Quality Assurance Project Plan (QAPP)

QAPP for Enhanced Anaerobic Bioremediation Treatability Study

811 East Arques Avenue Site Sunnyvale, California

16 September 2016

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Locus TECHNOLOGIES

Quality Assurance Project Plan (QAPP)

QAPP for Enhanced Anaerobic Bioremediation Treatability Study

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1 Introduction

This Quality Assurance Project Plan (QAPP) was prepared by Locus Technologies (Locus) for in situ enhanced anaerobic bioremediation activities at the 811 East Arques Avenue site ("Site") in Sunnyvale, California. A work plan dated 8 April 2016 was prepared by Locus and submitted to EPA: Treatability Study Work Plan: Bioremediation (Work Plan). The structure of the QAPP follows EPA requirements and guidelines for the Quality Assurance Project Plans (EPA, 2001; EPA, 2002).

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2 Project Management

2.1 Distribution List

Parties that will receive electronic copy of documents resulting from this project are listed in Table 1. All stakeholders will be provided the opportunity to comment on the methods for data collection, analysis, and data interpretation.

2.2 Project Organization

Individuals involved in this project are listed in Table 2, along with their project roles and contact information. This list may be modified as additional parties (laboratories, additional agency personnel, etc.) are added or substituted. Refer to Figure 19 in the main Work Plan for the Organizational Chart.

2.2.1 Quality Assurance Officer

The Project Quality Assurance Officer (PQAO) will be responsible for validating laboratory analytical data. The PQAO will be responsible for accepting or rejecting submittals from contract laboratories or field teams based on acceptability of work from a quality assurance perspective. The PQAO will furnish the Project Manager (PM) with data to begin analysis and interpretation of the data once the data have been properly validated.

The PQAO will not be involved in the supervision or execution of data collection in the field or laboratory. Contract laboratory data will be furnished directly to the PQAO. The PQAO will serve as a data flow control point to ensure that only validated data are used for the purposes of analysis, interpretation, testing hypotheses, and drawing conclusions. Data will not be disseminated among stakeholders before the PQAO has signed off on the data validation steps.

The PQAO will contact laboratory quality assurance/quality control (QA/QC) personnel on matters of data acceptability. The Sampling Coordinator will manage field data collection contractors and communicate with the laboratory's client services managers for the purpose of coordinating sample receipt and analysis. Once samples are submitted, the Data Evaluation Manager will await

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the PQAO's completion of data validation before beginning data analysis, hypothesis testing, and report preparation. The PQAO will remain independent of those generating the data.

2.2.2 QAPP Update and Maintenance

This QAPP may be changed, as warranted by problems or other needs identified by field or laboratory personnel, by the PQAO or by the PM. Each modification of the QAPP shall be accompanied by documentation of the change. Documentation shall record the date, nature of the revision, deletion, addition, or other change, reason for the change, and date that the QAPP users notified of the change. Changes to the QAPP will be disseminated to the QAPP users by electronic mail as soon as they are made. An appendix to the QAPP will document QAPP revisions.

2.3 Problem Definition and Background

This project seeks to evaluate the field-scale design of in-situ enhanced anaerobic bioremediation ("EAB") of volatile organic carbons (VOCs) at the 811 Arques Avenue site. During the course of the study Locus will collect and evaluate data to gain insight on design parameters and effectiveness of the technology. Upon concluding the study Locus will determine the potential of the remedial technology to meet remedial objectives, the optimal performance parameters, and conditions for the design of a full-scale implementation, if proven effective.

The groundwater beneath the site is impacted with trichloroethene (TCE). An extensive groundwater extraction and monitoring program has been in operation since 1982 to monitor and control the migration of VOCs in the groundwater beneath the site (Locus, 2011). Because TCE is the chemical most commonly present within the Site and at the neighboring operable units, it serves as the indicator chemical. However, there are eight chemicals of concern established in the Order for the Site: 1,1-dichloroethane; 1,1-dichloroethene; cis-1,2-dichloroethene (DCE); trans-1,2-dichloroethene; 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113); 1,1,1-trichloroethane; trichloroethene (TCE); and vinyl chloride. Additional detail on the hydrogeology and nature and extent of chemicals at the Site is available in Sections 1.1 and 1.2 of the Work Plan, which also includes the analytical contour maps.

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2.4 Project/Task Description

This document is in reference to the Treatability Study Work Plan for Bioremediation at the 811 Arques Ave site in Sunnyvale, California (Work Plan). Refer to Section 3.1 and 4.9 of the Work Plan for the project description and project scheduling, respectively.

2.5 Quality Objectives and Criteria

The following data quality objectives for each monitoring parameter will be used as defined in the Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans (EPA, 1980):

- Accuracy – The degree of agreement of a measurement (or an average of measurements of the same parameter). Accuracy of the laboratory results will be assessed for compliance with the established quality control criteria that are identified in Appendix A of this QAPP using the analytical results of method blanks, reagent/preparation blanks, matrix spike/matrix spike duplicate samples, field blanks, and bottle blanks. The percent recovery (%R) of matrix spike samples is calculated as indicated below:

  $$\%R = (A - B) \times 100 / C$$

  where:

  A = The analyte concentration determined experimentally from the spiked sample

  B = The background level determined by a separate analysis of the un-spiked sample

  C = The amount of the spike added

  Accuracy in the field will be assessed through the use of field and trip blanks, and through the adherence to all sample handling, preservation, and holding times.
- Precision – a measure of degree to which two or more measurements are in agreement. A description of how precision will be assessed for field and laboratory measurements will be presented. Precision of laboratory analysis will be internally assessed by comparing the analytical results between matrix spike/matrix spike duplicate for organic analysis, and

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laboratory duplicate analyses for inorganic analysis. The relative percent difference (RPD) will be calculated for each pair of duplicate analyses as indicated below:

$$RPD= (S-D) \times 100 / ((S + D)/2)$$

where:

S = First sample value original or matrix spike value)

D = Second sample value (duplicate or matrix spike duplicate value)

Laboratory precision RPD limits can be found in Appendix A. Field precision is assessed through the collection of field duplicates or co-located samples. Field precision will be reported as the RPD between two co-located field duplicates. The project RPD goal for field duplicates will be 25%.

- Completeness - a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained for that measurement. The percent of completeness to be obtained for the project will be stated for both field and laboratory analyses. Data completeness will be assessed for compliance with the amount of data required for decision making. The percent completeness is calculated as indicated below:

  % Completeness = (number of valid measurements) x 100 /(number of measurements planned)

  where:

  "valid measurements" refers to numbers of investigational samples obtained or to be obtained for specific purpose, or in order to satisfy a particular project objective.

