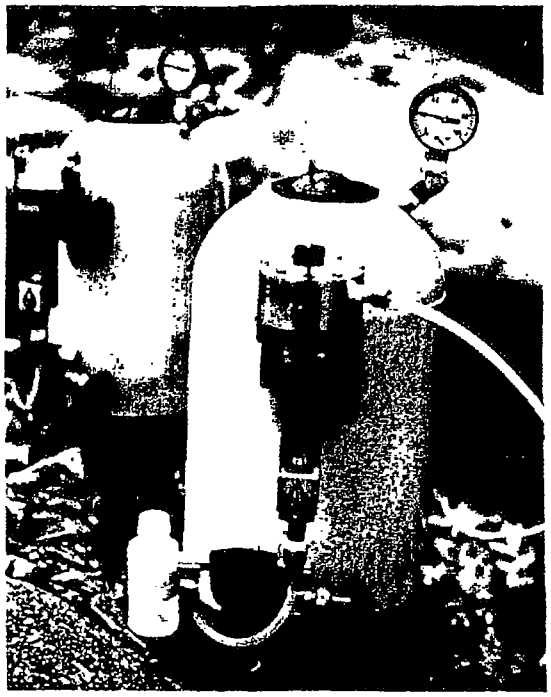

Figure 9.—Pressurized constant-rate injection tanks for injection of dye into streams.

The relation of stage to discharge is generally controlled by a section or reach of channel below the gage, known as the station control. Section controls may be either natural or constructed, and may consist of a ledge of rock across the channel, a boulder-covered riffle, an overflow dam or any other physical feature capable of maintaining a fairly stable relation between stage and discharge. Section controls are commonly effective only at low discharges, and are completely submerged by channel control at medium and high discharges. Channel control consists of all the physical features of the channel which determine the stage of the river at a given point for a certain rate of flow. These features include the size, slope, roughness, alinement, constrictions and expansions, and shape of the channel. The reach of channel which acts as the control may lengthen as the discharge increases; such changes introduce new features which affect the stage-discharge relation.

Knowledge of the channel features which

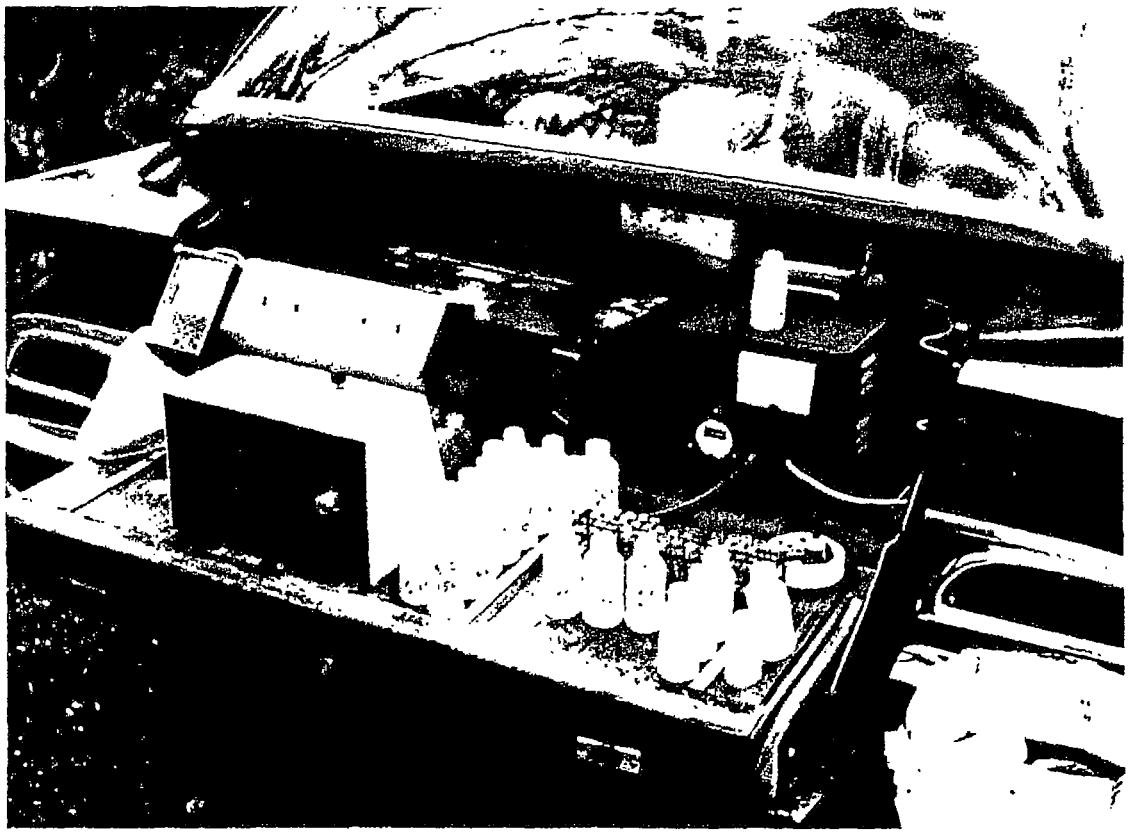

Figure 10.—Equipment for fluorometer testing of water samples in the field.

control the stage-discharge relation is important. The development of stage-discharge curves where more than one control is effective and the number of measurements is limited generally requires judgment in interpolating between measurements and in extrapolating beyond the highest measurements. This judgment is particularly necessary where the controls are not permanent and various discharge measurements represent different positions of the stage-discharge curve.

Stage-discharge relations are developed from a graphical analysis of the data plotted on either rectangular-coordinate or logarithmic plotting paper. A good analysis of the data requires a knowledge of the characteristics of the channel and a knowledge of open-channel hydraulics. The discharge measurements available for the analysis rarely define a unique stage-discharge relation because of changes in the channel during the period represented by the measurements. The determination of the proper shape of the rating curve and its position at various times requires considerable engineering knowledge, experience, and judgment. In general, a base stage-discharge relation is used, and deviations from this relation with time (shifts) are determined by consideration of the plotting of individual discharge measurements. These shifts, in the form of a stage adjustment, are then used with the base rating in computing the discharge record.

The stability of the stage-discharge relation governs the number of discharge measurements that are necessary to define the relation at any time. If the channel is stable, one measurement a month is generally sufficient; in sand-channel streams, three measurements a week may be required because of the random shifting of the stream channel.

Complex discharge ratings

If variable backwater or highly unsteady flow exists at a gaging station, the discharge rating cannot be described by stage alone.

Variable backwater may be caused by a tributary stream that enters the control reach downstream from the gage, by manipulation of gates at a dam, or by flow of water into and from overbank storage created by natural constrictions in the stream channel. The discharge under these conditions is a function of both stage and the slope of the energy gradient, which is approximated by the slope of the water surface between two stage gages. Stage-fall-discharge ratings are usually determined empirically from observations of (1) discharge, (2) stage at the base gage, and (3) the fall of the water surface between the base gage and an auxiliary stage gage downstream. The general procedures used in developing these ratings are described in book 3, chapter A9, of this series, by Carter and Davidian.[5]

If the flow is very unsteady, as in a tidal reach, the acceleration head governs the energy slope. Under this condition unsteady-flow equations must be used to describe the variation of discharge with time. This method is described by Davidian.[6]

A special type of unsteady flow is treated under the heading "Uniformly progressive flow" in Carter and Davidian.[5] For such flow the stage and rate of change of stage observed at a single gage are used to establish the discharge rating.

Computation and Preparation of Discharge Records

A continuous record of flow at a gaging station is computed from records of stage and the discharge rating for the station. The type of stage recorder used at the station determines whether the computations are done manually or by an electronic computer. In either system the engineer must study the data and prepare what is termed a station analysis before computations are performed.

Station analysis

A station analysis, which documents the result of the study of the data, is prepared for each station at the end of each water year. The study includes the following items:

1. A review of field surveys of gage datum and a determination of the datum corrections, if any, to be applied to gage readings taken during the year.
2. A review of discharge-measurement notes.
3. An analysis of the discharge rating and the determination of the rating (or shifts) applicable during each period of the year.
4. The preparation of tables which express the discharge rating.

Manual computations

If stage is recorded at the station on a strip-chart recorder, all computations are performed manually in the following order:

1. Determination and application of gage-height and time corrections to the gage-height chart.
2. Computation of the mean gage height for each day, or for shorter periods if the range in discharge during the day is large. Subdivision is necessary because of curvature in the discharge rating.
3. Computation of discharge for each period from mean values of stage and the discharge rating, including any shift corrections.
4. Computation of peak values of gage height and discharge.
5. Listing of the values of mean daily gage heights and discharge and momentary peaks.
6. Computation of mean flow for each month and the year in cubic feet per second and in inches.
7. Review and comparison of the record of discharge with that of nearby streams.

[5] Carter, R. W., and Davidian, Jacob, Discharge ratings at gaging stations: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. A9, unpub. data.

[6] Davidian, Jacob, Computation of discharge in tidal reaches: U.S. Geol. Survey Techniques Water-Resources Inv., unpub. data.

Automatic computations

If stage is recorded on a digital tape at the station, the computations just outlined are performed by an electronic computer. The input to the computer is the digital record of stage, with a list of any datum corrections, and the discharge rating, with a list of any necessary shift corrections. For stations at which the stage-fall-discharge type of rating is applicable, the digital-tape records of stage from both the primary and the auxiliary gages are furnished to the computer. In addition to the stage-discharge relation, supplementary information such as the stage-fall relation and the relation of fall ratio versus discharge ratio are supplied.

The output from the computer consists of two forms. The first includes a listing of the maximum, the minimum, and the mean gage height for each day, bihourly gage heights for each day, and the mean discharge for each day. The second form includes a listing of mean daily discharges and the monthly and yearly summaries in the same format as is used for publication. Besides being published, the daily discharges and yearly summaries are stored on magnetic tape. Corrections are made on the tape where necessary after the computed records are reviewed by engineering personnel in the district offices.

Publication of Records

Through September 30, 1960, the records of discharge of streams and contents of lakes or reservoirs were published in an annual series of Geological Survey water-supply papers entitled "Surface Water Supply of the United States." Each volume in the series covered an area whose boundaries coincided with those of certain natural drainage basins.

Beginning with the 1961 water year, streamflow records and related data have been released by the Geological Survey in annual reports on a State-boundary basis. These reports are prepared and released by the district offices soon after the close of the water year.

Daily discharges and annual summaries are also being published in water-supply papers at intervals of 5 years. The first series to be published covers the period 1961–65.

References

Benson, M. A., and Dalrymple, Tate, 1967, General field and office procedures for indirect measurements: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. A1, 30 p.

Bodhaine, G. L., 1968, Measurement of peak discharge at culverts by indirect methods: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. A3, 60 p.

Dalrymple, Tate, and Benson, M. A., 1967, Measurement of peak discharge by the slope-area method: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. A2, 12 p.

Hulsing, Harry, 1967, Measurement of peak discharge at dams by indirect methods: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. A5, 29 p.

Matthai, H. F., 1967, Measurement of peak discharge at width contractions by indirect methods: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. A4, 44 p.

☆ U.S. GOVERNMENT PRINTING OFFICE 1969 - 342-384 - 816/03979

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(Rev. May 1964)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

DISCHARGE MEASUREMENT NOTES

Meas. No. ....
Comp. by ....
Checked by ....

Sta. No. ....
....
Date ...., 19 ..... Party ....
Width .... Area .... Vel. .... G. H. .... Disch. ....
Method .... No. secs. .... G. H. change .... in .... hrs. Susp. ....
Method coef. .... Hor. angle coef. .... Susp. coef. .... Meter No. ....

GAGE READINGS				
Time		Recorder	Inside	Outside
Weighted M. G. H.				
G. H. correction				
Correct M. G. H.				

Date rated .... Used rating
for rod .... susp. Meter .... ft.
above bottom of wt. Tags checked ....
Spin before meas. .... after ....
Meas. plots ....% diff. from .... rating
Wading, cable, ice, boat, upstr., downstr., side
bridge .... feet, mile, above, below
gage, and ....
Check-bar, chain found .. ..
changed to .... at ....
Correct ....
Levels obtained ....

Measurement rated excellent (2%), good (5%), fair (8%), poor (over 8%), based on following conditions: Cross section ....
Flow .... Weather ....
Other .... Air .... °F@ ....
Gage .... Water .... °F@ ....
.... Record removed .... Intake flushed U L ....
Observer ....
....
Control ....
....
Remarks ....
....
....
G. H. of zero flow .... ft.

DISCHARGE MEASUREMENT NOTES - ICE COVER

....River, at..
Creek, near

Dist. from initial point	Width	Total depth of Water	W.S. to bot. ice	Effective depth	Depth of meter below water surface	Rev-olu-tions	Time in seconds	VELOCITY		Area	Discharge
								At point	Mean in vertical		

ATTACHMENT C-3

Roux Associates' Standard Operating Procedures

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to explain the quality control (QC) measures taken to ensure the integrity of the samples collected and to establish the guidelines for the collection of QC samples. The objective of the QC program is to ensure that water-quality data of known and reliable quality are developed.

Because valid water-chemistry data are integral to a hydrogeologic investigation that characterizes water-quality conditions, the data will be confirmed by QC samples. Without checks on the sampling and analytical procedures, the potential exists for contradictory or incorrect results. The acceptance of water-quality data by regulatory agencies and in litigation-support investigations depends heavily on the proper QC program to justify the results presented. The QC sampling requirements must be determined by the project manager and be clearly defined in the work plan. If data validation (for in-house purposes or for compliance with the United States Environmental Protection Agency [USEPA] regulations) is stipulated as part of the hydrogeologic investigation, QC sampling must be conducted.

2.0 QUALITY CONTROL SAMPLES

2.1 Samples taken for analysis of compounds require the use of quality control samples to monitor sampling activities and laboratory performance. Types of quality control samples may include replicate and/or replicate split, trip blank, field equipment blank, matrix spike and matrix spike duplicate, and fortification. A discussion pertaining to each quality control sample follows:

a. Replicate and Replicate Split - Replicate sample analysis is done to check on the reproducibility of results either within a laboratory or between laboratories. A replicate sample is called a split sample when it is collected with or turned over to a second party (e.g., regulatory agency, consulting firm) for an independent analysis. Replicate samples are aliquots (equal portions) from a sample in a common container.

To collect a replicate sample, water from the bailer or pump will be distributed first to fill one container and then to fill the second container. Adequate water should be available to fill the bottles completely before they are capped. If the water is insufficient to fill all the bottles at once, then incrementally fill each bottle with water from two or more bailer volumes or pump cycles.

For some test substances, water may have to be accumulated in a common container and then decanted slowly into the sample bottles. The work plan should be checked for a description of how replicate samples are to be collected. Additionally, in the case of wells that recover slowly and produce insufficient water to fill all the replicate sample containers, the

containers should be filled incrementally and kept on ice in the cooler in between filling periods.

b. Trip Blank - A trip blank sample is a sample bottle that is filled with "clean" (e.g., distilled/deionized) water in the laboratory, and travels unopened with the sample bottles. (The USEPA now uses the phrase "demonstrated analyte free water.") It is opened in the laboratory and analyzed along with the field samples for the constituent(s) of interest to detect if contamination has occurred during field handling, shipment, or in the laboratory. Trip blanks are primarily used to check for "artificial" contamination of the sample caused by airborne volatile organic compounds (VOCs) but may also be used to check for "artificial" contamination of the sample by a test substance or other analyte(s). One trip blank per cooler containing VOC samples, or test substance of other analyte(s) of interest would accompany each day's samples.

c. Field Equipment Blank - A field equipment blank (field blank) sample is collected to check on the sampling procedures implemented in the field. A field blank is made with "clean" (e.g., distilled/deionized/demonstrated analyte free) water by exposing it to sampling processes (i.e., the clean water must pass through the actual sampling equipment). For example, if samples are being collected with a bailer, the field blank would be made by pouring the clean water into a bailer which has been decontaminated and is ready for sampling, and then pouring from the bailer into the sample containers. If a metals equipment blank is to be made, and the water was filtered, then the sample must be filtered (i.e., exposed to the sampling process). One equipment blank would be incorporated into the sampling program for each day's collection of samples and analyzed for the identical suite of constituents as the sample. In some situations one equipment blank will be required for each type of sampling procedure (e.g., split-spoon, bailer, hand auger).

A special type of field blank may be needed where ambient air quality may be poor. This field blank sample would be taken to determine if airborne contaminants will interfere with constituent identification or quantification. This field blank sample is a sample bottle that is filled and sealed with "clean" (e.g., distilled/deionized/demonstrated analyte free) water in the analytical laboratory, and travels unopened with the sample bottles. It is opened in the field and exposed to the air at a location(s) to check for potential atmospheric interference(s). The field blank is resealed and shipped to the contract laboratory for analysis.

d. Matrix Spike and Matrix Spike Duplicate - Spikes of compounds (e.g., standard compound, test substance, etc.) may be added to samples in the laboratory to determine if the ground-water matrix is interfering with constituent identification or quantification, as well as a check for systematic errors and lack of sensitivity of analytical equipment. Samples

for spikes are collected in the identical manner as for standard analysis, and shipped to the laboratory for spiking. Matrix spike duplicate sample collection, and laboratory spiking and analysis is done to check on the reproducibility of matrix spike results.

e. Fortification - A fortification, which is performed in the field, is used to check on the laboratory's ability to recover the test substance (analyte) added as well as its stability between fortification and analysis.