  The completeness requirement is 90% for this project.

- Representativeness - expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. The measures to be employed to ensure representativeness for field and laboratory measurements will be stated in the contracted laboratories' standard operating procedures (Appendix A).

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Representativeness of field data is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the field sampling plan is followed and that proper sampling techniques are used.

Representativeness in the laboratory is ensured by using the proper analytical procedures, meeting sample holding times and analyzing and assessing field duplicate samples.

- Comparability - an expression of the confidence with which one data set can be compared with another data set. The measures to be employed to ensure comparability for field and laboratory measurements will be stated in the contracted laboratories' standard operating procedures (Appendix A). Field and laboratory analytical data will be comparable when similar sampling and analytical methods are used and documented in the QAPP. Comparability is also dependent on similar QA objectives.

Field data, assessed by the project Quality Control (QC) Officer will review the field results for compliance with the established QC criteria that are specified in the QAPP. Accuracy of the field measurements will be assessed using daily instrument calibration, calibration check, and analysis of blanks. Precision will be assessed on the basis of reproducibility by multiple readings of a single sample. Data completeness (C) will be calculated using the following equation:

C= Valid Data Obtained x 100 / Total Data Planned

Groundwater samples will be submitted to Curtis & Tompkins, Ltd., of Berkeley, California. Curtis & Tompkins will complete all laboratory analyses, with the exception of metabolic acids, hydrogen, carbon dioxide, and DHC analyses. Samples for the former three analytes will be submitted to Pace Analytical in Pittsburgh, PA. DHC analyses will be submitted to Microbial Insights, Inc. of Rockford, TN. The goals for laboratory accuracy, precision, and completeness are presented in Appendix A for Curtis and Tompkins laboratories, Microbial Insights, Inc., and Pace Analytical, respectively.

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2.6 Specialized Training or Certifications

The investigators and decision makers involved in this project should have experience and training in groundwater sampling and data analysis. In addition, staff implementing this plan should be familiar with the work plan, QAPP, and associated procedures. However, no specialized training or certifications are required.

The sampling and analysis team has many years of experience in groundwater sampling and data validation and analysis. Therefore, training of laboratory and data review personnel on groundwater sampling will not be a requirement for this project; however, training and review for field personnel using sampling equipment is recommended. If new staff join the project, on the job training and evaluation will be conducted for the individual(s).

2.7 Documentation and Records

This project will generate many data records and several reports in the course of the investigation. Copies of laboratory reports and validation packages will be made available to EPA upon request. The methods of report and data management are described below.

2.7.1 Documents

All documents prepared for this project will either be produced directly as electronic documents or scanned into electronic format. Files will be maintained in Adobe Acrobat Portable Document Format (Adobe PDF). The Locus Project Manager will be responsible for maintaining records for this project. Document retention, archive, and disposition is listed in Table 3.

2.7.2 Records

Data from both laboratory analyses and field measurements will be imported to and maintained in an electronic database. For the duration of the project, the database will be updated and maintained by Locus Technologies; thereafter, copies of data subsets or access to the entire database will be available from Philips as requested.

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3 Data Generation and Acquisition

3.1 Sampling Process Design (Experimental Design)

The treatability study will be conducted in an approximately 5,800 square foot area upgradient of, and including, the 811 East Arques extraction trench area (Figure 17 of the Work Plan). This area was selected because it is the area of highest TCE, cis-1,2-DCE, and Freon 113 concentrations at the 811 East Arques source area.

The amendments SRS-SD and TSI DC Bioaugmentation Culture will be injected using direct push technologies into three injection points, each 10 ft upgradient of monitoring wells S138A, S139A, and S146A to enhance the distribution of the amendments and cost effectiveness of the treatability study. The required volume of SRS-SD will be determined using the ESTCP Substrate Design Tool with the best available geochemical and hydraulic values and most recent VOC concentrations (Tables 4 and 5 of the Work Plan).

To evaluate and overcome the inhibitory effects of Freon 113 on TCE degradation, SRS-Z will be applied to a 100 sq-ft test area targeting the region with highest levels of Freon 113 within the treatment zone. The substrate will be applied using direct push via two injection points at a 10 ft radial distance upgradient of monitoring well S140A. For additional details of the experimental design, refer to the Work Plan.

Groundwater samples for volatile organics, general chemistry, and DNA analysis will be collected from existing monitoring wells within the proposed treatment area plus a downgradient, cross-gradient, and upgradient well. Table 4 lists the selected wells for sampling, frequency of sample collection, laboratory analysis, and field measurements. Refer to Figure 17 of the Work Plan for well locations.

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The sampling frequency will be consistent across the set of wells listed in Table 4. For description of the screen interval depth, depth, and diameter of the monitoring wells refer to the boring logs in Appendix A of the Treatability Study Work Plan: Bioremediation Report. Supplementary ad-hoc samples will be gathered at strategic locations when data from the monitoring wells is insufficient for performance assessment. If needed, methane soil gas samples will be taken in proximity to well locations exhibiting levels > 10 mg/L methane in groundwater. After reviewing the results, a subsequent sampling schedule may be developed. The initial study is expected to last one year.

3.2 Sampling Methods

Groundwater samples will be collected using standard procedures as described in this document. If necessary, soil-gas samples will be collected using methods established for the sampling device.

3.2.1 Groundwater Sampling

All sampling equipment will be decontaminated before purging and sampling of each sampling location. Water level measurements will be obtained at each of the sampling locations before purging and sampling. If the well does not have a designated pump, the wells will be purged using a Teflon® or stainless steel bailer or a submersible pump, depending on well conditions.

The standard monitoring well purging procedure will consist of, at minimum, the removal of three times the initial volume of water contained by the well casing before purging. Physical parameters such as pH, specific conductance, and temperature will be monitored and recorded in field log sheets while the well is purging. This will verify that complete purging of the static water has been accomplished. Depending on individual well conditions, if recharge of the monitoring well is too slow to allow purging at a reasonable rate the well may be completed evacuated prior to removing three casing volumes. In this case, the samples will be taken when sufficient recharge has occurred.

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Hydropunch or Geoprobe are ad hoc screen point sampling tools used to collect groundwater samples. The sampling tools use direct push technologies to drive the sampling rods to the desired depth. The contract drilling company will carry out equipment inspections and standard operation methods according to the instrumentation selected.

3.2.1.1 Filling sample containers

Sample container types, preservation methods, and holding times for general chemistry, VOC, and DNA analysis are specified in Appendix B.