A field fortification (spike) is prepared by filling the container(s) with field or distilled/deionized/demonstrated analyte free water (as specified by the laboratory) to a predetermined volume (as specified by the laboratory) and adding the spike (supplied by the laboratory). The predetermined volume of water is measured with a clean (decontaminated) graduated cylinder. Field spikes will be prepared following the collection, labeling, and sealing of nonspiked samples in a separate cooler. The spike is kept at a safe distance from the sampling point (e.g., in the hotel room).

2.2 The work plan must be referred to for details regarding the type of QC samples to be collected and the QC sample collection method.

3.0 PROCEDURE

3.1 Implement QC sampling as outlined above, depending on the type of QC sample(s) specified in the work plan.

3.2 Ensure unbiased handling and analysis of replicate and blank QC samples by concealing their identity by means of coding so that the analytical laboratory cannot determine which samples are included for QC purposes. Attempt to use a code that will not cause confusion if additional samples are collected or additional monitoring wells are installed. For example, if there are three existing monitoring wells (MW-1, 2 and 3), do not label the QC blank MW-4. If an additional monitoring well were installed, confusion could result.

3.3 Label matrix spike and field fortification (spike) QC samples so that the analytical laboratory knows which samples are to be spiked in the laboratory and which samples were fortified (spiked) in the field, respectively. In certain situations, the field fortification will be "blind" or undisclosed to the laboratory to independently verify their analytical ability.

3.4 Verify that each sample is placed in an individual "zip-lock" bag, wrapped with "bubble wrap," and placed in its appropriate container (holder) in the cooler, and that the cooler has sufficient ice (wet ice or blue packs) to preserve the samples for transportation to the analytical laboratory. Consult the site work plan to determine if a particular ice is specified as the preservative for transportation (e.g., the USEPA prefers the use of wet ice because they claim that blue ice will not hold the samples at 4° Centigrade/Celsius).

3.5 Document the QC samples on the appropriate field form and in the field notebook. On the chain-of-custody form, replicate and blank QC samples will be labeled using the codes (Number 3.2, above), and matrix spike and field fortification QC samples will be identified as such (Number 3.3, above).

3.6 Follow standard shipping procedures for samples (i.e., retain one copy of the chain-of-custody form, secure the cooler with sufficient packing tape and a custody seal, forward the samples via overnight [express] mail or hand deliver to the designated analytical laboratory preferably within 24 hours but no later than 48 hours after sampling). However, check the site work plan for information on the analyte(s), as some have to be analyzed immediately (e.g., CN).

END OF PROCEDURE

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide procedures and standards for record keeping and maintenance, for all field activities conducted by Roux Associates, Inc. (Roux Associates).

Strict quality assurance/quality control (QA/QC) is necessary to properly and accurately document and preserve all project-related information. Quality assurance is implemented to corroborate that quality control procedures are followed. Quality control provides a means to monitor investigation activities (e.g., sampling and laboratory performance) as a check on the quality of the data.

Valid data and information are integral to all aspects of Roux Associates' field activities. These aspects include, but are not necessarily limited to, activities that involve: drilling; sediment, sludge, and soil sampling (lithologic, and soil-quality and analysis); well construction and development; aquifer testing and analysis; water-quality sampling and analysis (surface water and ground water); free-product sampling and analysis; air-quality sampling and analysis; geophysical testing; demolition activities; waste removal operations; engineering installations; etc. The data will be confirmed by QA/QC methods established and set forth in the work plan/scope of work. Without checks on the field and analytical procedures, the potential exists for contradictory results, and associated incomplete or incorrect results from the interpretation of potentially questionable data.

Documentation will be entered in the field notebook and must be transcribed with extreme care, in a clear and concise manner, as the information recorded will become part of the permanent legal record. Because field notes are the legal record of site activities, they must be taken in a standard and consistent manner. If abbreviations are used, then they must first be spelled out for clarity (i.e., to avoid ambiguity and misunderstanding). All entries must be dated and initialed, and the time (military time) of the entry included. Field notebooks and forms must be assigned to an individual project and properly identified (i.e., client name, project number, location and name of site, individual recording information, dates, times, etc.). Change of possession of field notebooks or forms must be documented with the date and time, and initialed by both individuals. Following each day's entries, the field notebook or form must be photocopied in the event that the original documentation is lost or stolen. All field notebooks must have the company name and address legibly printed in indelible ink along with the message "If found, then please forward to Roux Associates, Inc. at the above address - REWARD OFFERED."

Information must be recorded while onsite because it may be difficult to recall details at a later date. Furthermore, information must be documented immediately as it provides unbiased information which will be used for writing the report when the field activities are completed. Project-related documentation is an irreplaceable, important record for other individuals who may become involved in the project, and provides the project

manager with a complete history of project-related activities. Written information must be accompanied by maps, sketches, and photographs where appropriate, especially if these supplemental sources of information assist in the documentation process. A new page must be used in the field notebook for each new day's entries (i.e., unused portions of a previous page must have an "X" placed through it). The end of the day's records must be initialed and dated.

As part of record keeping and QA/QC activities, state and federal regulatory agencies should be contacted to check if special or different protocols are required and/or if particular or unconventional methods are required for the given field activity. Thus, the record keeping and QA/QC activities implemented by Roux Associates are based on technically sound standard practices and incorporate Roux Associates own, extensive experience in conducting hydrogeologic field activities.

2.0 MATERIALS

In order to track investigation activities, specific materials are required. These materials include the following:

a. A bound, waterproof field notebook.

b. Appropriate Roux Associates' forms (e.g., daily log, geologic log, monitoring well construction log, well sampling data form, location sketch, chain of custody, telephone conversation record, meeting notes, etc.).

c. Appropriate labels (e.g., sample, Roux Associates' Custody Seal, etc.)

d. Work plan/scope of work.

e. Health and safety plan (HASP).

f. Appropriate Roux Associates' SOPs.

g. Black pens, and indelible markers.

h. Camera and film.

3.0 DOCUMENTATION

3.1 Before the Roux Associates personnel leave the field, they must ensure that their field notes include comprehensive descriptions of the hydrogeologic conditions, and all investigation-related activities and results (onsite and offsite). This will safeguard against the inability to reconstruct and comprehend all aspects of the field investigation after its completion, and will serve to facilitate the writing of an accurate report. Properly documented information provides the QA/QC tracking (back-up) required for all Roux Associates' projects. General types of information that must be recorded (where pertinent to the investigation being conducted) include, but may not necessarily be limited to, the following:

a. List of Roux Associates personnel on site.

b. Name, date, and time of arrival on site by Roux Associates personnel, including temporary departures from, and returns to, the site during the work day.

c. Client and project number.

d. Name and location of study area.

e. Date and time of arrival on site by non-Roux Associates personnel (names and affiliation) and equipment (e.g., subcontractors and facility personnel, and drilling equipment, respectively, etc.), including temporary departures from, and returns to, the site during the work day, and departure at the end of the work day.

f. List of non-Roux Associates personnel on site.

g. Weather conditions at the beginning of the day as well as any changes in weather that occur during the working day.

h. Health and safety procedures including level of protection, monitoring of vital signs, frequency of air monitoring, and any change (i.e., downgrade or upgrade) in the level of protection for Roux Associates and other on-site personnel (e.g., subcontractors, facility personnel, etc.).

i. Health and safety procedures not in compliance with the HASP (for all on-site personnel).

j. Site reconnaissance information (e.g., topographic features, geologic features, surface-water bodies, seeps, areas of apparent contamination, facility/plant structures, etc.).

k. Air monitoring results (i.e., photoionization detector [PID], etc. measurements).

l. Task designation and work progress.

m. Work-related and site-related discussions with subcontractors, regulatory agency personnel, plant personnel, the general public, and Roux Associates personnel.

n. Delays, unusual situations, problems and accidents.

o. Field work not conducted in accordance with the work plan/scope of work, and rationale and justification for any change(s) in field procedures including discussions with personnel regarding the change(s) and who authorized the change(s).

p. QA/QC procedures not conducted in accordance with the QA/QC procedures established in the work plan/scope of work and rationale and justification for any change(s) in QA/QC procedures including discussions with personnel regarding the change(s) and who authorized the change(s).

q. Equipment and instrument problems.

r. Decontamination and calibration procedures.

s. Activities in and around the site and work area by any and all on-site personnel which may impact field activities.

t. Sketches, maps, and/or photographs (with dates and times) of the site, structures, equipment, etc. that would facilitate explanations of site conditions.

u. Contamination evidenced as a result of work-related activities (e.g., visible contaminants [sheen] in drilling fluids or on drilling equipment; sheen on, or staining of, sediments; color of, or separate [nonaqueous] phase on, water from borehole or well; vapors or odors emanating from a borehole or well; etc.); make all observations as objectively as possible (e.g., grey-blue, oil-like sheen; black and orange, rust-like stain; fuel-like odor; etc.) and avoid using nontechnical or negative-sounding terms (e.g., slimy, goopy, foul-smelling).

v. Date and time of final departure from the site of all personnel at the end of the work day.

3.2 In addition to the general types of information that must be recorded (as presented in Section 3.1), task-specific information must also be properly documented. Task-specific information which is required is provided in each respective task-oriented SOP, and the documentation procedures outlined in each SOP must be followed.

END OF PROCEDURE

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish guidelines for sample handling which will allow consistent and accurate results. Valid chemistry data are integral to investigations that characterize media-quality conditions. Thus, this SOP is designed to ensure that once samples are collected, they are preserved, packed and delivered in a manner which will maintain sample integrity to as great an extent as possible. The procedures outlined are applicable to most sampling events and any required modifications must be clearly described in the work plan.

2.0 CONSIDERATIONS

Sample containers, sampling equipment decontamination, quality assurance/quality control (QA/QC), sample preservation, and sample handling are all components of this SOP.

2.1 Sample Containers

Prior to collection of a sample, considerations must be given to the type of container that will be used to store and transport the sample. The type and number of containers selected is usually based on factors such as sample matrix, potential contaminants to be encountered, analytical methods requested, and the laboratory's internal quality assurance requirements. In most cases, the overriding considerations will be the analytical methodology, or the state or federal regulatory requirements because these regulations generally encompass the other factors. The sample container selected is usually based on some combination of the following criteria:

a. Reactivity of Container Material with Sample

Choosing the proper composition of sample containers will help to ensure that the chemical and physical integrity of the sample is maintained. For sampling potentially hazardous material, glass is the recommended container type because it is chemically inert to most substances. Plastic containers are not recommended for most hazardous wastes because the potential exists for contaminants to adsorb to the surface of the plastic or for the plasticizer to leach into the sample.

In some instances, however, the sample characteristics or analytes of interest may dictate that plastic containers be used instead of glass. Because some metals species will adhere to the sides of the glass containers in an aqueous matrix, plastic bottles (e.g., nalgene) must be used for samples collected for metals analysis. A separate, plastic container should accompany glass containers if metals analysis is to be performed along with other analyses. Likewise, other sample characteristics may dictate that glass cannot be used. For example, in the

case of a strong alkali waste or hydrofluoric solution, plastic containers may be more suitable because glass containers may be etched by these compounds and create adsorptive sites on the container's surface.

b. Volume of the Container

The volume of sample to be collected will be dictated by the analysis being performed and the sample matrix. The laboratory must supply bottles of sufficient volume to perform the required analysis. In most cases, the methodology dictates the volume of sample material required to complete the analysis. However, individual laboratories may provide larger volume containers for various analytes to ensure sufficient quantities for duplicates or other QC checks.

To facilitate transfer of the sample from the sampler into the container and to minimize spillage and sample disturbance, wide-mouth containers are recommended. Aqueous volatile organic samples must be placed into 40-milliliter (ml) glass vials with polytetrafluoroethylene (PTFE) (e.g., TeflonTM) septums. Non-aqueous volatile organic samples should be collected in the same type of vials or in 4-ounce (oz) wide-mouth jars provided by the laboratory. These jars should have PTFE-lined screw caps.

c. Color of Container

Whenever possible, amber glass containers should be used to prevent photodegradation of the sample, except when samples are being collected for metals analysis. If amber containers are not available, then containers holding samples should be protected from light (i.e., place in cooler with ice immediately after filling).

d. Container Closures

Container closures must screw on and off the containers and form a leak-proof seal. Container caps must not be removed until the container is ready to be filled with the sample, and the container cap must be replaced (securely) immediately after filling it. Closures should be constructed of a material which is inert with respect to the sampled material, such as PTFE (e.g., TeflonTM). Alternately, the closure may be separated from the sample by a closure liner that is inert to the sample material such as PTFE sheeting. If soil or sediment samples are being collected, the threads of the container must be wiped clean with a dedicated paper towel or cloth so the cap can be threaded properly.

e. Decontamination of Sample Containers

Sample containers must be laboratory cleaned by the laboratory performing the analysis. The cleaning procedure is dictated by the specific analysis to be performed on the sample. Sample containers must be

carefully examined to ensure that all containers appear clean. Do not mistake the preservative as unwanted residue. The bottles should not be field cleaned. If there is any question regarding the integrity of the bottle, then the laboratory must be contacted immediately and the bottle(s) replaced.

f. Sample Bottle Storage and Transport

No matter where the sample bottles are, whether at the laboratory waiting to be packed for shipment or in the field waiting to be filled with sample, care must be taken to avoid contamination. Sample shuttles or coolers, and sample bottles must be stored and transported in clean environments. Sample bottles and clean sampling equipment must never be stored near solvents, gasoline, or other equipment that is a potential source of cross-contamination. When under chain of custody, sample bottles must be secured in locked vehicles, and custody sealed in shuttles or in the presence of authorized personnel. Information which documents that proper storage and transport procedures have been followed must be included in the field notebook and on appropriate field forms.

2.2 Decontamination of Sampling Equipment

Proper decontamination of all re-usable sampling equipment is critical for all sampling episodes. The SOP for Decontamination of Field Equipment and SOPs for method-specific or instrument-specific tasks must also be referred to for guidance for decontamination of various types of equipment.

2.3 Quality Assurance/Quality Control Samples

QA/QC samples are intended to provide control over the proper collection and tracking of environmental measurements, and subsequent review, interpretation and validation of generated analytical data. The SOPs for Collection of Quality Control Samples, for Evaluation and Validation of Data, and for Field Record Keeping and Quality Assurance/Quality Control must be referred to for detailed guidance regarding these respective procedures. SOPs for method-specific or instrument-specific tasks must also be referred to for guidance for QA/QC procedures.

2.4 Sample Preservation Requirements

Certain analytical methodologies for specific analytes require chemical additives in order to stabilize and maintain sample integrity. Generally, this is accomplished under the following two scenarios:

a. Sample bottles are preserved at the laboratory prior to shipment into the field.

b. Preservatives are added in the field immediately after the samples are collected.

Many laboratories provide pre-preserved bottles as a matter of convenience and to help ensure that samples will be preserved immediately upon collection. A problem associated with this method arises if not enough sample could be collected, resulting in too much preservative in the sample. More commonly encountered problems with this method include the possibility of insufficient preservative provided to achieve the desired pH level or the need for additional preservation due to chemical reactions caused by the addition of sample liquids to pre-preserved bottles. The use of pre-preserved bottles is acceptable; however, field sampling teams must always be prepared to add additional preservatives to samples if the aforementioned situations occur. Furthermore, care must be exercised not to overfill sample bottles containing preservatives to prevent the sample and preservative from spilling and therefore diluting the preservative (i.e., not having enough preservative for the volume of sample).

When samples are preserved after collection, special care must be taken. The transportation and handling of concentrated acids in the field requires additional preparation and adherence to appropriate preservation procedures. All preservation acids used in the field should be trace-metal or higher-grade.

2.5 Sample Handling

After the proper sample bottles have been received under chain-of-custody, properly decontaminated equipment has been used to collect the sample, and appropriate preservatives have been added to maintain sample integrity, the final step for the field personnel is checking the sample bottles prior to proper packing and delivery of the samples to the laboratory.

All samples should be organized and the labels checked for accuracy. The caps should be checked for tightness and any 40-ml volatile organic compound (VOC) bottles must be checked for bubbles. Each sample bottle must be placed in an individual "zip-lock" bag to protect the label, and placed on ice. The bottles must be carefully packed to prevent breakage during transport. When several bottles have been collected for an individual sample, they should not be placed adjacent to each other in the cooler to prevent possible breakage of all bottles for a given sample. If there are any samples which are known or suspected to be highly contaminated, these should be placed in an individual cooler under separate chain-of-custody to prevent possible cross contamination. Sufficient ice (wet or blue packs) should be placed in the cooler to maintain the temperature at 4 degrees Celsius (°C) until delivery at the laboratory. Consult the work plan to determine if a particular ice is specified as the preservation for transportation (e.g., the United States Environmental Protection Agency does not like the use of blue packs because they claim that the samples will not hold at 4°C). If additional coolers are required, then they should be purchased. The chain-of-custody form should be properly completed, placed in a "zip-lock" bag, and placed in the cooler. One copy must be maintained for the project files. The cooler should be sealed with packing tape and a custody seal. The custody seal number should be noted in the field book. Samples collected from Monday through Friday will be delivered to the laboratory within 24 hours of collection. If Saturday delivery is

not available, samples collected on Friday must be delivered by Monday morning. Check the work plan to determine if certain analytes require a shorter delivery time. If overnight mail is utilized, then the shipping bill must be maintained for the files and the laboratory must be called the following day to confirm receipt.

3.0 EQUIPMENT AND MATERIALS

3.1 General equipment and materials may include, but not necessarily be limited to, the following:

a. Sample bottles of proper size and type with labels.

b. Cooler with ice (wet or blue pack).

c. Field notebook, appropriate field form(s), chain-of-custody form(s), custody seals.

d. Black pen and indelible marker.

e. Packing tape, "bubble wrap", and "zip-lock" bags.

f. Overnight (express) mail forms and laboratory address.

g. Health and safety plan (HASP).

h. Work plan/scope of work.

i. Pertinent SOPs for specified tasks and their respective equipment and materials.