Sample bottles for VOCs and general chemistry constituents should be kept closed until ready to be filled. Area surrounding the wellhead should be kept as clean as possible to minimize contamination. The potential for airborne contamination should be minimized during sample collection. Protect samples with covers and shields if surrounded by engine exhaust sources or dusty areas. Clean pair of gloves should be used at each sampling well. When sampling with a pump, hold the discharge tube as close as possible to the sample container without allowing the sample tubing to contact the container.

Sample containers for VOC analyses should be filled in a manner that minimizes turbulence, air entrapment, and overfilling. If using a pump, check for air bubbles in the line and ensure that flow is steady and does not exceed 100 ml/min. Bottles should be filled completely leaving a positive meniscus at the top of the container. After capping, invert the vial and tap with a finger to check for bubbles. If bubbles are present, discard the vial and fill a replacement. Unpreserved samples should be collected and noted on the chain of custody form.

Groundwater samples for the analysis of dissolved metals should be filtered onsite prior to relinquishing to lab or employing a field test using a HACH kit. The sampling process will require a hand vacuum pump with hose, one 500 ml Teflon FEP bottle pre-filled with DI water, one empty 500 ml Teflon FEP bottle, disposable 0.45 µm cellulose nitrate filter unit, and pre-preserved vials with nitric acid provided by the lab. For sample filtering and preparation refer to Section 6.5 of

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Standard Operating Procedure for the Collection and Field Processing of Metals Samples document in Appendix B.

3.2.1.2 Sampling Field Log

A well sampling log (Appendix C) must be completed for each sampling location onsite. Log information will be entered into project environmental information database by the data analyst.

3.2.1.3 Field Measurements for Groundwater

Field data will be collected during sampling and monitoring activities described in Section 4.3 of the Work Plan. The routine procedures and methods described herein are intended to ensure that field measurements are consistent and reproducible.

3.2.1.3.1 Water Level Measurements

Water level measurements will be made by an electric sounder by the field technician. Prior to sounding a well, the equipment will be inspected and calibrated according to manufacturer specifications.

At each location, a minimum of two measurements should be taken, the most representative of the measurements will be determined the judgement of the technician and recorded in a water levels measurements field log sheet. Data should be recorded to nearest 0.01 foot and compared to previous measurements at the well site.

The following field measurement protocols will be employed while collecting water level measurements with an electric sounder for investigations at the Arques Site:

- The sounder will have firmly affixed or permanent marks on the sounder line. A steel ruler will be used to measure in between marks, if needed.
- All measurements will be made to the nearest hundredth of a foot and converted to mean sea level using the known elevation of the surveyed point.
- Electrical sounders will be calibrated monthly and after any incident that may affect the accuracy of the sounder.

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- Sounders will be kept clean and in working order. The sounder and portions of the cable that submerged below fluid levels in wells will be sprayed with deionized water.

3.2.1.3.2 Specific Conductance, ORP, Temperature, and pH Measurements

A commercial multi-function meter will be used to measure specific conductance, oxidation-reduction potential (ORP), water temperature, and pH. For meter description, maintenance, and calibration procedures refer to Appendix D and Sections 3.6 and 3.7. Brand and model of meter might differ throughout the project, in such cases the respective meter operations manual will be included in Appendix D.

Following the calibration of the meter the technician will collect a representative sample using low flow purging techniques and used solely for field-parameter determinations. Samples will be gathered using a pump to fill the flow-through cell at 100 to 5,000 mL/min. The meter probe will be inserted into the flow-through cell block or single cell to take readings. For guidance on using the meter please refer to Appendix D.

Field technician conducting the measurements will be responsible to oversee the calibration and decontamination of the instruments.

3.2.1.3.3 Dissolved Oxygen Measurements

Dissolved oxygen (DO) measurements will be taken using a handheld optical sensor as part of a multi-meter or a stand-alone instrument. For meter description, maintenance, and calibration procedures refer to the manual in Appendix D and Sections 3.6 and 3.7. Brand and model of meter might differ throughout the project, in such cases the respective meter operations manual will be included in Appendix D.

Following the calibration of the meter the technician will collect a representative sample using low flow purging techniques and used solely for field-parameter determinations. Samples will be gathered using a pump to fill the flow-through cell at 100 to 5,000 mL/min. The meter probe will

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be inserted into the flow-through cell block or single cell to take readings. For guidance on using the meter please refer to Appendix D.

Field technician conducting the measurements will be responsible to oversee the calibration and decontamination of the instruments.

3.2.2 Methane Soil-Gas Sampling

Soil gas concentrations in the bioremediation area can be measured in the dedicated vapor ports using a calibrated Flame Ionization Detector (FID), combustible gas meter or soil gas sampling canisters. Care needs to be taken to ensure that well screens are not submerged as unrepresentatively high readings would result from the gas trapped in the well. Additional care should be taken to avoid interference from VOCs FID or combustible gas meter readings which can cause false high readings. A carbon filter should be used with the FID to filter VOC gases from the detector.

3.3 Sample Handling and Custody

The ability to trace samples, and maintain proper sample handling from the time they are collected to receipt of final data is essential to the sampling program. In particular, prior to sampling, sample containers for VOC's and other chemistry constituents are to be kept closed until ready to be filled. Once the groundwater has been collected, the container must be sealed tightly and affixed with proper labeling. A chain-of-custody (COC) (Appendix C) must be filled out correctly, and shipped along with the samples. Samples must be placed in coolers, with all remaining space in the cooler to be filled with blue ice or regular ice that has been bagged in Ziploc bags. The samples should be kept at around 4°C during shipment. Sample containers, preservatives, and holding times specific to the analytical methods listed in Section 3.1 of this document can be found in Appendix B.

All information relevant to field sampling will be documented on field logs and on COC forms, and samples will be labeled in the field to ensure location mix-ups do not occur. All samples will be

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shipped to the laboratory for arrival before expiration of the sample holding time as described in Attachments B1 and B2 in Appendix B. Samples will be delivered to the laboratory person authorized to receive samples, who will inspect and note the condition of the equipment and enter the samples into laboratory record for analysis. If there are any discrepancies between the received samples and the COC documentation, the sender will be immediately notified. As with corrections made in the field, any changes made to the COCs will be made by striking the item and initialing and dating the correction in ink.

3.4 Analytical Methods

Sampling technicians will submit samples to a California-certified laboratory for analysis by EPA Methods described in Section 4.3 of the Work Plan. Samples will be analyzed for all parameters of concern as described in Section 4.3 of the Work Plan. The contract laboratory will carry out pre-determined quality assurance measures as described in their respective quality assurance plans. SOP numbers and method performance criteria are provided in Appendix A. Samples will be disposed of in accordance with all applicable local, state, and federal regulations.

3.4.1 Performance Criteria

Quality control limits for laboratory analyses, which meet DQOs, are documented in Appendix A of this QAPP.

3.4.2 Corrective Actions

The contracted laboratories will have corrective action programs to address any unacceptable data or conditions. After completion of analyses, the laboratories will verify compliance with their laboratory QAPP. Corrective action will be implemented for any parameters that are outside of control limits. Initial corrective action is to verify that calculation errors have not occurred. If necessary, reanalysis will be performed if holding time permits. If it is confirmed that the parameters are outside of the control limits, the corrective action process will be initiated. Corrective actions may include the following:

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- Verification of dilution factors
- Verification of sample preparation and instrument performance
- Verification of procedure by monitoring method performance; If necessary, amending sampling and analytical procedures
- Re-sampling and analysis

Laboratories will maintain records of corrective action reports and submit them to the contractor with the electronic copies of the laboratory reports. Corrective actions will also be included in the project report.

Corrective actions for EAB direct push injection activities are described in Section 4.2.2 of the Work Plan. Daily activity logs will document field activities including any corrective actions implemented.

3.5 Quality Control

Quantitative control criteria should be established at a level which will reduce the potential for false data to an acceptable probability. Any laboratory quality control issues associated with data collected as part of the investigation must be quantified and minimized. This plan provides detailed descriptions of the measures that will be taken to guard against false-positives and false-negatives. False-positives can occur due sample contamination. The primary strategy for preventing false-positives will be the proper use of quality control samples in the field and laboratory.

3.5.1 Quality Control Samples

Quality control samples are added to the sampling program to ensure an appropriate level of data quality and to identify any potential sampling or analytical errors that could impact sample results. If any results for quality control samples fall outside the acceptable range, the results will only be used if the Project Quality Assurance Officer confirms that the problem did not affect integrity of the rest of the samples. Quality control samples for this project require the use of field quality control samples and laboratory quality control samples. Field quality control samples

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are collected in the field and provide quality information regarding sampling methods in the field as well as the handling, and transportation of samples from the field to the laboratory. Laboratory quality control samples are prepared and analyzed in the laboratory and confirm the quality of analytical procedures. Laboratory blanks, laboratory control spikes, and analytical surrogates will be provided and analyzed by the laboratory per the analytical method protocol for the given parameter of study. Laboratory control samples are independent sources of reference to validate the accuracy and calibration of instruments used for sample analysis.

3.5.2 Quality Control Limits

Contract laboratory personnel will document accuracy, precision, and recovery for laboratory analyses by following established quality assurance procedures defined by EPA Method guidance, and in-house quality assurance project plans for laboratory procedures.

3.6 Instrument/Equipment Testing, Inspection, and Maintenance

The laboratory will have written standard operating procedures (SOPs) defining the instrumentation, maintenance, calibration, method detection limits, QC analysis, acceptance criteria and any other requirements for the analytical methods used. The SOPs must be available to the laboratory chemists performing the work, and they must meet or exceed the requirements of the methods to be used for analysis. The laboratory must maintain records of all activities that have an impact on the quality of the results. The laboratory must maintain instrumentation required for analysis; any method substitution due to instrument failure will not be permitted without prior approval. Instrumentation deficiencies found will be evaluated by the laboratory and contractor to determine if analytical results were affected. Deficiencies affecting analytical results will be addressed through re-analysis or re-sampling, if necessary.

The EAB Injection Contractor will maintain instrumentation and equipment for EAB substrate mixing and injection activities. Final acceptance of instrumentation and equipment will be performed by the Project Manager. The EAB Injection Contractor will have written standard operating procedures (SOPs) or equivalent manufacturer's documentation defining the

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instrumentation and equipment testing, inspection, and maintenance requirements (e.g. refer to Appendix A and D). The documentation must be available to the operators of the instrumentation and equipment. The EAB Injection Contractor must maintain records of all activities that have an impact on the quality of the installation and results. The EAB Injection Contractor and the Field Services Coordinator must maintain instrumentation required for field data collection. Instrumentation deficiencies found will be evaluated by the EAB Injection Contractor and the Field Services Coordinator, as applicable, to determine if field readings were affected. Deficiencies affecting field readings will be addressed through re-measurement, if necessary and possible.

3.7 Instrument/Equipment Calibration and Frequency

The laboratory will calibrate all instruments and equipment in accordance with the method specifications. Calibrations are conducted when the method is initially set up and whenever the calibrations fail to meet the acceptance criteria. If instrumentation undergoes significant repairs or maintenance, a valid initial calibration will be conducted. Instrumentation deficiencies found will be evaluated by the laboratory and contractor to determine if analytical results were affected. Deficiencies affecting analytical results will be addressed through re-analysis or re-sampling, if necessary.

The EAB Injection Contractor and the Field Services Coordinator, as applicable, will calibrate all instruments and equipment in accordance with manufacturer specifications (e.g. refer to Appendix D). Calibrations are conducted when the instrument/equipment is initially set up and whenever the calibrations fail to meet the acceptance criteria. If instrumentation/equipment undergoes significant repairs or maintenance, a valid initial calibration will be conducted. Instrumentation/equipment deficiencies found will be evaluated by the EAB Injection Contractor and the Field Services Coordinator, as applicable, to determine if field readings were affected. Deficiencies affecting field readings will be addressed first through proper instrument/equipment recalibration, maintenance, and/or replacement, to be followed by re-measurement, if necessary and possible.

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3.8 Inspection/Acceptance of Supplies and Consumables

All sample containers for VOC's and other chemistry constituents are to be kept closed until ready to be filled. All sampling equipment will be decontaminated before purging and sampling of each sampling location. Equipment that fails inspection will be replaced prior to use. The Sampling Coordinator will be responsible for inspection and acceptance of supplies and consumables.

All EAB supplies and consumables must be checked for proper quality prior to installation. Materials that fail inspection will be replaced prior to use. The EAB contractor will be responsible for inspection and acceptance of supplies and consumables.