3.2 Preservatives for specific samples/analytes as specified by the laboratory. Preservatives must be stored in secure, spillproof glass containers with their content, concentration, and date of preparation and expiration clearly labeled.

3.3 Miscellaneous equipment and materials including, but not necessarily limited to, the following:

a. Graduated pipettes.

b. Pipette bulbs.

c. Litmus paper.

d. Glass stirring rods.

e. Protective goggles.

f. Disposable gloves.

g. Lab apron.

h. First aid kit.

i. Portable eye wash station.

j. Water supply for immediate flushing of spillage, if appropriate.

k. Shovel and container for immediate containerization of spillage-impacted soils, if appropriate.

4.0 PROCEDURE

4.1 Examine all bottles and verify that they are clean and of the proper type, number, and volume for the sampling to be conducted.

4.2 Label bottles carefully and clearly with project name and number, site location, sample identification, date, time, and the sampler's initials using an indelible marker.

4.3 Collect samples in the proper manner (refer to specific sampling SOPs).

4.4 Conduct preservation activities as required after each sample has been collected. Field preservation must be done immediately and must not be done later than 30 minutes after sample collection.

4.5 Conduct QC sampling, as required.

4.6 Seal each container carefully and place in an individual "zip lock" bag.

4.7 Organize and carefully pack all samples in the cooler immediately after collection (e.g., bubble wrap). Insulate samples so that breakage will not occur.

4.8 Complete and place the chain-of-custody form in the cooler after all samples have been collected. Maintain one copy for the project file. If the cooler is to be transferred several times prior to shipment or delivery to the laboratory, it may be easier to tape the chain-of-custody to the exterior of the sealed cooler. When exceptionally hazardous samples are known or suspected to be present, this should be identified on the chain-of-custody as a courtesy to the laboratory personnel.

4.9 Add additional ice as necessary to ensure that it will last until receipt by the laboratory.

4.10 Seal the cooler with packing tape and a custody seal. Record the number of the custody seal in the field notebook and on the field form. If there are any exceptionally hazardous samples, then shipping regulations should be examined to ensure that the sample containers and coolers are in compliance and properly labeled.

4.11 Samples collected from Monday through Friday will be delivered to the laboratory within 24 hours of collection. If Saturday delivery is not available,

samples collected on Friday must be delivered by Monday morning. Check the work plan to determine if certain analytes require a shorter delivery time.

4.12 Maintain the shipping bill for the project files if overnight mail is utilized and call the laboratory the following day to confirm receipt.

END OF PROCEDURE

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish guidelines for surface-water sampling. The specific procedure and equipment selection will be dependent upon the data objectives of the sampling program and must be identified in the work plan. The sampling procedure can range from one grab sample to multiple horizontal and vertical locations and should be carefully designed and fully described in the work plan/scope of work. This SOP presents an approach that will be required for most sampling events. Section 7.0 describes a more rigorous procedure for selecting sample locations which may be required in certain situations.

The objective of surface-water sampling is to collect samples which are representative of the entire surface-water body. Frequently this objective can be quite easy and routine such as one "grab" sample for a small stream or pond with uniform conditions. Other times, the nature of the site-specific conditions make collection of a representative sample more difficult. Consideration of such variables as flow velocity, turbulence, access, health and safety, water composition, tidal fluctuation, surface runoff, factory outfalls, tributaries, etc. is essential in the proper work plan design and sample collection procedures.

Surface-water bodies are constantly subjected to hydraulic forces and a changing environment which brings about variations in the chemical character of the water. Where flow is completely controlled by large storage reservoirs or is maintained at a nearly steady rate by large, constant ground-water inflows, a single sample or observation may suffice to characterize the quality for many days, weeks, or longer. Normally, however, one sample cannot be safely extrapolated for more than a day or two and for some streams not more than a few hours. Thus, the frequency of sampling is an important consideration for the sampling procedure.

Theoretically, a sample representing the overall composition of a surface-water body can be obtained by compositing several depth-integrated samples of equal volume taken at places with equal flow across the cross section. Due to the large number of samples which may be required, it is highly desirable to find a location in which the water composition is uniform with depth and cross section. Again, where uniform sections can be found, the sampling procedure may often be simplified to the extent that a single "grab" sample may be obtained that is representative of the surface-water body.

The United States Geological Survey (USGS) has long followed a practice of collecting samples once daily, as this appears to be the minimum frequency necessary to adequately define the water quality for the majority of water uses. Once-daily sampling has been considered as a standard for the usual comprehensive chemical-quality investigation for surface water. Less frequent sampling schedules are often used, however, and the value of weekly, monthly, or quarterly sampling in reconnaissance or unit basin studies should not be minimized. In general, a surface-water sampling schedule that, at a minimum,

coincides with the frequency of ground-water sampling allows for continuity over the sampling period.

2.0 CONSIDERATIONS

Collecting samples from surface-water bodies require special considerations regarding sampling location and general safety.

2.1 The location of a surface-water sampling point is the first consideration for a surface-water sampling program. The general sampling location will be selected based on the requirements of the investigation. The specific sampling location should be selected where flow and turbulence are uniform and access is favorable (i.e., a bridge or shallow section for a river or pond, respectively).

The sampling location should avoid tributaries, parking lot runoff, factory outfalls, and obstructions unless these inputs are of specific interest. Sampling from the boundaries of the surface-water body should generally be avoided, except where these regions are of direct interest. Sampling must proceed from downstream locations to upstream locations (unless site-specific conditions preclude this order) in order that disturbance related to sampling does not affect downstream sample quality. If sediment samples will be collected at the same locations as liquid samples, then the liquid samples must be collected first.

2.2 Health and safety is a key aspect of all sampling procedures and therefore must be addressed when selecting a sampling location. Therefore, the health and safety plan (HASP) must be referred to regarding the implementation of health and safety procedures (for compliance with the Occupational Safety and Health Administration [OSHA] and for general safety for sampling personnel). An USGS gauging station or a bridge are often the most desirable locations because they eliminate the need for entering the water body. If entering the water body is necessary, then the water velocity, depth, sediment type and uniformity, tidal stage, and water chemistry must be evaluated. If any potential hazard is identified, the sampler must use a safety harness and life jacket, and a buddy system must be employed. A vessel (e.g., raft, boat, etc.) may also be necessary to collect samples. Depending upon the geographic location and season, considerations such as water temperature, snakes, rats, ticks, etc. may be important. Thus, the site-specific HASP must address all possible contingencies and allow flexibility for revision if unanticipated conditions arise.

3.0 EQUIPMENT AND MATERIALS

In order to sample surface water, specific equipment and materials are required. The equipment and materials list may include, but not necessarily be limited to, the following:

a. A work plan which outlines sampling requirements.

b. A health and safety plan.

c. Decontamination supplies (including as necessary: non-phosphate, laboratory-grade detergent; bucket; brushes; distilled/deionized water; potable water; regulatory-required reagents [e.g., acetone, nitric acid, etc.]; aluminum foil; etc.).

d. Field notebook and field form(s).

e. Maps (topographic and road/county).

f. Cooler and ice (wet or blue packs).

g. Sample bottles (including as necessary: appropriate field blanks, trip blanks, duplicates, preservatives, extra bottles for breakage, proper size and type for analyte, labels, etc.).

h. Plastic sheeting.

i. Meters (including as necessary: pH, conductivity, turbidity, eH, dissolved oxygen, iron, manganese, etc.), thermometer, and calculator.

j. Calibration equipment/materials for all meters or devices.

k. Wading rod and current meter.

l. Sampler (including as necessary: laboratory sample bottles, bailer, pond sampler, weighted-bottle sampler, Wheaton dip sampler, Kemmerer depth sampler, Bacon Bomb sampler, etc.).

m. Disposable sampling gloves.

n. Health and safety equipment (including as necessary: proper level of protection [OSHA], rubber boots, hip waders, chest waders, safety harness, rope, life jacket, life preserver, air horn, two-way communication, etc.).

o. Measuring tape (100-foot, weighted).

p. Non-absorbent cord (e.g., polypropylene) to lower samplers.

q. Camera and film.

r. Filtering apparatus, filters, pre-filters.

s. Paper towels, clean rags.

t. Black pen and indelible marker.

u. Tools (e.g., screwdrivers, hammer, pliers, flashlight, pen knife, etc.)

v. Masking and packing tape.

w. Packing material (e.g., "bubble wrap") and "zip-lock" plastic bags.

x. Chain-of-custody form(s) and custody seals.

y. Overnight (express) mail forms.

4.0 DECONTAMINATION

Where possible, thoroughly pre-cleaned and wrapped sampling equipment should be used and dedicated to individual sampling locations. Disposable items such as cord, tubing, and gloves will be changed between each use and discarded in an appropriate manner. If a non-disposable item is to be reused during a sampling event, it will be thoroughly cleaned according to the field equipment decontamination SOP. Appropriate field, equipment and trip blanks will be collected as outlined in the work plan to demonstrate proper decontamination procedures.

5.0 CALIBRATION OF FIELD ANALYSIS EQUIPMENT

Calibrate field analysis equipment before use (e.g., thermometers, pH and conductivity meters, etc.). Refer to the specific SOPs for field analysis for each respective piece of equipment. Equipment such as current meters must have the manufacturer's manual maintained with the instrument and must be referred to for use, repair, maintenance, trouble-shooting, or calibration, if required. Document, and initial and date the calibration procedures on the appropriate field form, in the field notebook, and in the calibration log book.

6.0 PROCEDURE

6.1 Identify each location to be sampled based upon requirements of the work plan. If any of the considerations outlined in Section 2.0 impact the proposed sampling method, then contact the project manager to get authorization to modify as necessary.

6.2 Record the site and sample location, weather conditions, date, and time of the selected sampling point in the field notebook and on any field forms being used, and initial entry.

6.3 Describe the surface-water body characteristics including as pertinent: width (feet [ft]), depth (ft), flow (none, low, intermediate or flood; or measured velocity, if possible), turbidity (clear, turbid, very turbid), turbidity or flow variations across the surface-water body, tributary locations and distances, surface runoff impacts, and adjacent land use. A photograph of each sampling location should be included as part of the documentation.

6.4 Evaluate health and safety concerns and take appropriate measures to eliminate potential hazards.

6.5 Prepare sample containers for collection by organizing, labeling, and verifying proper preservation methods.

6.6 Ensure all sampling equipment has been thoroughly decontaminated and is operational.

6.7 Place plastic sheeting on ground to protect sampling materials from potential contamination.

6.8 Ensure all meters to be used are operational and have been calibrated.

6.9 Remove each appropriate container's cap only when ready to fill each with the water sample, and then replace and secure the cap immediately.

6.10 Collect the sample utilizing the selected sampling method and immediately place into pre-labeled, laboratory-supplied containers. Fill each appropriate, pre-labeled sample container carefully and cautiously to prevent: 1) agitating or creating turbulence; 2) breaking the container; 3) entry of, or contact with, any other medium; and 4) spilling/splashing the sample and exposing the sampling team to contaminated water. Immediately place the filled sample container in a ice-filled (wet ice or blue pack) cooler for storage. Check the work plan as to whether wet ice or blue packs are specified for cooling the samples because certain regulatory agencies may specify the use of one and not the other.

6.11 "Top-off" containers for volatile organic compounds (VOCs) and tightly seal with Teflon™-lined septums held in place by open-top screw caps to prevent volatilization. Ensure that no bubbles are present by turning the container upside down and tapping gently.

6.12 Filter water samples collected for dissolved metals analysis prior to preservation to remove the suspended sediment from the sample. If water samples are to be collected for total metals analysis, then collect a second set of samples without field filtering. Refer to the field filtering SOP for specific procedures.

6.13 Add the appropriate preservative to each container, if required, prior to, or after (preferred), the collection of the sample, unless the appropriate preservative(s) have already been added to the container(s) by the laboratory before shipment.

6.14 Collect quality control (QC) samples to monitor sampling and laboratory performance as required in the work plan. Refer to the SOP for collection of QC samples for a detailed discussion of proper methods.

6.15 Analyze samples for field parameters (e.g., temperature, pH, conductivity, turbidity, etc.) immediately after collecting samples for laboratory analysis. Whenever possible, sufficient volume should be collected in the initial sample to complete all laboratory and field parameters.

6.16 Verify that each sample is placed in an individual "zip-lock" bag, wrapped with "bubble wrap," and placed in its appropriate container in the cooler, and that the cooler has sufficient ice (wet ice or blue packs) to preserve the samples for transportation to the analytical laboratory.

6.17 Thoroughly clean bailers, hoses, and samplers as discussed in the field equipment decontamination SOP. Wrap decontaminated equipment with a suitable material (e.g., clean plastic bag or aluminum foil). Discard cords, rags, gloves, etc. in a manner consistent with accepted procedures.

6.18 Complete field forms, field notebook entries, and the chain of custody forms. Retain one copy of each chain-of-custody form. Secure the cooler with sufficient packing tape and a custody seal.

6.19 Samples collected from Monday through Friday will be delivered to the laboratory within 24 hours of collection. If Saturday delivery is not available, samples collected on Friday must be delivered by Monday morning. Check the work plan to determine if certain analytes require a shorter delivery time.

7.0 SELECTING SAMPLE LOCATIONS

In certain situations the work plan will require a more rigorous method to determine the number and location of surface-water samples. The following calculations may be used to determine where to sample and how many samples are to be collected:

a. Calculate the mixing length (L), using the following data:

stream velocity (u), in feet per second (ft/sec)

channel width (w), in feet (ft)

channel depth (d), in feet (ft)

with the equation:

$$L = \frac{2.6\,(u)(w^2)}{(d)}$$

$$L = \frac{2.6\,(\quad ft/sec)(\quad ft^2)}{(\quad ft)}$$

b. Respond to the following three questions:

1. Is the mixing length, L, less than 1 mile?

2. Is the mixing length less than the distance to the nearest upstream tributary?

3. Is the stream homogeneous in turbidity?

If all three answers are Yes, then collect only one sample at a depth of 1 foot.

If the answer to any of the above is No, then calculate the width of the mixed zone.

c. Calculate the width of the mixed zone (w) using the following data:

L = 5280 ft or the distance to the nearest upstream tributary (whichever is less)

d = depth, in ft

u = velocity, in ft/second (ft/sec)

with the equation:

$$w^2 = \frac{(L)(d)}{(2.6)(u)}$$

Collect samples at distances across the streams that are less than the mixed zone width, w.

END OF PROCEDURE

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish guidelines for the field filtration of ground-water samples for dissolved metals analysis prior to sample preservation. Filtering is implemented when the water sample contains suspended fine-grained materials (fines) that cannot be prohibited from entering the water sample by well development or well design. However, as fines are not always distinctly visible in the water sample, all water samples to be analyzed for dissolved metals will undergo filtration. Ground-water samples from bedrock formations to be analyzed for dissolved metals must also be filtered.

It should be noted that filtration of ground water for metals analysis has been a standard practice with the United States Geological Survey (USGS) for many years. However, it should also be noted that certain regulatory agencies insist that ground-water samples for metals analysis are not filtered. In this case, the analytical results are actually representative of total metals (i.e., dissolved and suspended). Nevertheless, in order to quantify the concentrations of dissolved metals in ground water, filtration will be employed.

Within this framework, filtration refers to the filtering of water either directly or at the end of a filtration series through a 0.45 micrometer (micron) membrane filter. The presence of a large quantity of fines may require the prefiltering of the sample with a larger-size membrane filter prior to the 0.45 micron filter to avoid clogging the 0.45 micron filter and using an exorbitant amount of time to filter the sample.

Filtration must be done as soon as possible after a water sample is collected, preferably at the same time that the water is produced. If there is a delay between the time that the water sample is collected and the time that filtration occurs, then the time lag and reason for the delay must be documented. The filtering equipment and membrane must be suitable for the intended analysis. Where permitted by regulatory agencies, disposable in-line filters and disposable funnel-type filters may be used. Depending upon the sampling needs, sterile disposable filtering devices may be preferable since they eliminate the need for field decontamination. Materials known to adversely affect the analytical procedure must not be used. The site sampling and analysis plan (SAP) must be referred to for these and other site specific filtration conditions.

In the event that surface water is being analyzed for dissolved metals, the filtration process described below is also used.

2.0 MATERIALS AND EQUIPMENT

To field filter ground-water samples, specific equipment and materials are required. The equipment and materials listed below may be needed in addition to the materials and equipment listed in various sampling SOPs.

a. Non-phosphate, laboratory-grade detergent.

b. Distilled/Deionized water.

c. Potable water.

d. Field forms (e.g., daily log, sampling, etc.) and field notebook.

e. Filtration apparatus (e.g., disposable plastic filtering apparatus, disposable in-line filters, Gelman apparatus, Buchner funnel, etc.), filters, prefilters.

f. Plasticware (e.g., premeasured buckets, beakers, flasks, funnels).

g. Teflon™ tape.

h. Vacuum pump (e.g., hand-operated or electric).

i. Appropriate tubing and fittings.

j. Disposable gloves.

k. Sample jars with appropriate preservative (e.g., nitric acid) and labels.