3.9 Non-Direct Measurements (Existing Data)

As discussed in the main Work Plan, some Enhanced Anaerobic Bioremediation data is available within the study area and from affiliated groundwater and soil gas background sampling. In addition, groundwater data is available from EAB that has been effectively implemented at adjacent sites. Data quality for the two data types (groundwater, and potentially soil gas) is documented in the analytical database and in reports provided to EPA. These data sets may be used in combination with new data in supporting interpretations for background levels and source analysis. In addition, groundwater data will be used to define the bioremediation treatability study area of VOC's within the "A" aquifer at or near the site source area, as described in Section 1.1 of the Work Plan. Use of existing data will be dependent on the comparability of the new and existing datasets, including the age, sampling conditions, and location of the samples.

3.10 Data Management

Data received from the laboratory, and verified and validated by the PQAO, will be managed by the Data Evaluation Manager for storage, retrieval, and transmittal. Sample information (location, date, time, etc.) will be entered into the electronic database from field logs and chain of custody documentation. Wherever possible, laboratory data will be received in an Electronic Data Deliverable (EDD) format directly from the laboratory to avoid potential transcription errors. Once received, the EDD will be uploaded into a holding table where it is checked for formatting

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and general data validation (quality control limits, consistency with chain of custody information, etc.). If the EDD fails any of the checks at this point, the error or discrepancy will be identified and either corrected or qualified depending on the severity of the error. No changes or corrections will be made to the EDD file itself without being reissued from the laboratory. Any validation qualifiers tagged onto the data set will identify the rationale for the qualifier and the person adding the qualifier. Wherever possible, re-analysis options should be examined to avoid applying qualifiers to the data set, since qualifiers may limit the usability of the data.

4 Assessment and Oversight

4.1 Assessment and Response Actions

The Locus Project Manager will monitor, and if necessary, audit field activities including EAB installation activities and sampling. System audits involve the inspection of equipment for sampling and data gathering, and are usually conducted early in the initial stages of a field activity. Performance audits involve the inspection of field and laboratory activities to verify that standard procedures are completed to provide accurate data generation and to conform to specifications. Performance audits, if necessary, will also be completed by the Locus Project Manager and at the same time field audits are completed. Audit results would be reported to the Philips Project Manager and, upon request, to the EPA Project Manager. The Philips Project Manager and EPA Project Manager are also authorized to conduct audits and have the authority to issue stop work orders, if necessary.

4.1.1 Field and Performance Audits

Field audits may include evaluation of EAB substrate mixing and injection procedures, sample collection and identification in the field, observations of COC procedures, field documentation and measurements, and instrument/equipment calibrations. Field documents and COC forms will be reviewed to ensure that they are signed and dated, and that all entries are legible and in ink. Samples may be randomly checked for proper labeling.

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Performance audits may be completed to ensure that work is completed in a controlled manner and that data quality requirements are met.

4.1.2 Laboratory Audits

The laboratories selected for analysis will have their own system of routine performance and system audits. As such, the contractor will not perform audits of the laboratory unless deemed necessary.

4.1.3 Corrective Actions

Corrective actions for adverse findings from field and performance audits will be promptly implemented to restore compliance with the procedures, guideline, and inspection protocols outlined in the Work Plan and this QAPP. Corrective actions implemented in the field during the course of the treatability study will be recorded in the field log.

Corrective actions for laboratories are outlined in Section 3.4.2 and Appendix A. Laboratory data that would warrant a corrective action may include: data that falls outside acceptance criteria, incorrect calculation, data that exceeds the upper control limit (UCL) or lower control limit (LCL), data that was obtained outside the calibration range, and samples that were extracted and/or analyzed after the holding times specified by the test method.

4.2 Reports to Management

A Treatability study evaluation report will be submitted to the EPA 90 days after receipt of results from the final sampling event, which will occur approximately one year after substrate injection. Report will include at a minimum:

- Description of study activities
- A compilation of data collected during the study
- Concentration plots
- An evaluation of the results of the study
- Recommendations for future actions.

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Additional content may be incorporated into the evaluation report as necessary. Refer to Section 4.8 of the Work Plan for reporting content.

5 Data Validation and Usability

The following sections cover data validation, verification methods, and reconciliations with user requirements.

5.1 Data Review, Verification, and Validation

Data review will be performed by the contractor ensuring that:

- The COC is properly completed,
- Samples are analyzed before the holding time limit expires,
- Calculations and units are performed and reported correctly,
- Results obtained are within the working calibration range of instrument used, and
- Complete and correct sample information is available.

Data verification will be performed by the contractor ensuring that:

- Correct sampling procedures are followed,
- Samples are analyzed in accordance with the analytical method, and
- QC results meet the acceptance criteria for quality control limits identified in Section 3.5.2.

Data validation will be performed by the PQAO ensuring that QC results meet the quality objectives and criteria identified in Section 2.5. The quality control limits identified in Section 3.5.2 are sufficient to ensure an appropriate level of data quality to meet the project's quality objectives.

5.2 Verification and Validation Methods

The laboratory will conduct the initial review and verification of data. As part of the process, if necessary, data are flagged with qualifiers, which may include the following:

- J = Estimated result

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- U = Compound analyzed for, but not detected at or above the reporting limit.
- UJ = Non-detected compound associated with low bias in the CCV (continuous calibration)
- Q = Exceeds quality control limits.
- E = Exceeds instrument calibration range
- B = Compound present in laboratory blank greater than reporting limit (background subtraction not performed).

All data generated for this project will be screened by the contractor in accordance with Section 5.1 prior to incorporation into the site database and prior to any use of the data to derive conclusions. Wherever possible, the comparison to numeric quality control limits should be done electronically to avoid potential errors. If any results fall out of the quality control limits and quality objectives, the results will be further investigated. Data falling outside of these limits and objectives may be allowed into the database with the addition of a qualifier for each affected data record.

5.3 Reconciliation with Practitioner Requirements

The PQAO will validate data to confirm that the practitioner objectives have been satisfied per established criteria presented in Section 5.1 and that data are suitable for inclusion in data analysis. The Data Evaluation Manager will await the PQAO's completion of data validation before beginning data analysis, hypothesis testing, and report preparation. Based on preliminary evaluation of data and data use, the PQAO may select all or a portion of the data for full, independent (third party) validation consistent with the latest version of the National Functional Guidelines for Superfund Organic Methods Data Review by EPA.

The project report will present data analysis and data interpretations. The report narrative will provide an explanation for the means by which conclusions and recommendations were reached. The report will explain why or why not the data is suitable for drawing conclusions for risk assessment and mitigation measures.

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Locus Technologies, 2011, Five-Year Status Report and Remedial Effectiveness Evaluation, 2006 to 2010, 811 East Arques Avenue Site, Sunnyvale, California

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Tables

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Table 1. Project Distribution List.