3.0 DECONTAMINATION

3.1 Decontamination is not necessary if sterile, disposable plastic filtering equipment is utilized. If applicable, it may be useful to collect a distilled water field blank through a representative disposable filter to demonstrate proper "decontamination." If reusable filtering equipment is being used, the following is the minimum decontamination procedure:

a. Wear disposable gloves while cleaning filtering equipment to avoid contamination and change gloves as needed.

b. Prepare a non-phosphate, laboratory-grade detergent solution and distilled or deionized water in a bucket.

c. Remove vacuum tubing from flask.

d. Remove filter membrane from funnel.

e. Disassemble filtering apparatus (flask and funnel) and scrub each piece of equipment with a brush and solution.

f. Rinse with potable water.

g. Rinse with copious amounts of distilled or deionized water.

h. Allow to dry and wrap equipment with a suitable material (e.g., clean plastic bag) in preparation for the next use.

3.2 The decontamination procedure must consider regulatory agency(ies) specifications which must be provided in the site SAP, and may include decontamination variations such as nitric acid rinses, acetone rinses, etc.

4.0 PROCEDURE

4.1. Ensure that the filtering equipment is disposable and dedicated or is properly decontaminated before each use.

4.2. Assemble the filtering apparatus (funnel and flask), and connect the vacuum pump in case it is needed to augment gravity filtration.

4.3. Place a clean (new) 0.45-micron pore-size filter in the funnel. Use larger, pore-size filters if prefiltering is required (i.e., if significant suspended sediment is present that would quickly clog the 0.45-micron filter and prevent continuous filtration or result in excessive time for filtration).

4.4. Obtain the water sample using an appropriate, decontaminated sample-collection device (e.g., bailer, pump).

4.5. Pass the unpreserved water sample through the 0.45 micron filter into the flask. If the sample contains significant sediment, then pass it through a prefilter before using the 0.45 micron filter. Apply a vacuum using the vacuum pump if needed to facilitate filtering.

4.6. Transfer the filtered water sample to the appropriate, prelabeled sample container containing the preservative (e.g., nitric acid) being careful not to overfill the container and dilute the preservative.

4.7. Follow standard operating procedures for sample documentation, shipping, and tracking (i.e., record keeping).

4.8. Decontaminate all reusable filtering (and sampling) equipment that came in contact with the water sample. Properly disposal of all non-reusable equipment in a manner appropriate with site conditions.

END OF PROCEDURE

Date: May 5, 2000

1.0 PURPOSE

The purpose for this standard operating procedure (SOP) is to establish the guidelines for decontamination of all field equipment potentially exposed to contamination during drilling, and soil and water sampling. The objective of decontamination is to ensure that all drilling, and soil-sampling and water-sampling equipment is decontaminated (free of potential contaminants): 1) prior to being brought onsite to avoid the introduction of potential contaminants to the site; 2) between drilling and sampling events/activities onsite to eliminate the potential for cross-contamination between boreholes and/or wells; and 3) prior to the removal of equipment from the site to prevent the transportation of potentially contaminated equipment offsite.

In considering decontamination procedures, state and federal regulatory agency requirements must be considered because of potential variability between state and federal requirements and because of variability in the requirements of individual states. Decontamination procedures must be in compliance with state and/or federal protocols in order that regulatory agency(ies) scrutiny of the procedures and data collected do not result in non acceptance (invalidation) of the work undertaken and data collected.

2.0 PROCEDURE FOR DRILLING EQUIPMENT

The following is a minimum decontamination procedure for drilling equipment. Drilling equipment decontamination procedures, especially any variation from the method itemized below, will be documented on an appropriate field form or in the field notebook.

2.1 The rig and all associated equipment should be properly decontaminated by the contractor before arriving at the test site.

2.2 The augers, drilling casings, rods, samplers, tools, rig, and any piece of equipment that can come in contact (directly or indirectly) with the soil, will be steam cleaned onsite prior to set up for drilling to ensure proper decontamination.

2.3 The same steam cleaning procedures will be followed between boreholes (at a fixed on-site location[s], if appropriate) and before leaving the site at the end of the study.

2.4 All on-site steam cleaning (decontamination) activities will be monitored and documented by a member(s) of the staff of Roux Associates, Inc.

2.5 If drilling activities are conducted in the presence of thick, sticky oils (e.g., PCBs) which coat drilling equipment, then special decontamination procedures may have to be utilized before steam cleaning (e.g., hexane scrub and wash).

2.6 Containment of decontamination fluids may be necessary (e.g., rinseate from steam cleaning) or will be required (e.g., hexane), and disposal must be in accordance with state and/or federal procedures.

3.0 PROCEDURE FOR SOIL-SAMPLING EQUIPMENT

The following is a minimum decontamination procedure for soil-sampling equipment (e.g., split spoons, stainless-steel spatulas). Soil-sampling equipment decontamination procedures, especially any variation from the method itemized below, will be documented on an appropriate field form or in the field notebook.

3.1 Wear disposable gloves while cleaning equipment to avoid cross-contamination and change gloves as needed.

3.2 Steam clean the sampler or rinse with potable water. If soil-sampling activities are conducted in the presence of thick, sticky oils (e.g., PCBs) which coat sampling equipment, then special decontamination procedures may have to be utilized before steam cleaning and washing in detergent solution (e.g., hexane scrub and wash).

3.3 Prepare a non-phosphate, laboratory-grade detergent solution and distilled or potable water in a clean bucket.

3.4 Disassemble the sampler, as necessary and immerse all parts and other sampling equipment in the solution.

3.5 Scrub all equipment in the bucket with a brush to remove any adhering particles.

3.6 Rinse all equipment with copious amounts of potable water followed by distilled or deionized water.

3.7 Place clean equipment on a clean plastic sheet (e.g., polyethylene)

3.8 Reassemble the cleaned sampler, as necessary.

3.9 Transfer the sampler to the driller (or helper) making sure that this individual is also wearing clean gloves, or wrap the equipment with a suitable material (e.g., plastic bag, aluminum foil.

As part of the decontamination procedure for soil-sampling equipment, state and/or federal protocols must be considered. These may require procedures above those specified as minimum for Roux Associates, Inc., such as the use of nitric acid, acetone, etc. Furthermore, the containment and proper disposal of decontamination fluids must be considered with respect to regulatory agency(ies) requirements.

4.0 PROCEDURE FOR WATER-SAMPLING EQUIPMENT

The following is a decontamination procedure for water-sampling equipment (e.g., bailers, pumps). Water-sampling equipment decontamination procedures, especially any variation from the method itemized below, will be documented on an appropriate field form or in the field notebook.

4.1 Decontamination procedures for bailers follow:

a. Wear disposable gloves while cleaning bailer to avoid cross-contamination and change gloves as needed.

b. Prepare a non-phosphate, laboratory-grade detergent solution and potable water in a bucket.

c. Disassemble bailer (if applicable) and discard cord in an appropriate manner, and scrub each part of the bailer with a brush and solution.

d. Rinse with potable water and reassemble bailer.

e. Rinse with copious amounts of distilled or deionized water.

f. Air dry.

g. Wrap equipment with a suitable material (e.g., clean plastic bag, aluminum foil).

h. Rinse bailer at least three times with distilled or deionized water before use.

4.2 Decontamination procedures for pumps follow:

a. Wear disposable gloves while cleaning pump to avoid cross-contamination and change gloves as needed.

b. Prepare a non-phosphate, laboratory-grade detergent solution and potable water in a clean bucket, clean garbage can, or clean 55-gallon drum.

c. Flush the pump and discharge hose (if not disposable) with the detergent solution, and discard disposable tubing and/or cord in an appropriate manner.

d. Flush the pump and discharge hose (if not disposable) with potable water.

e. Place the pump on clear plastic sheeting.

f. Wipe any pump-related equipment (e.g., electrical lines, cables, discharge hose) that entered the well with a clean cloth and detergent solution, and rinse or wipe with a clean cloth and potable water.

g. Air dry.

h. Wrap equipment with a suitable material (e.g., clean plastic bag).

As part of the decontamination procedure for water-sampling equipment, state and/or federal protocols must be considered. These may require procedures above those specified as minimum for Roux Associates, Inc., such as the use of nitric acid, acetone, etc. Furthermore, the containment and proper disposal of decontamination fluids must be considered with respect to regulatory agency(ies) requirements.

APPENDIX D

Health and Safety Plan

DRAFT

HEALTH AND SAFETY PLAN

Surafce Water Monitoring
Industri-Plex Superfund Site Operable Unit 2
(including Operable Unit 3 of the Wells G&H Superfund Site)
Woburn, Massachusetts

Prepared by:

ROUX ASSOCIATES, INC.
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January 23, 2009

Roux Associates Inc.
Approvals:

Project Manager: _____ Signature _____ 1/23/09 Date

Office Health and Safety Manager: _____ Signature _____ 1/23/09 Date

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1.0 INTRODUCTION

Pursuant to the Remedial Design/Remedial Action (RD/RA) Statement of Work (SOW) for Operable Unit 2 (OU 2) at the Industri-Plex Superfund Site (including Operable Unit 3 of the Wells G&H Superfund Site) in Woburn, Massachusetts (hereinafter, "Industri-Plex OU 2"), and on behalf of Pharmacia Corporation by its Attorney-in-Fact Monsanto Company and Stauffer Management Company LLC as litigation agent for Bayer CropScience Inc. (Settling Defendants), this Health and Safety Plan (HASP) has been prepared to identify the procedures, responsibilities, and training necessary to protect the health and safety of on-site personnel during implementation of the Surface Water Monitoring Plan (SWMP). The HASP was prepared in accordance with Attachment A of the RD/RA SOW, the Occupational Safety and Health Administration's (OSHA's) Hazardous Waste Operations and Emergency Response standard (29 CFR 1910.120), the National Institute for Occupational Safety and Health's (NIOSH's) Occupation Safety and Health Guidance Manual for Hazardous Waste Site Activities, and Roux Associates' corporate standard operating procedures for health and safety. Compliance with this HASP is required for all Roux Associates employees and subcontractors, as well as any authorized third-party personnel who enter work zones associated with the SWMP.

Applicability

This HASP is applicable only to the activities described in Section 3.0. It may undergo revision as site conditions change and/or based upon additional information made available. Any proposed changes must be reviewed and approved by Roux Associates' local Office Health and Safety Manager (OHSM) or his/her designee.

Roles and Responsibilities

Roux Associates' Project Manager is ultimately responsible for the performance of all SWMP-related tasks at Industri-Plex OU 2, including health and safety. The Project Manager is responsible for ensuring that an adequate number of field copies of this HASP are produced for field use, and that a duplicate office copy of this HASP is placed in the central project files. The Project Manager is also responsible for ensuring that all field team members have reviewed and signed off on the HASP and that current training certificates, medical clearance, and medical data sheets are on file for all field team members. Mr. Lawrence McTiernan has been designated Roux Associates' Project Manager for implementation of the SWMP.

The day-to-day management of health and safety issues for the SWMP is the responsibility of the designated Site Health and Safety Officer (SHSO). The SHSO's responsibilities include ensuring compliance with this HASP, determination of the appropriate level(s) of personnel protection (e.g., Level C), and coordination of emergency response if required. The SHSO also has stop-work authorization, which he or she will execute upon determination that an imminent safety hazard, emergency situation, or other potentially dangerous situation (such as detrimental weather conditions) exists. Authorization to proceed with work following a stop-work order will be issued by the SHSO in consultation with the Project Manager and the OHSM. Mr. James Dick has been designated Roux Associates' SHSO for implementation of the SWMP.

The OHSM serves to ensure that the policies and procedures of the HASP are implemented by the SHSO and provides guidance regarding the appropriate monitoring and safety equipment and other resources necessary in implementing the HASP. The OHSM also ensures that all Roux Associates personnel designated to work at Industri-Plex OU 2 are qualified according to applicable OSHA and state requirements. Mr. Mitchell Wiest currently serves as OHSM for Roux Associates' local (Burlington, Massachusetts) office.

All field team members are responsible for understanding and complying with this HASP and for reporting unsafe or hazardous conditions to the SHSO. If an unsafe or hazardous condition is perceived by a field team member, he/she has the authority to temporarily stop work pending consultation with the SHSO, OHSM, and/or Project Manager.

Training

All personnel who will perform work in areas of Industri-Plex OU 2 where the potential for toxic exposure exists will be health-and-safety trained prior to performing work onsite in accordance with 29 CFR 1910.120(e). Training records for all Roux Associates' field personnel will be maintained in Roux Associates' health and safety files. Training records for all subcontractor personnel must be provided to the Project Manager or SHSO prior to commencement of field activities; copies of these records will be maintained in Roux Associates' project files.

The SHSO will also provide the field team members with pre-activity training that will specifically address the activities to be performed during implementation of the SWMP, along with associated procedures and equipment. The training will include an overview of the

Industri-Plex OU 2 layout and history, hazards associated with the SWMP activities, and emergency services available in the various SWMP work areas. Pre-activity training will also reference provisions contained within this HASP. This training will allow field team members to obtain clarification for anything they do not understand and to reinforce their responsibilities regarding safety and procedures for their particular activities.

The SHSO will also provide daily safety briefings (i.e., tailgate meetings) to further assist field team members in conducting their activities safely, particularly when new operations are to be conducted and whenever changes in work practices must be implemented due to new information made available. A copy of Roux Associates' Daily Tailgate Health and Safety Meeting Log/Daily Site Safety Checklist, which will be used to document the daily safety briefings, is provided in Attachment D-1. All completed forms will become a permanent part of the project record.

Medical Clearance

All field team members must take part in a medical monitoring program pursuant to 29 CFR 1910.120(f) and must have received medical clearance to perform the planned activities. Proof of medical clearance for all Roux Associates' field personnel will be maintained in Roux Associates' health and safety files. Medical clearance for all subcontractor personnel must be provided to the Project Manager or SHSO prior to commencement of field activities; copies of these records will be maintained in Roux Associates' project files.

Record Keeping Requirements

Record keeping requirements mandated by 29 CFR 1910.120 will be strictly followed. Specifically, all Roux Associates personnel training records and medical examination records will be maintained by Roux Associates for a period of at least 30 years after the employment termination date of each employee. Any incident reports required during implementation of the SWMP will be maintained in Roux Associates' health and safety files for at least 30 years following the termination date of each employee involved in the incident(s), as well as in the project files. In addition, the SHSO will maintain a daily written log of health and safety monitoring activities, and monitoring results will become part of the project records.

2.0 DESCRIPTION AND HISTORY OF INDUSTRI-PLEX SITE

The Industri-Plex Site is a 245 (+/-) acre area, located about 10 miles northwest of Boston, Massachusetts in the north part of Woburn, within the Aberjona River Valley. It is bounded on the east side by Interstate 93, and Interstate 95/State Route 128 is located about one half mile south of the Site. The Boston Edison Power Company right-of-way No. 9 is the southwest boundary of the Site, while the Massachusetts Bay Transportation Authority (MBTA) railway transects roughly the western third of the Site in a northwest-southeast direction. The location of Industri-Plex Site is shown in Figure D-1.

Chemical manufacturing operations occurred at the Industri-Plex Site from 1853 to 1931, producing sulfuric acid and related chemicals, arsenic insecticides, acetic acid, dry colors, phenol, benzene, picric acid, toluene and trinitrotoluene (TNT). By 1929, the Merrimac Chemical Company, which occupied the Industri-Plex Site, had become one of the leading producers of insecticides and other chemicals in the United States. The Merrimac Chemical Company plant included 90 buildings on 417 acres, many of which were within the current Industri-Plex Site. Early operations included disposal of wastes in pits or low-lying wetlands. Liquid wastes were discharged into streams and later sewers. As a result, heavy metal wastes from the chemical operations contaminated soils and wetland sediments at the Industri-Plex Site.

From 1934 to 1969, the property was used by several companies to manufacture glues and gelatins from animal hides. Raw, salted or limed hides, hide fleshings, or chrome tanned leather scraps from cattle, hogs, sheep or other animals were used to manufacture glue by extracting a protein called collagen from animal tissues or bones. Animal hide waste products from the rendering process were disposed of in mounds or hide piles on-site. A developer purchased the plant property in the early 1970s intending to build a complex of industrial buildings (hence Industri-Plex) and began grading operations. During hide pile excavation, noxious gases and odors, attributable to the decomposing hide wastes, were released. The distinctive odor became known as the "Woburn odor." Complaints from local residents and encroachment on wetland areas stopped further development.

In 1981, the EPA proposed the Industri-Plex Site for the National Priorities List (NPL), also known as Superfund. The Industri-Plex Site was finalized on the NPL in 1983. In May 1982, EPA and the Massachusetts Department of Environmental Quality Engineering [DEQE –

currently known as the Massachusetts Department of Environmental Protection (MassDEP)] entered into a Consent Order with Stauffer Chemical Company to undertake a Remedial Investigation/Feasibility Study (RI/FS). In April 1985, Phase II of the RI/FS was completed. The Remedial Investigation identified arsenic, lead, and chromium in soils and wetland sediments at the Industri-Plex Site as well as impacts to the ground water and odors due to hydrogen sulfide and methyl mercaptans emitted from the hide piles. Abandoned buildings and waste lagoons were also present. Based on the RI/FS, EPA, along with MassDEP, established a Record of Decision (ROD) in 1986 for the first phase of the cleanup at the Industri-Plex Site (known as Operable Unit 1, OU-1), which included a protective cover over more than 100 acres of soil contaminated with heavy metals and animal wastes, a gas collection and treatment system, institutional controls, an interim groundwater remedy, as well as further investigations of related contamination at and downstream of the Industri-Plex Site to support a future second phase (known as Operable Unit 2, OU-2). OU 1 cleanup was substantially completed by June 1996.

The additional investigations performed at and downstream of the Industri-Plex Site pursuant to the 1986 ROD demonstrated that arsenic, benzene, and ammonia are present in surface water and/or sediment in the Halls Brook Holding Area (HBHA) Pond, located just south of the Industri-Plex Site boundary, as a result of the discharge of contaminated groundwater into the pond. Arsenic is also present in sediments in the Wells G&H Site wetlands and the Cranberry Bog Conservation Area, located further south of the Industri-Plex Site (see Figure D-1). Consequently, in January 2006, EPA and MassDEP established a ROD for Industri-Plex OU 2, which comprises all of Industri-Plex OU 1 as well as the downstream Wells G&H Site Wetlands and the Cranberry Bog Conservation Area (see Figure D-2). The OU 2 ROD includes the following major components:

- dredging and off-site disposal of contaminated sediments in the southern portion of the HBHA Pond and dredging and off-site disposal of contaminated near-shore sediments at the Wells G&H Wetland and Cranberry Bog Conservation Area
- use of the northern portion of the HBHA Pond as a sediment retention area that will intercept contaminated groundwater plumes and minimize downstream migration of contaminants
- if necessary, in-situ enhanced bioremediation of contaminated groundwater plumes at the West Hide Pile

- construction of an impermeable cap to line the New Boston Street Drainway and prevent discharge of contaminated groundwater plumes and downstream migration of contaminants
- construction of a permeable cap at the northern end of the HBHA Pond to prevent contaminated soil erosion and downstream migration of contaminants
- institutional controls
- construction of compensatory wetlands
- long-term monitoring of ground water, surface water, and sediments

Pre-design investigations will be conducted concurrently with surface water monitoring activities to support the design of the Industri-Plex OU 2 remedy.

3.0 SCOPE OF WORK

SWMP activities planned at this time and covered by this HASP include the following:

Establishment of Surface Water Monitoring Stations – Automated monitoring equipment will be installed at a number of surface water monitoring stations throughout and downstream of Industri-Plex OU 2 (see Figures D-3 and D-4). This activity will also involve refurbishing of existing security enclosures and conduit used during previous monitoring activities.

Stage-Response Evaluation – This activity will entail surveying of stream profiles and manual measurement of stream flow at each of the aforementioned surface water monitoring stations. Both of these activities will involve wading into surface water bodies.

Surface Water Monitoring and Sampling – Surface water samples will be collected at the various surface water monitoring stations at and downstream of Industri-Plex OU 2. Some sampling will be conducted using automated equipment, but much of the sampling will be performed manually in-stream.

Operation and Maintenance (O&M) Activities – O&M activities will be periodically conducted at the various surface water monitoring stations, requiring some amount of wading into surface water bodies.

Over time, Roux Associates may be tasked to perform additional activities at Industri-Plex OU 2. Health and safety hazards associated with such additional activities must be evaluated to determine if this HASP would cover those activities. In addition, personnel performing SWMP field activities must also be cognizant of other remedial activities potentially being conducted at Industri-Plex OU 2 concurrently with implementation of the SWMP. Additional chemical or physical hazards may be associated with these activities that are not covered by this HASP. Therefore, at a minimum, personnel performing SWMP field activities must communicate with those performing other activities, including the applicable SHSO. If necessary, SWMP personnel may be required to read and comply with the requirements of the HASP associated with the concurrent activities.

4.0 HAZARD ASSESSMENT

This section identifies the chemical, physical, and biological hazards that are associated with the activities listed in Section 3.0.

4.1 Chemical Hazards

Chemical hazards associated with SWMP activities include the potential for exposure to contaminated surface water and sediment. Arsenic, benzene, and ammonia are the principal contaminants of concern in surface water at Industri-Plex OU 2, while arsenic is the principal contaminant in sediment. These contaminants may pose a potential exposure hazard through ingestion, skin absorption, eye contact, or a combination of these routes. Pertinent physical, chemical, and toxicological information regarding the contaminants of concern is provided in Attachment D-2.

4.2 Physical Hazards

There are a variety of potential physical hazards associated with the activities to be conducted during implementation of the SWMP. Paramount among these is the potential for drowning due to the amount of work requiring entry into surface water bodies. Although surface water depths at most of the SWMP monitoring stations are less than two feet on most occasions, greater depths are possible during the spring months and following storms and prolonged periods of precipitation. Moreover, drowning can occur even in shallow water, for example if a person becomes unconscious or otherwise incapacitated.

Additional potential physical hazards associated with the activities to be performed during implementation of the SWMP are identified below.

- Hazards associated with the working environment
  - Heat/Cold Stress – Heat- and cold-related stresses are potential hazards for SWMP fieldwork, particularly as many of the SWMP activities include work in and around water, which could hasten the onset of cold-stress conditions.
  - Noise – Loud noises could be generated by the equipment and power tools that will be employed during preliminary SWMP activities.
  - Inclement Weather – Wet weather and icy conditions increase the risk of slips, trips, and falls, particularly when working on uneven terrain such as stream banks.

- Hazards which could cause injurious contact
  - Vehicular Traffic – Some SWMP activities will be conducted adjacent to city streets, such that there is risk of injury to field personnel from moving vehicles.
  - Active Railroad Tracks – Some SWMP activities will be conducted adjacent to an active commuter rail line, such that there is risk of injury to field personnel from moving trains.
  - Hand Tools – Hand tools will be employed during preliminary SWMP activities. Field personnel can be cut or struck by hand tools such as saws and hammers, which may also generate airborne debris.
  - Electrical Hazards – Portable pumps, generators, and other power tools that may be used during portions of the SWMP represent electrical hazards.
  - Punctures –Sharp and/or rusty objects, such as broken glass and nails, are common along stream banks in urban and suburban areas such as at and downstream of Industri-Plex OU 2.
- Overexertion
  - Some SWMP activities involve lifting of heavy objects and/or repetitive motions.
- Slips, Trips, Falls
  - SWMP fieldwork involves traversing uneven and slippery terrain, which represent significant slip, trip, and fall hazards.

4.3 Biological Hazards

Potential biological hazards include exposure to

- poison ivy, poison oak, and poison sumac, which may be present along the stream banks at and downstream of Industri-Plex OU 2;
- ticks, bees, and wasps;
- snapping turtles;
- potentially poisonous snakes and potentially rabid, stray, or wild animals.

5.0 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) used during the performance of SWMP activities will be commensurate with the potential level of exposure to toxins and/or other hazards. The nature of chemical contamination at Industri-Plex OU 2 and downstream areas has been well characterized over many years of assessment, and based on this high level of characterization, the potential for chemical exposures during the performance of SWMP activities is expected to be negligible. Similarly, the potential for explosive or oxygen-deficient atmospheres is negligible. Therefore, the minimum PPE required for SWMP activities includes only the following:

- full-length pants and long-sleeved clothing, or coveralls
- high-top leather or rubber boots

Additional PPE will be worn under certain circumstances to protect against increased potential for chemical and physical hazards. The additional PPE and the circumstances under which it must be worn include:

- nitrile gloves, whenever samples are being collected;
- leather gloves, whenever hand tools are being used;
- cut-resistant gloves, whenever knives and other sharp instruments are being used or when handling glassware;
- a hard hat, whenever overhead hazards exist;
- steel-toed boots, whenever the potential exists to drop heavy objects on one's foot;
- a U.S. Coast Guard (USCG)-approved personal flotation device (PFD),[1] whenever wading in water greater than two feet deep is required;
- hearing protection, whenever ambient noise levels exceed 85 decibels (i.e., whenever one must raise their voice to be heard at close distances);
- safety glasses or splash shields, whenever liquid samples are being handled, when wading in surface water bodies, when traversing wooded areas, and whenever airborne debris may be generated;
- high-visibility clothing (e.g., fluorescent vest), whenever working near roadways/other areas with potential traffic hazards or near the Massachusetts Bay Transportation Authority (MBTA) commuter rail line.

Additional PPE may be required on an activity- or location-specific basis, as determined by the SHSO, or if required by third-party property owners (particularly the MBTA).

[1] PFDs must be labeled Type 1 PFD, Type II PFD, Type III PFD, or shall be a USCG-approved Type V PFD that is marked or labeled for use as a work vest for commercial use or for use on vessels.

6.0 SITE CONTROL

This section describes the establishment of work zones, communications practices, and safe work practices for the protection of site workers and the general public.

6.1 Work Zones

The establishment of specific work zones (e.g., exclusion zone, contamination reduction zone, and support zone) is typically required at hazardous waste sites to prevent undue chemical exposure to other site workers and visitors and to prevent or minimize the spread of contamination. However, since the potential for chemical exposures and the spread of contamination is expected to be minimal during implementation of the SWMP, a three-zone approach to field operations will not be adopted during performance of SWMP activities. Rather, during performance of field activities, Roux Associates will temporarily demarcate a general "work zone" around the various surface water monitoring stations using cones or high-visibility flagging tape to prevent unauthorized access. Regardless of the low potential for chemical exposures, limitation of third-party access to work zones is necessary due to the presence of potential physical hazards.

6.2 Communications

Prior to the commencement of SWMP field activities, emergency signals (e.g., air horn, car horn, etc.) and/or hand signals and their meanings (e.g., stop work, evacuate) will be specified and communicated to all field team members. All Roux Associates personnel will be equipped with cellular telephones for communication with emergency support services/facilities. In addition, the location of the nearest public telephone will be identified and communicated to all field team members prior to the start of field activities.

6.3 Safe Work Practices

Safe work practices necessary to minimize or eliminate the potential chemical, physical, and biological hazards associated with activities to be performed during implementation of the SWMP are listed below.

- Chemical Hazards
  - Potential chemical exposures will be controlled through the use of personal protective equipment (PPE) and minimization of exposure to chemical contaminants.

- Physical hazards
  - To minimize the potential for drowning, under no circumstances shall a Roux Associates or subcontractor employee wade into a surface water body at any time when depths are greater than two feet (as preliminarily indicated by visual observation), unless he or she is wearing a Coast Guard-approved PFD, is tied off securely to the bank, and is accompanied by a spotter onshore with a working cell phone. Moreover, all personnel entering surface water bodies less than two feet deep shall be either tied off to the bank or accompanied by a spotter onshore with a working cell phone, unless such personnel will at no time be greater than five feet from shore.
  - Protection against heat and cold stress must be implemented when warranted, particularly as many of the SWMP activities include work in and around water and could hasten the onset of cold-stress conditions. Heat stress and cold stress symptoms, prevention, and treatment are described in Attachment D-3.
  - High noise operations (i.e., greater than 85 decibels) will be evaluated by the SHSO. Noise exposure will be controlled through the use of hearing protection such as ear plugs or ear muffs or by maintaining set-backs from high noise equipment.
  - The SHSO will determine when a work stoppage is required due to conditions caused by inclement weather.
  - High visibility clothing is required at all times in high-traffic areas, and company or personal vehicles should be used to block traffic. In addition, cones, caution tape, signage, and/or fencing should be deployed to ensure safety in high traffic areas. High visibility clothing must also be worn whenever working near the MBTA commuter rail line.[2]
  - Power tools require proper grounding and/or a ground fault circuit interrupter (GFCI) during operation.
  - Field team members should always be on the lookout for sharp/rusty objects, broken glass, and nails. High-top work boots are required at all times in SWMP work areas.
  - Employees will wear safety glasses, goggles, or face shields as appropriate to guard against airborne debris (soil particles, metal fragments, etc.).
  - Field team members must maintain proper body position and use proper lifting techniques when lifting heavy objects. Care must also be taken to change positions and techniques when performing repetitive-motion activities.
  - Particular care must be taken when traversing uneven terrain and when wading due to the potential for uneven/slippery surfaces. An employee's travel path should be selected ahead of time and good housekeeping must also be practiced to reduce slip, trip and fall hazards.

[2] Additional safe-work practice may be specified by the MBTA for work near the commuter rail line.

- Biological Hazards
  - Exposure to poison ivy and other poisonous plants will be minimized through the use of full-length pants, long-sleeved shirts, and gloves. In addition, after working in vegetated areas, workers should wash areas of exposed skin thoroughly with soap and water as an added protective measure.
  - Personnel shall examine themselves for ticks at reasonable frequencies, but at a minimum at the end of the work day. Insecticides containing DEET may be an effective tick repellent. Personnel allergic to bee and/or wasp stings shall carry medicine and antidotes to treat allergic reactions as prescribed by their personal physician at all times and inform other field team members of their existence and location.
  - When entering vegetated areas, workers should make noise to alert potentially poisonous snakes to their presence. Workers should always avoid extending hands or feet under rocks, logs, and other potential hiding places for snakes.
  - Care shall be taken not to confront wild animals, and workers should make as much noise as possible when traversing wooded areas. Long pants and shirts will provide a measure of protection against animal bites.

7.0 DECONTAMINATION AND DISPOSAL PROCEDURES

Given the negligible potential for chemical exposures at the various SWMP surface water monitoring stations, decontamination of field workers and/or equipment will generally not be required during implementation of the SWMP. Only non-dedicated field sampling equipment such as Van Dorn samplers and the Isco Model 6712 central compositing vessels will be decontaminated, generally following sampling events. Such field equipment will be decontaminated using non-phosphorus detergent and water. Since potential contaminant concentrations associated with the field equipment will be negligible, decontamination rinseates will not be collected or containerized.

Some amount of investigation-derived waste (IDW) will be generated during implementation of the SWMP, including polyethylene and silicone rubber sample tubing, laboratory sample bottles (polyethylene and glass), and nitrile gloves. All such IDW will be handled in such a way as to preclude the potential for spreading contamination, creating a sanitary hazard, or causing litter to be left on site. Specifically, all IDW will be bagged at the time and point of generation and brought to a secured, central IDW-staging area located at the former Industri-Plex Site groundwater treatment building, just north of the HBHA Pond.

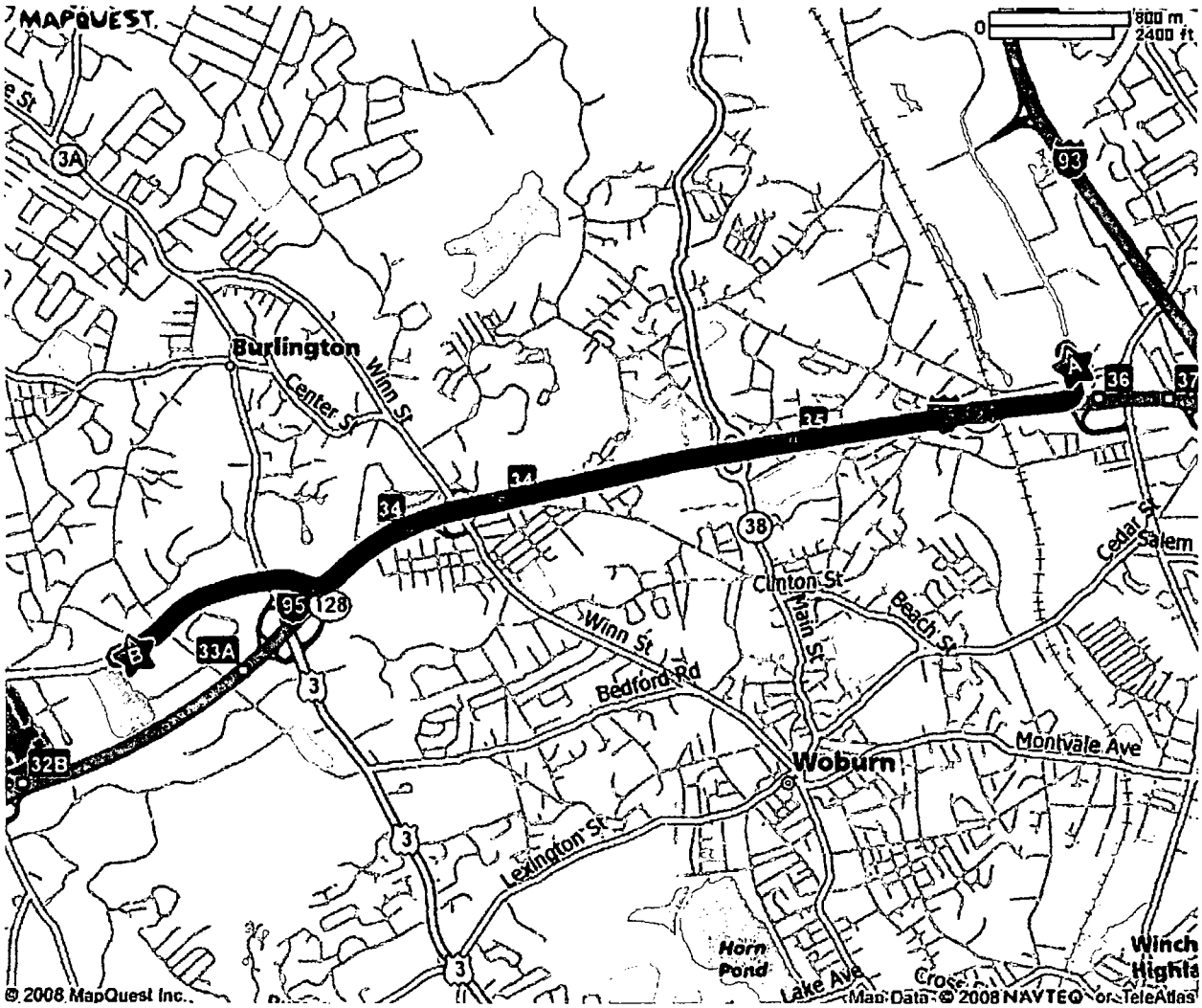
8.0 EMERGENCY RESPONSE AND CONTINGENCY PLAN

Given the potential chemical, physical, and biological hazards associated with the performance of field activities during implementation of the SWMP, the possibility of an emergency exists. This emergency plan has therefore been prepared in accordance with 29 CFR 1910.120. A copy of this section will be made available at each SWMP surface water monitoring station, and its location thereat will be communicated to all site workers prior to the performance of any activities at that location.