Title	Name (Affiliation)	Tel. No.
EPA Project Manager	Melanie Morash, EPA	913-538-2357
Philips Project Manager	Shau-Luen Barker, Philips	913-538-2124
Locus Project Manager	J. Wesley Hawthorne, Locus	415-799-9937
Project Quality Assurance Officer	Sean Sandborgh, Locus	415-692-5435

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Table 2. Project Personnel and Contact Information.

Name	Organizational Affiliation	Title and Responsibilities	Contact Information
Melanie Morash	EPA	EPA Project Manager Oversee all aspects of data collection, analysis, interpretation, and reporting; lead community outreach	415-972-3050 morash.melanie@epa.gov
Shau-Luen Barker	Philips Electronics North America Corporation	Philips Project Manager Oversee and coordinate all aspects of contractor implementation, data collection, analysis, interpretation, and reporting	913-538-2357 shauluen.barker@philips.com
J. Wesley Hawthorne, P.E., P.G.	Locus Technologies	Locus Project Manager Maintain project schedule, budget, and communication with Philips and EPA project managers; Prepare bioremediation and sampling design; Provide QA/QC	415-799-9937 hawthornej@locustec.com
Dan Ducasse	Locus Technologies	Field Services Coordinator Support EAB injection contractor; Manage Locus field and sampling technicians	408-640-8174 ducassed@locustec.com
Nancy-Jeanne LeFevre, P.E.	Locus Technologies	Project Supervisor Coordinate and support design, implementation and reporting	415-992-5360 lefevren@locustec.com
Linda Ocampo, E.I.T	Locus Technologies	Data Evaluation Manager Field supervision, data validation, evaluation, and reporting	415-799-9964 ocampol@locustec.com

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Name	Organizational Affiliation	Title and Responsibilities	Contact Information
Sean Sandborgh, PhD, P.E.	Locus Technologies	Project Quality Assurance Officer Confirm contractor data verification, data validation, and confirming data integrity, updating QAPP, error tracking, use G-8 process	415-692-5435 sandborghs@locustec.com
TBD		EAB Injection Contractor Field services associated with EAB injection including drilling and preparation of materials to be injected	
Dina Ali	Curtis & Tompkins	Lab Project Manager Receive, record, prepare, extract, analyze VOC and General Chemistry samples; report results	510-204-2223 dina.ali@ctberk.com
Ruth Welsh	Pace Analytical Energy Services, LLC	Lab Project Manager Receive, record, prepare, extract, analyze VFA, Hydrogen, Dissolved Gases, and Carbon Dioxide samples; report results	412-826-5245 Ruth.Welsh@pacelabs.com
Kate Clark	Microbial Insights, Inc.	Lab Project Manager Receive, record, prepare, extract, analyze DHC samples; report results	865-573-8188 kclark@microbe.com

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Table 3. Document Retention, Archive, and Disposition.

	Identify Type Needed	Retention	Archival	Disposition
Sample Collection Records	Hard Copy	5 year	20 years	On file with Locus
	PDF	5 years	20 years	On file with Locus
Field Records	Hard Copy	5 year	20 years	On file with Locus
	PDF	5 years	20 years	On file with Locus
Analytical Records	PDF	5 years	20 years	On file with Locus
	Relational Database	5 years	20 years	On file with Locus
Final Report	PDF	5 years	20 years	On file with Locus

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Table 4. Baseline and Post-Injection Groundwater Sampling Frequency, Analysis, and Field Measurements for Selected Monitoring Wells in the Arques Treatability Study.

Sampling Wells	Sampling Frequency	Sample Analysis – Analytical Method	Field Measurements
S049A S134A S138A S137A S139A S143A S146A S140A S141A	Baseline VOCs, Geochemical, and Biological Monthly (post-injection) Month (1-3): VOCs and Geochemical parameters Quarterly (post-injection) Quarter (1-4): Biological Quarter (2-4): VOCs and Geochemical parameters	Chlorinated VOCs (eight COCs plus PCE) - EPA 8260 Nitrate and Sulfate - EPA 300.0 Alkalinity (as CaCO3) - SM2320B Dissolved Metals (Manganese, Arsenic, Iron) – HACH or EPA 200.7 TOC - SM5310C Sulfide - SM4500 Methane, Ethane, Ethene - RSK175 Metabolic Acids (lactic, pyruvic, acetic, propionic, and butyric)or Volatile Fatty Acids (VFA) - AM23G Hydrogen - AM20GAX Carbon Dioxide - AM20GAX Dechlorinating Bacteria (DHC) - CENSUS	pH Specific Conductance Temperature Dissolved Oxygen (DO) Oxidation-Reduction Potential (ORP) Water Level Measurements

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Appendix A
Laboratory and Field Measurement Device Documentation

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Curtis & Tompkins Laboratories

FULL SERVICE ENVIRONMENTAL ANALYTICAL TESTING

Summary of Control Limits

Dina Ali
Project Manger
2/14/16

EPA 300.0, EPA 9056, EPA 9056A QC Limits

C&T In-House Limits
effective: Jan 12, 2015

Matrix	Analyte	LCS/LCSD Recovery	RPD	MS/MSD Recovery	RPD
Water	Fluoride	75 - 120	20	79 - 120	20
	Chloride	80 - 120	20	79 - 120	20
	Nitrogen, Nitrite	80 - 120	20	80 - 120	20
	Bromide	80 - 120	20	80 - 120	20
	Nitrogen, Nitrate	80 - 120	20	80 - 120	20
	Orthophosphate (as P)	80 - 120	20	80 - 145	20
	Sulfate	80 - 120	20	80 - 120	20
Soil	Fluoride	78 - 120	20	68 - 130	30
	Chloride	80 - 120	20	70 - 130	30
	Nitrogen, Nitrite	80 - 120	20	70 - 130	30
	Bromide	80 - 120	20	70 - 130	30
	Nitrogen, Nitrate	80 - 120	20	70 - 130	30
	Orthophosphate (as P)	80 - 120	20	70 - 130	30
	Sulfate	80 - 120	20	70 - 130	30

C&T internal list numbers: 93587, 93589

EPA 624, EPA 8260B, EPA 8260C QC Limits

C&T In-House Limits
effective: Jan 28, 2015

Matrix	Analyte	LCS/LCSD Recovery	RPD	MS/MSD Recovery	RPD
Water	Acrolein	62 - 140	20	52 - 150	30
	Acrylonitrile	57 - 144	20	47 - 154	30
	Ethanol	32 - 158	46	48 - 152	45
	Iodomethane	1 - 155	53	18 - 151	55
	1,1-Dichloroethene	66 - 135	24	73 - 129	25
	Benzene	80 - 123	20	80 - 120	20
	Trichloroethene	80 - 123	20	73 - 123	20
	Toluene	80 - 121	20	80 - 120	21
	Chlorobenzene	80 - 123	20	80 - 120	24
	Freon 12	45 - 131	29	54 - 126	29
	Chloromethane	48 - 133	25	54 - 121	27
	Vinyl Chloride	63 - 132	23	66 - 126	24
	Bromomethane	38 - 161	32	31 - 152	39
	Chloroethane	62 - 131	24	69 - 126	29
	Trichlorofluoromethane	64 - 137	23	71 - 132	24
	Acetone	46 - 151	29	47 - 129	27
	Freon 113	61 - 138	25	67 - 127	25
	Methylene Chloride	74 - 131	21	80 - 127	21
	MTBE	65 - 120	22	71 - 120	20
	Carbon Disulfide	63 - 150	25	76 - 138	24
	trans-1,2-Dichloroethene	72 - 134	22	79 - 127	23
	Vinyl Acetate	60 - 194	25	62 - 173	24
	1,1-Dichloroethane	68 - 127	21	77 - 123	22
	2-Butanone	50 - 141	24	56 - 134	25
	cis-1,2-Dichloroethene	73 - 129	20	74 - 126	21
	2,2-Dichloropropane	72 - 146	24	69 - 130	29
	Chloroform	73 - 126	20	80 - 123	22
	Bromochloromethane	78 - 127	20	80 - 122	20
	1,1,1-Trichloroethane	72 - 134	22	80 - 130	23
	1,1-Dichloropropene	79 - 135	23	80 - 128	22
	Carbon Tetrachloride	72 - 142	22	80 - 138	24
	1,2-Dichloroethane	74 - 133	20	80 - 130	20
	1,2-Dichloropropane	74 - 120	20	80 - 120	20
	Bromodichloromethane	79 - 121	20	80 - 120	20
	Dibromomethane	80 - 120	20	80 - 120	20
	Epichlorohydrin	80 - 120	20	80 - 120	20
	4-Methyl-2-Pentanone	57 - 129	23	67 - 130	22
	cis-1,3-Dichloropropene	80 - 130	20	80 - 125	20
	trans-1,3-Dichloropropene	76 - 122	20	77 - 120	20
	1,1,2-Trichloroethane	80 - 120	20	80 - 120	20
	2-Hexanone	49 - 136	24	57 - 131	24
	1,3-Dichloropropane	80 - 120	20	80 - 120	20
	Tetrachloroethene	78 - 130	21	77 - 122	22
	Dibromochloromethane	80 - 123	20	80 - 120	20
	1,2-Dibromoethane	80 - 120	20	80 - 120	20
	2-Chloroethylvinylether	1 - 120	64	1 - 120	84
	1,1,1,2-Tetrachloroethane	80 - 124	20	80 - 120	20

Matrix	Analyte	LCS/LCSD Recovery	RPD	MS/MSD Recovery	RPD
	1,1,1,2-Tetrachloroethane	80 - 126	22	48 - 122	49
	Ethylbenzene	80 - 122	20	45 - 120	55
	m,p-Xylenes	80 - 127	20	45 - 123	53
	o-Xylene	80 - 125	20	44 - 122	55
	Styrene	80 - 121	20	40 - 120	55
	Bromoform	77 - 132	22	45 - 125	49
	Isopropylbenzene	76 - 128	20	40 - 124	58
	1,1,2,2-Tetrachloroethane	70 - 127	22	29 - 120	57
	1,2,3-Trichloropropane	70 - 126	24	44 - 120	48
	Propylbenzene	79 - 129	20	36 - 121	57
	Bromobenzene	80 - 123	20	38 - 120	54
	1,3,5-Trimethylbenzene	80 - 132	20	36 - 123	59
	2-Chlorotoluene	80 - 130	20	40 - 120	59
	4-Chlorotoluene	80 - 129	20	35 - 120	57
	tert-Butylbenzene	79 - 127	20	36 - 126	58
	1,2,4-Trimethylbenzene	79 - 129	20	33 - 120	60
	sec-Butylbenzene	80 - 131	20	32 - 126	55
	Methyl Isothiocyanate	50 - 150	20	50 - 150	30
	para-Isopropyl Toluene	75 - 130	20	27 - 122	59
	1,3-Dichlorobenzene	80 - 133	20	30 - 120	59
	1,4-Dichlorobenzene	80 - 131	20	29 - 120	63
	n-Butylbenzene	73 - 140	22	22 - 124	61
	1,2-Dichlorobenzene	80 - 125	20	30 - 120	62
	1,2-Dibromo-3-Chloropropane	66 - 122	24	31 - 120	54
	1,2,4-Trichlorobenzene	74 - 143	23	10 - 121	59
	Hexachlorobutadiene	76 - 146	21	11 - 131	63
	Naphthalene	63 - 135	21	16 - 120	59
	1,2,3-Trichlorobenzene	80 - 140	21	9 - 120	61
	tert-Butyl Alcohol (TBA)	49 - 131	40	44 - 120	46
	Isopropyl Ether (DIPE)	54 - 129	24	46 - 120	41
	Ethyl tert-Butyl Ether (ETBE)	60 - 120	24	48 - 120	40
	Methyl tert-Amyl Ether (TAME)	70 - 120	22	52 - 120	36
	Isopropanol	42 - 136	47	30 - 120	51
	Cyclohexanone	1 - 149	85	1 - 120	95
	Tetrahydrofuran	53 - 138	28	46 - 120	39
	1-Chlorohexane	69 - 125	20	37 - 120	52
	1,4-Dioxane	42 - 148	20	67 - 125	30
	n-Hexane	66 - 146	22	39 - 135	52
	Gasoline C5-C12	55 - 130	20	45 - 140	30
	Gasoline C6-C10	57 - 137	20	47 - 147	30
	Gasoline C7-C12	67 - 125	20	57 - 135	30
	Dibromofluoromethane	78 - 134		78 - 134	
	1,2-Dichloroethane-d4	80 - 138		80 - 138	
	Toluene-d8	80 - 120		80 - 120	
	Bromofluorobenzene	78 - 123		78 - 123	
	Trifluorotoluene	52 - 147		52 - 147	