In the event of a non-life-threatening chemical release or physical injury, or an incident of property or equipment damage, a pre-determined signal (e.g., short bursts of an air horn) will be sounded and all work will cease immediately (with heavy equipment being secured if safe to do so). The SHSO or his designee will secure the incident scene, take appropriate measures (e.g., first aid), and notify the Project Manager and/or OHSM. In the event of a minor chemical spill or release, the spread of contamination will be controlled or stopped to the extent possible. If the incident is a non-life-threatening but nonetheless requires additional medical attention beyond first aid, and the injured person(s) is(are) ambulatory, the injured person(s) can be transported to the closest hospital, which will vary from location to location within the SWMP study area. In general, for locations north of Route 128 (Interstate 95), the closest hospital is Lahey Clinic, located at 41 Mall Road in Burlington, Massachusetts (781-744-5100). For locations south of Route 128, the closest hospital is Winchester Hospital, located at 41 Highland Avenue in Winchester, Massachusetts (781-729-9000). The approximate driving time to either hospital is 5 to 10 minutes under optimal traffic conditions. Directions to the two hospitals from the various sampling stations are given below.

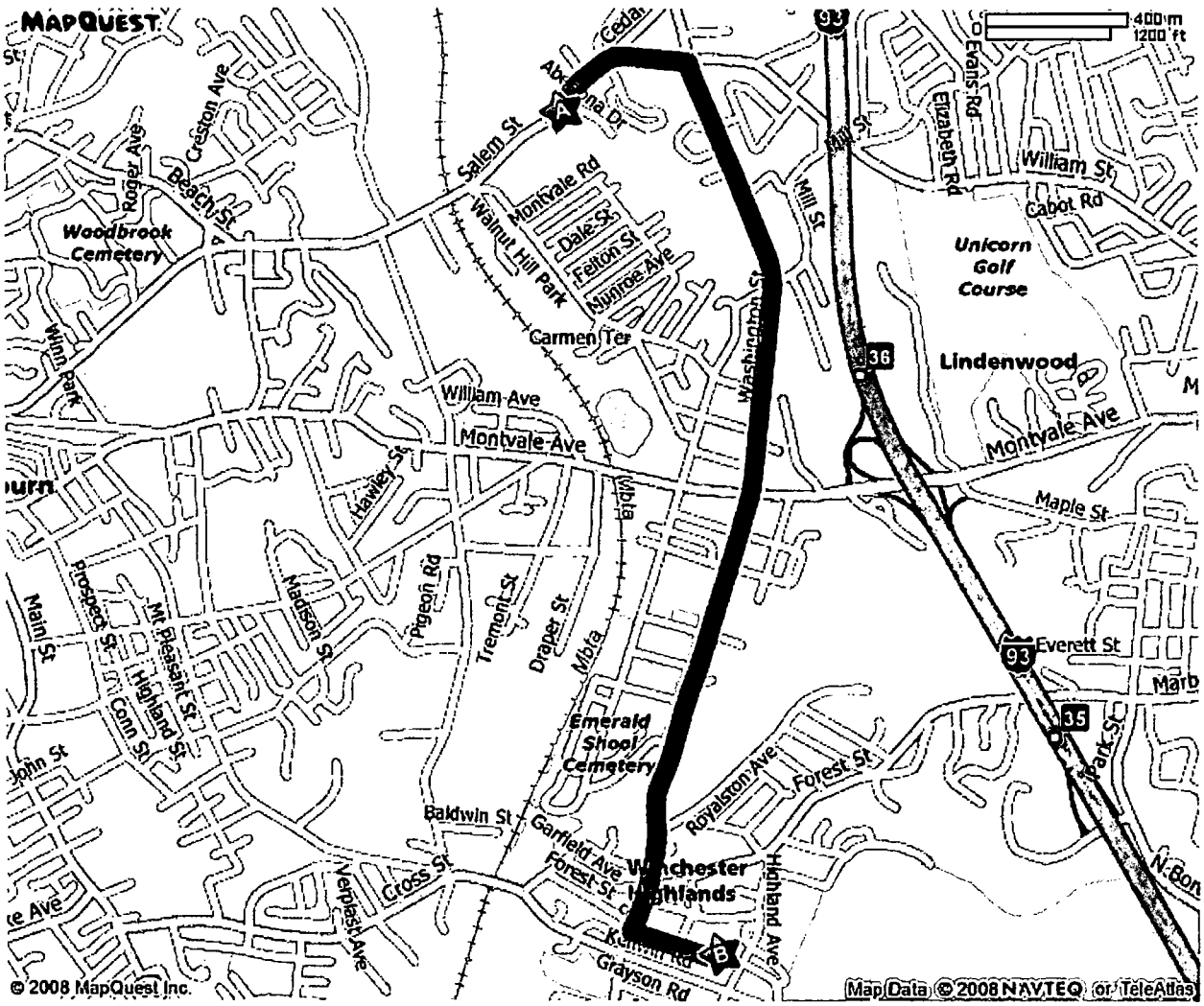
Directions to Lahey Clinic (for all stations north of Route 128):

1. Access Route 128 southbound at the Commerce Way/Mishawum road intersection.
2. Proceed on Route 128 southbound to third exit (Exit 33B - Route 3A north, Burlington).
3. Proceed straight at set of lights at end of exit ramp, onto Mall Road.
4. Lahey Clinic is located on the left at the third set of lights on Mall Road.



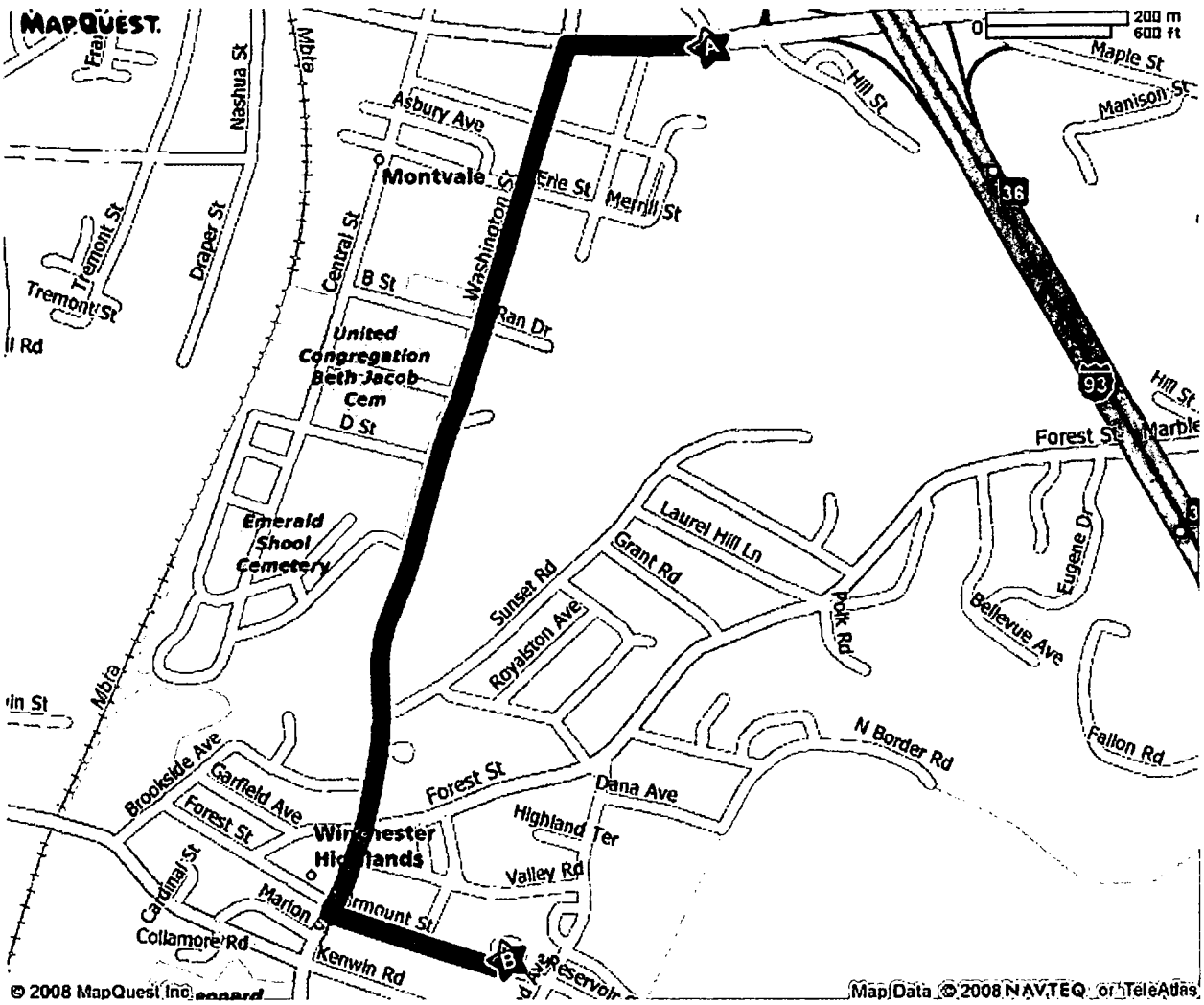
Directions to Winchester Hospital from monitoring station SW-05-TT:

1. Head east on Salem Street, and bear right at fork (stay on Salem Street).
2. Turn right onto Washington Street.
3. Proceed south on Washington Street past Montvale Avenue.
4. Go past one additional traffic signal (Forest Street), then make second left onto Fairmount Street.
5. Drive up hill and turn left into hospital's emergency room entrance.



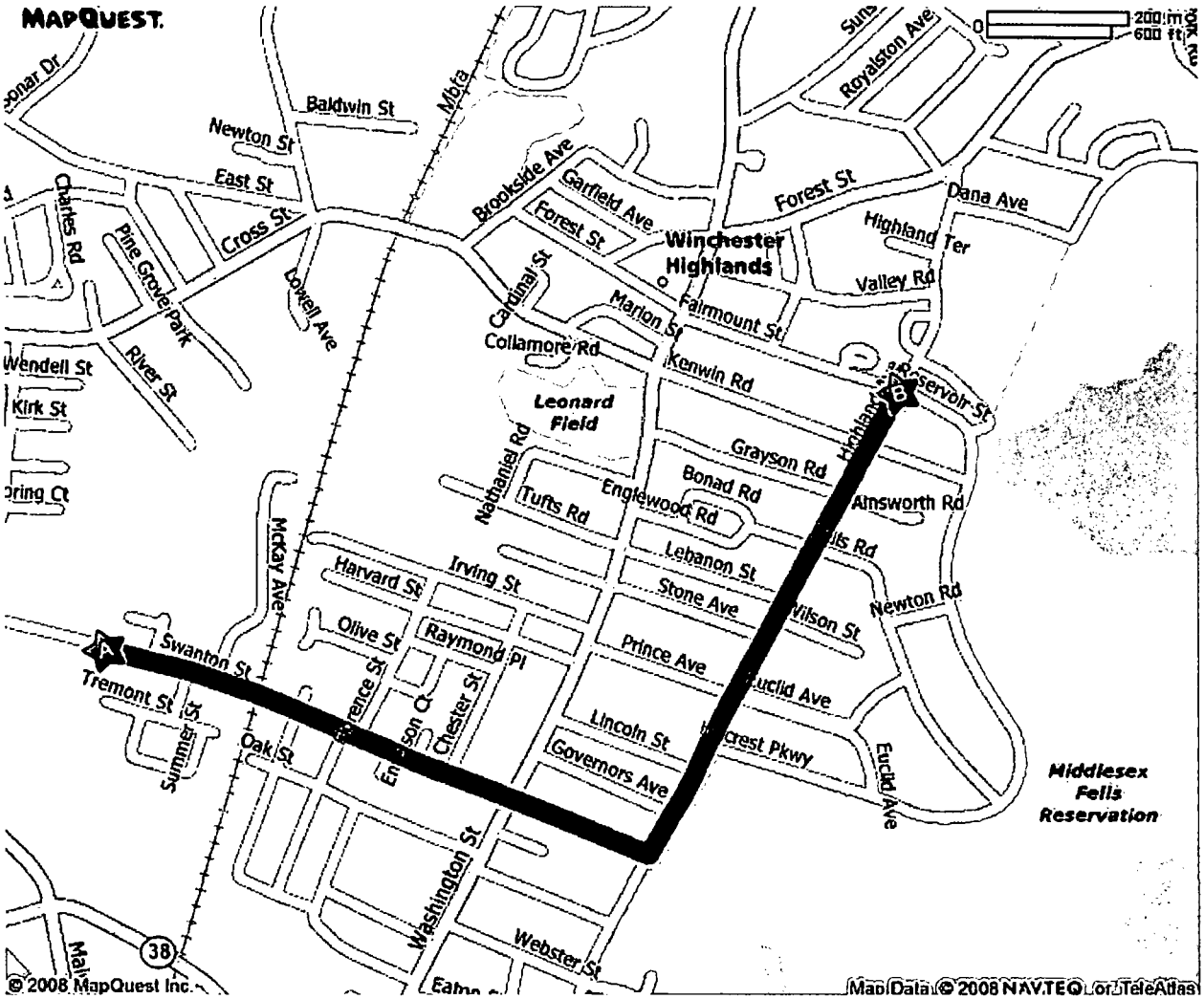
Directions to Winchester Hospital from monitoring station SW-06-TT:

1. Head west on Montvale Avenue (away from highway), staying in left lane.
2. Make left at first light (Washington Street).
3. Proceed south on Washington Street past one traffic signal (Forest Street), then make second left onto Fairmount Street.
4. Drive up hill and turn left into hospital's emergency room entrance.



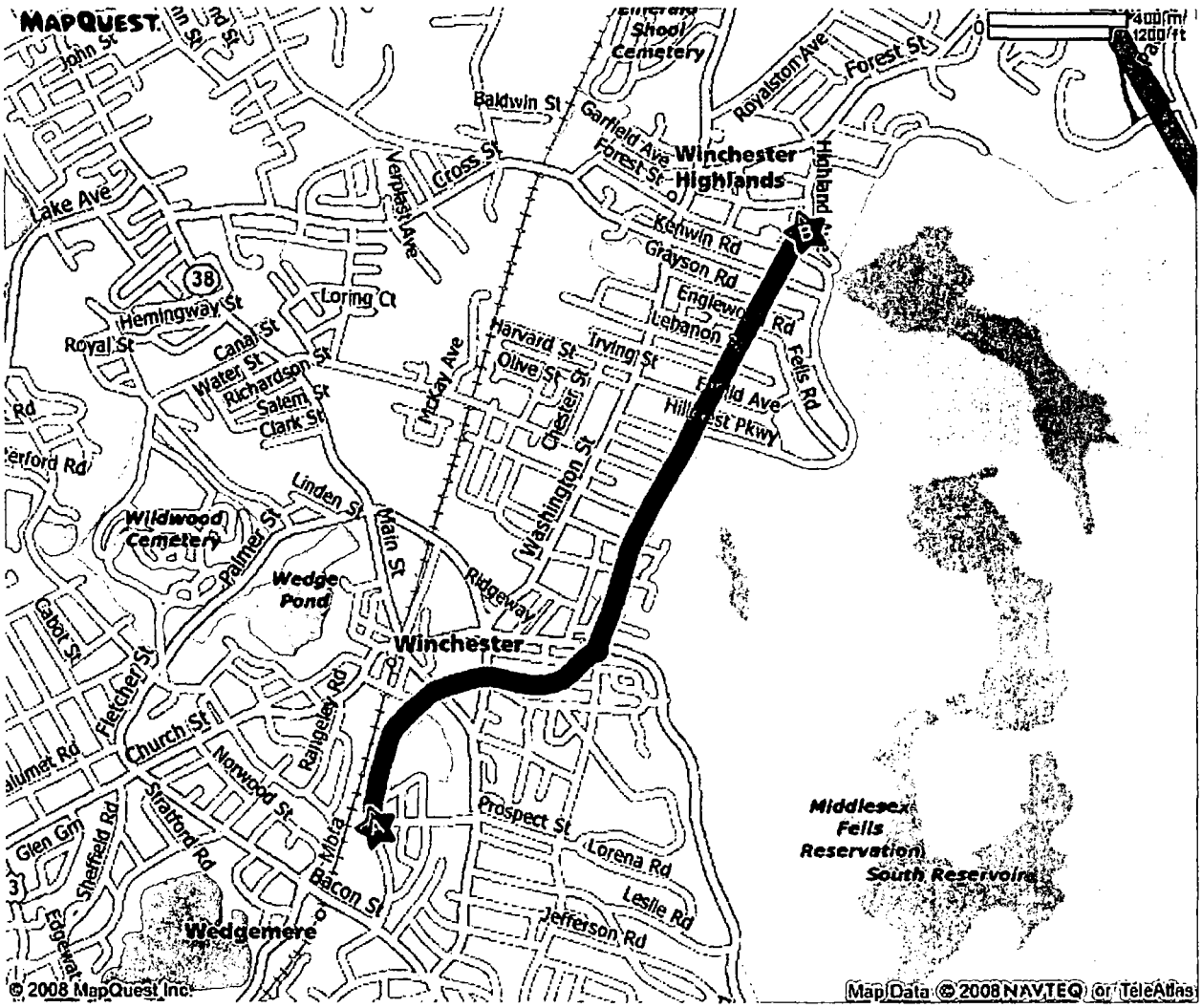
Directions to Winchester Hospital from monitoring station SW-07-TT:

1. Drive east on Swanton Street to end.
2. Turn left onto Highland Avenue.
3. Just before hospital, turn left onto Fairmount Street.
4. Turn right into hospital's emergency room entrance.



Directions to Winchester Hospital from monitoring station SW-08-TT:

1. Drive north (upstream) on Mystic Valley Parkway.
2. At end (third light), make slight left onto Highland Avenue.
3. Just before hospital, turn left onto Fairmount Street.
4. Turn right into hospital's emergency room entrance.



In the event of an emergency situation, such as explosion/fire, significant physical injury, or significant chemical release, a pre-determined signal (e.g., long bursts of an air horn) will be sounded, all work will cease immediately, and all ambulatory personnel will immediately evacuate the work area and assemble at a pre-determined "rally point." (Note: For serious physical injuries, and if conditions permit, designated site personnel may remain with the injured person(s) to perform first aid, etc.) The SHSO or his/her designee, who will also function as the Emergency Response Coordinator, will immediately notify the appropriate emergency responders (see table below), and then secure the work area to the extent possible. (No unauthorized personnel should be allowed to enter the work area during an emergency.) The Emergency Response Coordinator will also ensure that access for emergency vehicles and equipment is provided, and will provide emergency responders with information regarding site hazards (especially chemical hazards) and with medical data sheets (Attachment D-4) for injured parties. The medical data sheets provide important medical information regarding field team personnel, and must be completed for all field team personnel prior to commencement of SWMP activities.

EMERGENCY CONTACT INFORMATION

Below is a list of phone numbers for use in emergency situations which may develop during implementation of the SWMP.

Responder	Telephone Number
Ambulance (EMS) Woburn/Winchester Police Department Woburn/Winchester Fire Department	911
National Response Center (Release or Spill)	(800) 424-8802
State Poison Control Center	(800) 682-9211
Lahey Clinic Winchester Hospital	(781) 744-5100 (781) 729-9000

Other contact information is provided below.

Title	Name	Phone Number
Project Manager	Lawrence McTiernan	(781) 270-6600 (978) 884-1748 (cell)
Site Health and Safety Officer	James Dick	(781) 270-6600 (617) 596-8841 (cell)
Office Health and Safety Manager	Mitchell Wiest	(781) 270-6600 (631) 258-5751 (cell)
Project Coordinator	Bruce Thompson (*de maximis, inc.*)	(860) 298-0541 (860) 662-0526 (cell)
Remedial Project Manager	Joseph LeMay (EPA)	(617) 918-1323

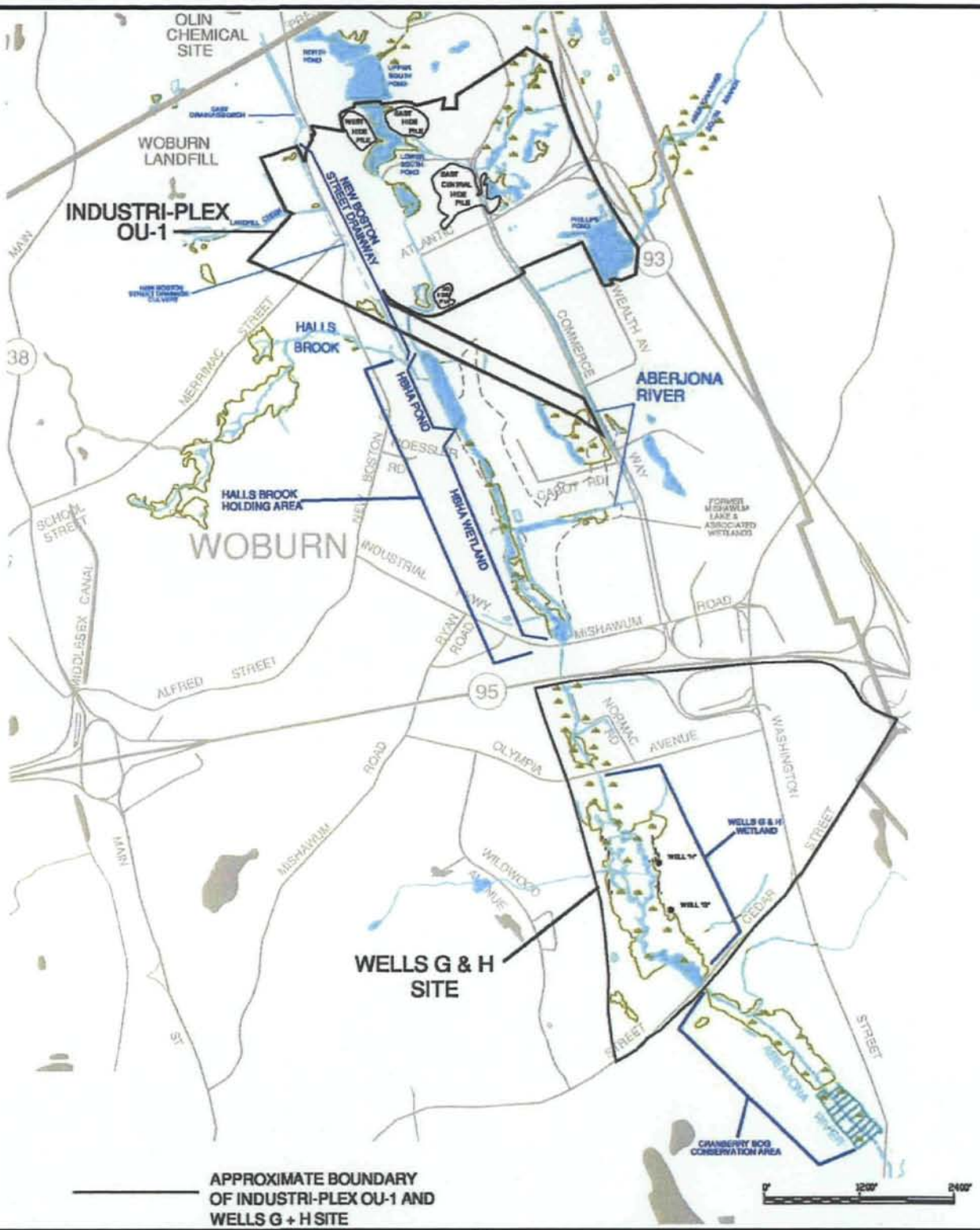
9.0 FIELD TEAM REVIEW

Each Roux Associates field member, subcontractor, or authorized third-party personnel entering SWMP work areas shall review this HASP and sign below to indicate that they have reviewed the HASP, understand the potential hazards associated with SWMP activities, and understand the provisions of the HASP. Subcontractors are encouraged to have their own HASP, which must, at a minimum, comply with the requirements herein.

"I have read and understand this site-specific HASP and will comply with the provision contained herein. I have been provided with an opportunity to have questions and concerns addressed by the SHSO, OHSM, and /or Project Manager."

Site: Industri-Plex OU 2, Woburn, Massachusetts

Name (Printed)	Signature	Date



■ APPROXIMATE SITE LOCATION

SOURCE:
USEPA, 2006. Record of Decision
Industri-Plex Superfund Site
Operable Unit 2.

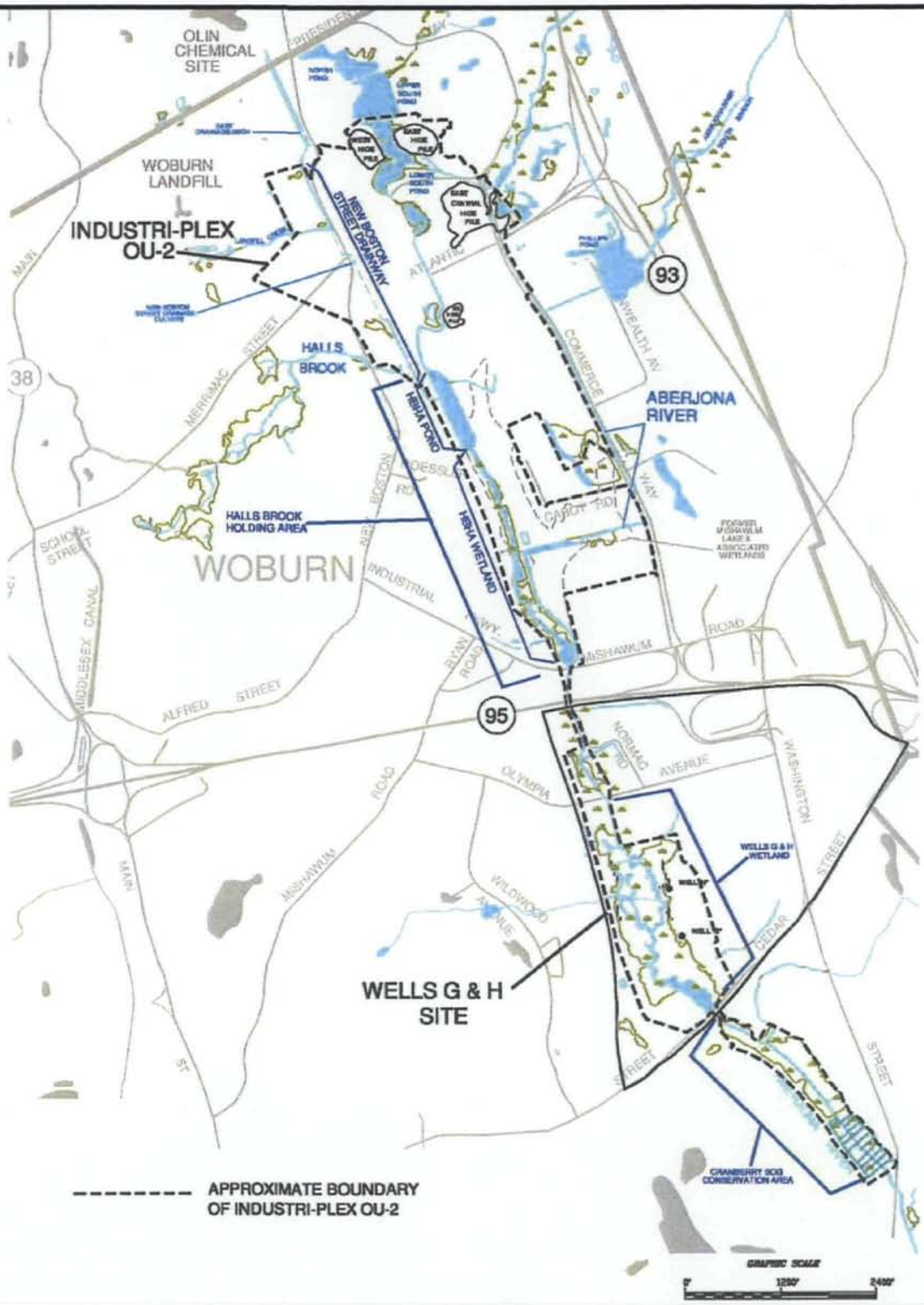
Title:

LOCATION OF INDUSTRI-PLEX OPERABLE UNIT 1 AND WELLS G&H SITE

Prepared for:
INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES, INC. *Environmental Consulting & Management*	Compiled by: BH	Date: 3/31/08	FIGURE
	Prepared by: CRS	Scale: AS SHOWN	D-1
	Project Mgr.: LM	Office: MA	
	File No.: IPS0110007	Project No.: 119401M07	

N:\PROJECTS\I-PLEX\119401M07\100\NEWFIGURES\5-15-08\D-FIGURES\FIGURED-1.cdr



■ APPROXIMATE SITE LOCATION

SOURCE:
USEPA, 2006. Record of Decision
Industri-Plex Superfund Site
Operable Unit 2.

Title:

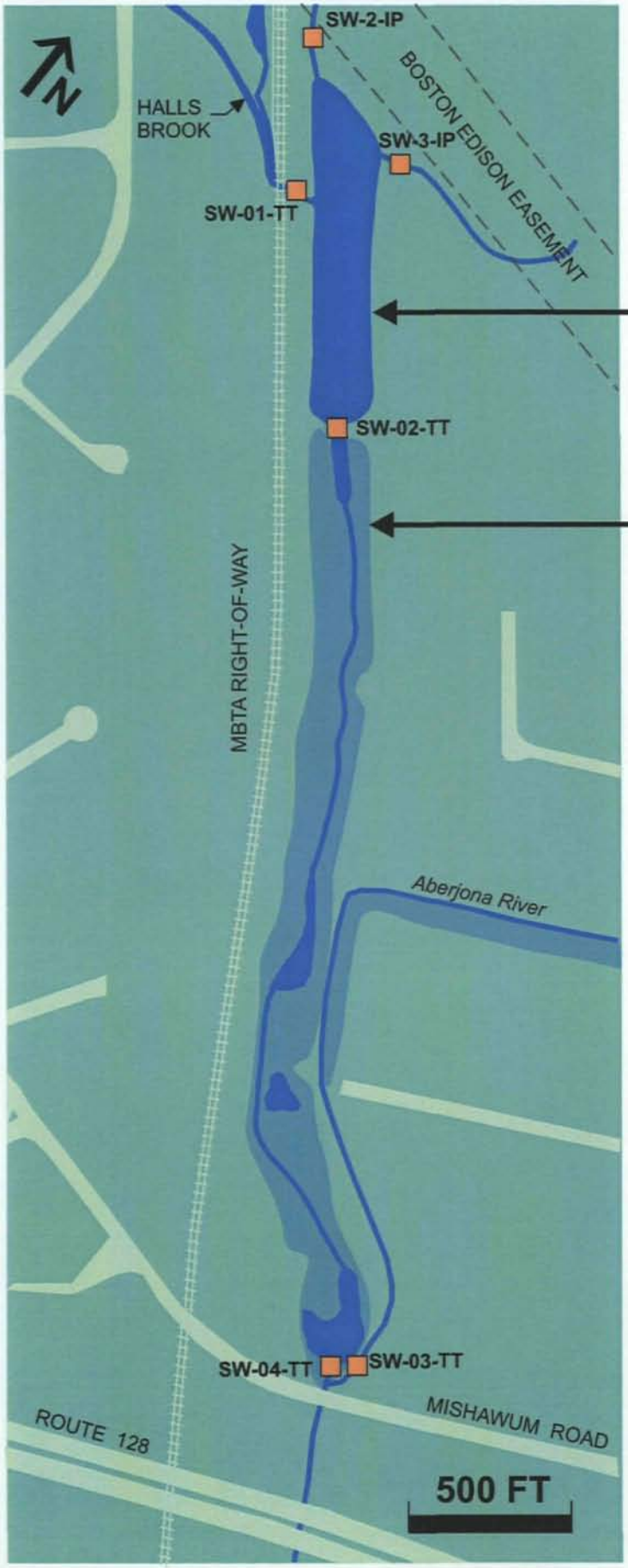
LOCATION OF INDUSTRI-PLEX OPERABLE UNIT 2

Prepared for:
INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: BH		Date: 5/15/08	FIGURE
Prepared by: CRS		Scale: AS SHOWN	D-2
Project Mgr.: LM		Office: MA	
File No.: FIGURED-2		Project No.:119401M07	

N:\PROJECTS\I-PLEX\119401M07\100\NEWFIGURES\5-15-08\D-FIGURES\FIGURED-2.cdr



LEGEND

SW-01-TT ■ APPROXIMATE LOCATION AND DESIGNATION OF SURFACE WATER MONITORING STATION

Title:

SURFACE WATER MONITORING STATIONS NORTH OF ROUTE 128

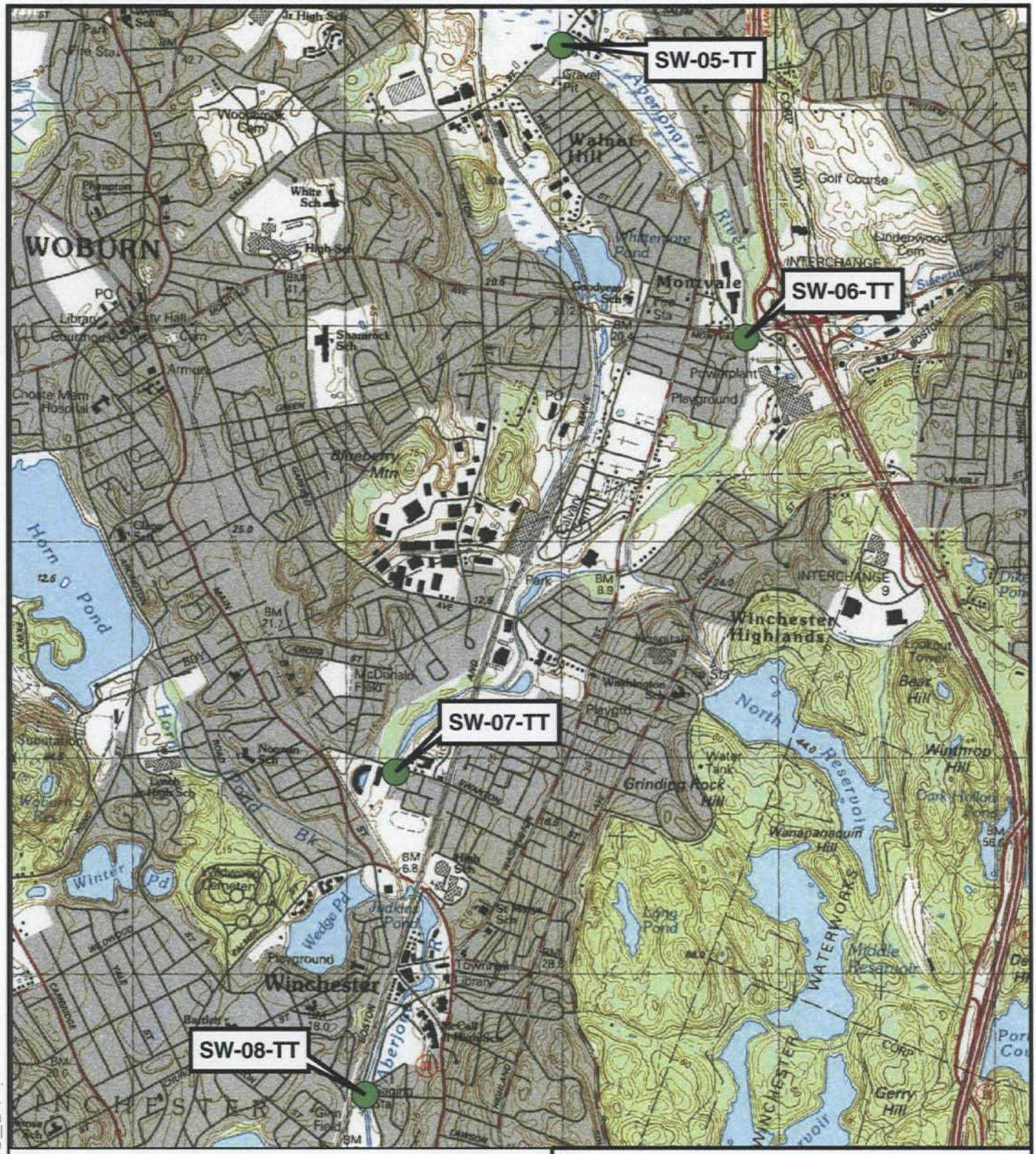
Prepared for:

INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES INC.
Environmental consulting & Management

Compiled by: LM	Date: 1/10/09	FIGURE	
Prepared by: CRS	Scale: AS SHOWN	D-3	
Project Mgr.: LM	Office: MA		
File No.: FIGURED-3	Project No.: 119407M07		

N:\PROJECTS\I-PLEX\119401M07\100D-FIGURES\FIGURED-3.cdr



■ QUADRANGLE LOCATION

N

SOURCE:
USGS, 1987.
Reading (Massachusetts) Quadrangle
1:25,000–scale Topographic Map

0 1,000 2,000 Feet

Title:

SURFACE WATER MONITORING STATIONS SOUTH OF ROUTE 128

Prepared For:

INDUSTRI-PLEX OU 2 SETTLING DEFENDANTS

ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled By: LM	Date: 1/13/09	FIGURE
Prepared By: CRS	Scale: AS SHOWN	D-4
Project Mgr.: LM	Office: MA	
File No.:IPS0110005_D4	Project: 119401M	

T:\GIS\I-PLEX\IPS0110005_D4

ATTACHMENT D-1

Daily Tailgate Health and Safety Meeting Log/Site Safety Checklist

DAILY TAILGATE HEALTH & SAFETY MEETING LOG

Job Name _____ Date(s) _____

Job # _____ Client Site # _____

Activities Planned _____

_____

_____

Potential Hazards	Mitigative Measures

Meeting Attended by:

Name	Signature	Company	Dates

NOTE: THIS IS A TWO-SIDED FORM; PLEASE COMPLETE BOTH SIDES

DAILY SITE SAFETY CHECKLIST

Job Name _____ **Date(s)** _____

Job # _____ **Client Site #** _____

•"On the Job" interactive meeting held before work starts	•Provide details of work planned for the day
•Conducted at least once per day	•Review the Job Safety Analysis (JSA) and work hazards
•Involves everyone working at the Site	•Required PPE for the planned work
•Should familiarize everyone with work area & vicinity	•SPSAs are discussed
•Work permit procedures	•HASP is reviewed
•Emergency access/exits	•Ensure safety equipment is on Site (fire extinguisher(s), eyewash & first aid kits, etc.)
•Emergency contacts/phone #s, hospital route	•Test required safety equipment (such as emergency stop controls)
•Should be interactive	•Can also include inspection of tools and equipment to be used

Instructions: Please use form for up to five consecutive days. Write in date, place checkmark to indicate item has been completed, then initial at bottom of column to verify.

#	CHECKLIST ITEM	DATE				
1	The HASP (including emergency phone #s) has been reviewed & signed by Roux staff & subcontractors.					
2	The daily site-safety meeting has been conducted. (Refer to reverse side of form)					
3	Fire extinguishers are available for use and are fully charged.					
4	A fully stocked first aid kit and eye wash bottle are readily available.					
5	Any potential slips, trips or fall hazards have been identified.					
6	All vessels containing flammable or corrosive material are properly labeled.					
7	Use of proper PPE has been identified and is being used for present conditions.					
8	Equipment on-Site is noted and is in safe working order.					
9	Site control has been established (using safety cones or barricades to mark out work area).					
10	No person on-Site has the appearance of being under the influence of motor skill altering substances.					
11	All workers on-Site are clothed in an appropriate manner (no tank tops, muscle shirts or shorts).					
12	Electrical power operated tools shall be properly grounded and used with a GFCI.					
13	All health and safety concerns have been communicated to the Local H&S Officer and PM.					
14	Roux personnel & subcontractors have discussed hazards associated with Site-specific work.					
15	Excavated soils are properly stored; excavations are properly shored/sloped and barricaded.					
16	No smoking signs are visibly posted in areas of potential flammable vapors.					
Initial at right to verify that these actions have taken place						

Comments and Exceptions _____

NOTE: THIS IS A TWO-SIDED FORM; PLEASE COMPLETE BOTH SIDES

ATTACHMENT D-2

Physical, Chemical, and Toxicological Information Regarding Contaminants of Concern

September 2005

NIOSH Pocket Guide to Chemical Hazards

NPG Home | Introduction | Synonyms & Trade Names | Chemical Names | CAS Numbers | RTECS Numbers | Appendices | Search

Arsenic (inorganic compounds, as As)

CAS 7440-38-2 (metal)

As (metal)

RTECS CG0525000 (metal)

Synonyms & Trade Names
Arsenic metal: Arsenia
Other synonyms vary depending upon the specific As compound. [Note: OSHA considers "Inorganic Arsenic" to mean copper acetoarsenite & all inorganic compounds containing arsenic except ARSINE.]

DOT ID & Guide
1558 152 (metal)
1562 152 (dust)

Exposure Limits
NIOSH REL: Ca C 0.002 mg/m^3 [15-minute] See Appendix A
OSHA PEL: [1910.1018] TWA 0.010 mg/m^3

IDLH Ca [5 mg/m^3 (as As)] See: 7440382

Conversion

Physical Description
Metal: Silver-gray or tin-white, brittle, odorless solid.

MW: 74.9	BP: Sublimes	MLT: 1135°F (Sublimes)	Sol: Insoluble
VP: 0 mmHg (approx)	IP: NA		Sp.Gr: 5.73 (metal)
Fl.P: NA	UEL: NA	LEL: NA	

Metal: Noncombustible Solid in bulk form, but a slight explosion hazard in the form of dust when exposed to flame.

Incompatibilities & Reactivities
Strong oxidizers, bromine azide [Note: Hydrogen gas can react with inorganic arsenic to form the highly toxic gas arsine.]

Measurement Methods
NIOSH 7300, 7301, 7303, 7900, 9102; OSHA ID105
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated/Daily
Remove: When wet or contaminated
Change: Daily
Provide: Eyewash, Quick drench

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations (See Appendix E) NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an N100, R100, or P100 filter. Click here for information on selection of N, R, or P filters./Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, skin absorption, skin and/or eye contact ingestion

Symptoms Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin, [potential occupational carcinogen]

Target Organs Liver, kidneys, skin, lungs, lymphatic system

Cancer Site [lung & lymphatic cancer]

See also: INTRODUCTION See ICSC CARD: 0013 See MEDICAL TESTS: 0017

September 2005

NIOSH Pocket Guide to Chemical Hazards

NPG Home | Introduction | Synonyms & Trade Names | Chemical Names | CAS Numbers | RTECS Numbers | Appendices | Search

Arsenic, organic compounds (as As)

CAS

RTECS

Synonyms & Trade Names
Synonyms vary depending upon the specific organic arsenic compound.

DOT ID & Guide

Exposure Limits

NIOSH REL: none

OSHA PEL: TWA 0.5 mg/m^3

IDLH N.D. See: IDLH INDEX

Conversion

Physical Description
Appearance and odor vary depending upon the specific organic arsenic compound.

Properties vary depending upon the specific organic arsenic compound.			

Incompatibilities & Reactivities
Varies

Measurement Methods
NIOSH 5022
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Recommendations regarding personal protective clothing vary depending upon the specific compound.
Recommendations regarding eye protection vary depending upon the specific compound.
Recommendations regarding washing the skin vary depending upon the specific compound.
Recommendations regarding the removal of personal protective clothing that becomes wet or contaminated vary depending upon the specific compound.
Recommendations regarding the daily changing of personal protective clothing vary depending upon the specific compound.
Recommendations regarding the need for eyewash or quick drench facilities vary depending upon the specific compound.

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations Not available.
Important additional information about respirator selection

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms In animals: irritation skin, possible dermatitis; respiratory distress; diarrhea; kidney damage; muscle tremor, convulsions; possible gastrointestinal tract, reproductive effects; possible liver damage

Target Organs Skin, respiratory system, kidneys, central nervous system, liver, gastrointestinal tract, reproductive system

See also: INTRODUCTION

September 2005

NIOSH Pocket Guide to Chemical Hazards

NPG Home | Introduction | Synonyms & Trade Names | Chemical Names | CAS Numbers | RTECS Numbers | Appendices | Search

Benzene

CAS 71-43-2

C_6H_6

RTECS CY1400000

Synonyms & Trade Names
Benzol, Phenyl hydride

DOT ID & Guide
1114 130

Exposure Limits
NIOSH REL: Ca TWA 0.1 ppm ST 1 ppm See Appendix A
OSHA PEL: [1910.1028] TWA 1 ppm ST 5 ppm See Appendix F

IDLH Ca [500 ppm] See: 71432

Conversion 1 ppm = 3.19 mg/m^3

Physical Description
Colorless to light-yellow liquid with an aromatic odor. [Note: A solid below 42°F.]

MW: 78.1	BP: 176°F	FRZ: 42°F	Sol: 0.07%
VP: 75 mmHg	IP: 9.24 eV		Sp.Gr: 0.88
Fl.P: 12°F	UEL: 7.8%	LEL: 1.2%	

Class IB Flammable Liquid: Fl.P. below 73°F and BP at or above 100°F.

Incompatibilities & Reactivities
Strong oxidizers, many fluorides & perchlorates, nitric acid

Measurement Methods
NIOSH 1500, 1501, 3700, 3800; OSHA 12, 1005
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation
Provide: Eyewash, Quick drench

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Soap wash immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations (See Appendix E) NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression; [potential occupational carcinogen]

Target Organs Eyes, skin, respiratory system, blood, central nervous system, bone marrow

Cancer Site [leukemia]

See also: INTRODUCTION See ICSC CARD: 0015 See MEDICAL TESTS: 0022

September 2005

NIOSH Pocket Guide to Chemical Hazards

NPG Home | Introduction | Synonyms & Trade Names | Chemical Names | CAS Numbers | RTECS Numbers | Appendices | Search

Ammonia

CAS 7664-41-7

NH_3

RTECS BO0875000

Synonyms & Trade Names
Anhydrous ammonia, Aqua ammonia, Aqueous ammonia [Note: Often used in an aqueous solution.]

DOT ID & Guide
1005 125 (anhydrous)
2672 154 (10-35% solution)
2073 125 (>35-50% solution)
1005 125 (>50% solution)

Exposure Limits
NIOSH REL: TWA 25 ppm (18 mg/m^3) ST 35 ppm (27 mg/m^3)
OSHA PEL†: TWA 50 ppm (35 mg/m^3)

IDLH 300 ppm See: 7664417

Conversion 1 ppm = 0.70 mg/m^3

Physical Description
Colorless gas with a pungent, suffocating odor. [Note: Shipped as a liquefied compressed gas. Easily liquefied under pressure.]

MW: 17.0	BP: -28°F	FRZ: -108°F	Sol: 34%
VP: 8.5 atm	IP: 10.18 eV	RGasD: 0.60	
Fl.P: NA (Gas)	UEL: 28%	LEL: 15%	

[Note: Although NH_3 does not meet the DOT definition of a Flammable Gas (for labeling purposes), it should be treated as one.]

Incompatibilities & Reactivities
Strong oxidizers, acids, halogens, salts of silver & zinc [Note: Corrosive to copper & galvanized surfaces.]

Measurement Methods
NIOSH 3800, 6015, 6016; OSHA ID188
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated (solution)
Remove: When wet or contaminated (solution)
Change: No recommendation
Provide: Eyewash (>10%), Quick drench (>10%)

First Aid (See procedures)
Eye: Irrigate immediately (solution/liquid)
Skin: Water flush immediately (solution/liquid)
Breathing: Respiratory support
Swallow: Medical attention immediately (solution)

Respirator Recommendations NIOSH
Up to 250 ppm:
(APF = 10) Any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern*
(APF = 10) Any supplied-air respirator*
Up to 300 ppm:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode*
(APF = 25) Any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern*
(APF = 50) Any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece
Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern/Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion (solution), skin and/or eye contact (solution/liquid)
Symptoms Irritation eyes, nose, throat; dyspnea (breathing difficulty), wheezing, chest pain; pulmonary edema; pink frothy sputum; skin burns, vesiculation; liquid: frostbite
Target Organs Eyes, skin, respiratory system
See also: INTRODUCTION See ICSC CARD: 0414 See MEDICAL TESTS: 0013

NIOSH Home | NIOSH Search | Site Index | Topic List | Contact Us

ATTACHMENT D-3

Heat and Cold Stress Information

Heat Stress

Heat stress is a significant potential hazard and can be associated with heavy physical activity and/or the use of personal protective equipment (PPE) in hot weather environments.

Heat cramps are brought on by prolonged exposure to heat. As an individual sweats, water and salts are lost by the body resulting in painful muscle cramps. The signs and symptoms of heat cramps are as follows:

- severe muscle cramps, usually in the legs and abdomen;
- exhaustion, often to the point of collapse; and
- dizziness or periods of faintness.

First aid treatment includes moving to a shaded area, rest, and fluid intake. Normally, the individual should recover within one-half hour. If the individual has not recovered within 30 minutes and the temperature has not decreased, the individual should be transported to a hospital for medical attention.

Heat exhaustion may occur in a healthy individual who has been exposed to excessive heat. The circulatory system of the individual fails as blood collects near the skin in an effort to rid the body of excess heat. The signs and symptoms of heat exhaustion are as follows:

- rapid and shallow breathing;
- weak pulse;
- cold and clammy skin with heavy perspiration;
- skin appears pale;
- fatigue and weakness;
- dizziness; and
- elevated body temperature.

First aid treatment includes cooling the victim, elevating the feet, and replacing fluids and electrolytes. If the individual has not recovered within 30 minutes and the temperature has not decreased, the individual should be transported to the hospital for medical attention.

Heat stroke occurs when an individual is exposed to excessive heat and stops sweating. This condition is classified as a **MEDICAL EMERGENCY**, requiring immediate cooling of the victim and transport to a medical facility. The signs and symptoms of heat stroke are as follows:

- dry, hot, red skin;
- body temperature approaching or above 105°F;
- large (dilated) pupils; and
- loss of consciousness - the individual may go into a coma.

First aid treatment requires immediate cooling and transportation to a medical facility.

Heat stress (heat cramps, heat exhaustion, and heat stroke) is a significant hazard if any type of protective equipment (semi-permeable or impermeable) which prevents evaporative cooling is worn in hot weather environments. Local weather conditions may require restricted work schedules in order to adequately protect personnel. The use of work/rest cycles (including working in the cooler periods of the day or evening) and training on the signs and symptoms of heat stress should help prevent heat-related illnesses from occurring. Work/rest cycles will depend on the work load required to perform each task, type of protective equipment, temperature, and humidity. In general, when the temperature exceeds 88°F, a 15 minute rest cycle will be initiated once every two hours. In addition, potable water and fluids containing electrolytes (e.g., Gatorade) will be available to replace lost body fluids.

Cold Stress

Cold stress is a danger at low temperatures and when the wind-chill factor is low. Prevention of cold-related illnesses is a function of whole-body protection. Adequate insulating clothing must be used when the air temperature is below 40°F. In addition, reduced work periods followed by rest in a warm area may be necessary in extreme conditions. Training on the signs and

symptoms of cold stress should prevent cold-related illnesses from occurring. The signs and symptoms of cold stress include the following:

- severe shivering;
- abnormal behavior;
- slowing of body movement;
- weakness;
- stumbling or repeated falling;
- inability to walk;
- collapse; and/or
- unconsciousness.

First aid requires removing the victim from the cold environment and seeking medical attention immediately. Also, prevent further body heat loss by covering the victim lightly with blankets. Do not cover the victim's face. If the victim is still conscious, administer hot drinks, and encourage activity, such as walking wrapped in a blanket.

ATTACHMENT D-4

Medical Data Sheets

MEDICAL DATA SHEET

This form must be completed by all on-site personnel prior to the commencement of activities, and shall be kept by the Site Health and Safety Officer during site activities. This form must be delivered to any attending physician when medical assistance is needed.

(This form should be typed or printed legibly.)

Site: _____

Name: _____ Home Telephone: _____
(Area Code/Telephone Number)

Address: _____

Date of Birth: _____ Height: _____ Weight: _____

Emergency Contact: _____ Telephone: _____
(Area Code/Telephone Number)

Drug Allergies or Other Allergies: _____

_____

Previous Illnesses or Exposures to Hazardous Substances: _____

_____

_____

Current Medication (Prescription and Non-Prescription): _____

_____

_____

Medical Restrictions: _____

_____

Name, Address and Telephone Number of Person Physician: _____

_____