C&T internal list numbers: 93637

SM2320B QC Limits

C&T In-House Limits
effective: Jan 12, 2015

Matrix	Analyte	LCS/LCSD Recovery	RPD	MS/MSD Recovery	RPD
Water	Alkalinity, Bicarbonate	90 - 110	20	80 - 120	25
	Alkalinity, Carbonate	90 - 110	20	80 - 120	25
	Alkalinity, Hydroxide	90 - 110	20	80 - 120	25
	Alkalinity, Total as CaCO3	90 - 110	20	80 - 120	25
	Carbonate	90 - 110	20	80 - 120	25
	Bicarbonate	90 - 110	20	80 - 120	25

C&T internal list numbers: 93662

SM3500FE-B QC Limits

C&T In-House Limits
effective: Jan 12, 2015

Matrix	Analyte	LCS/LCSD Recovery	RPD	MS/MSD Recovery	RPD
Water	Ferric Iron (Fe+3)	90 - 110	20	80 - 120	20
	Ferrous Iron (Fe+2)	90 - 110	20	80 - 120	20

C&T internal list numbers: 93670

SM4500S2-D QC Limits

C&T In-House Limits
effective: Jan 12, 2015

Matrix	Analyte	LCS/LCSD Recovery	RPD	MS/MSD Recovery	RPD
Water	Sulfide	90 - 110	20	34 - 121	31

C&T internal list numbers: 93686

SM5310C QC Limits

C&T In-House Limits
effective: Jan 12, 2015

Matrix	Analyte	LCS/LCSD Recovery	RPD	MS/MSD Recovery	RPD
Water	Total Organic Carbon	90 - 110	20	35 - 129	44

C&T internal list numbers: 93691

Curtis & Tompkins Laboratories

FULL SERVICE ENVIRONMENTAL ANALYTICAL TESTING

Summary of RLs and MDLs

Dina Ali
Project Manger
2/14/16

Reference Limits and Evaluation Table
2/14/2016

Matrix :	Water		
Method :	EPA 8260 (8010)		
Analyte	**CAS #**	**RL (ug/L)**	**MDL (ug/L)**
1,1-Dichloroethene	75-35-4	0.5	0.159
Benzene	71-43-2	0.5	0.149
Trichloroethene	79-01-6	0.5	0.116
Toluene	108-88-3	0.5	0.115
Chlorobenzene	108-90-7	0.5	0.13
Freon 12	75-71-8	1	0.173
Chloromethane	74-87-3	1	0.272
Vinyl Chloride	75-01-4	0.5	0.154
Bromomethane	74-83-9	1	0.209
Chloroethane	75-00-3	1	0.267
Trichlorofluoromethane	75-69-4	1	0.228
Acetone	67-64-1	10	3.3
Freon 113	76-13-1	2	0.173
Methylene Chloride	75-09-2	5	0.179
MTBE	1634-04-4	0.5	0.119
Carbon Disulfide	75-15-0	0.5	0.12
trans-1,2-Dichloroethene	156-60-5	0.5	0.158
Vinyl Acetate	108-05-4	10	1.15
1,1-Dichloroethane	75-34-3	0.5	0.159
2-Butanone	78-93-3	10	0.581
cis-1,2-Dichloroethene	156-59-2	0.5	0.149
2,2-Dichloropropane	594-20-7	0.5	0.155
Chloroform	67-66-3	0.5	0.117
Bromochloromethane	74-97-5	0.5	0.151
1,1,1-Trichloroethane	71-55-6	0.5	0.146
1,1-Dichloropropene	563-58-6	0.5	0.13
Carbon Tetrachloride	56-23-5	0.5	0.159
1,2-Dichloroethane	107-06-2	0.5	0.107
1,2-Dichloropropane	78-87-5	0.5	0.15
Bromodichloromethane	75-27-4	0.5	0.121
Dibromomethane	74-95-3	0.5	0.146
4-Methyl-2-Pentanone	108-10-1	10	0.654
cis-1,3-Dichloropropene	10061-01-5	0.5	0.105
trans-1,3-Dichloropropene	10061-02-6	0.5	0.139
1,1,2-Trichloroethane	79-00-5	0.5	0.16
2-Hexanone	591-78-6	10	0.5
1,3-Dichloropropane	142-28-9	0.5	0.149
Tetrachloroethene	127-18-4	0.5	0.156
Dibromochloromethane	124-48-1	0.5	0.146
1,2-Dibromoethane	106-93-4	0.5	0.134

2-Chloroethylvinylether	110-75-8	2	0.258
1,1,1,2-Tetrachloroethane	630-20-6	0.5	0.111
Ethylbenzene	100-41-4	0.5	0.156
m,p-Xylenes	1330-20-7	0.5	0.145
o-Xylene	95-47-6	0.5	0.154
Styrene	100-42-5	0.5	0.147
Bromoform	75-25-2	1	0.179

Matrix : Water
Method : EPA 300.0

Analyte	**CAS #**	**RL(mg/L)**	**MDL (mg/L)**
Chloride	16887-00-6	0.20	0.03
Nitrogen, Nitrite	14797-65-0	0.05	0.01
Nitrogen, Nitrate	14797-55-8	0.05	0.01
Sulfate	14808-79-8	0.50	0.06

Matrix : Water
Method : EPA 6010
Prep Method : 3010

Analyte	**CAS #**	**RL (ug/L)**	**MDL (ug/L)**
Iron	7439-89-6	100	20

Method : **SM3500FE-B (Ferrous/Ferric Iron)**
Matrix : **Water**

Analyte	**CAS #**	**RL (mg/L)**	**MDL (mg/L)**
Ferric Iron (Fe+3)	0	0.1	
Ferrous Iron (Fe+2)	0	0.1	0.032

Method : **SM2320B (Alkalinity)**
Matrix : Water

Analyte	**CAS #**	**RL (mg/L)**	**MDL (mg/L)**
Alkalinity	--	1.0	N/A

Matrix :	Water		
Method :	SM5310		
Analyte	**CAS #**	**RL (mg/L)**	**MDL (mg/L)**
Total Organic Carbon	7440-44-0	0.5	0.106

Matrix :	Water		
Method :	SM4500S2-D		
Analyte	**CAS #**	**RL (mg/L)**	**MDL (mg/L)**
Sulfide	18496-25-8	0.04	0.0061

Summary of Calibration and QC Procedures for Methods Requested

Dina Ali
Project Manger
2/14/16

ALKALINITY
By Titration Method SMWW 2320B

5.0 QC REQUIREMENTS & DEFINITIONS

5.1 QC Requirements

QC Element	Frequency	Acceptance Limits	Corrective Action
Method Blank	1 for every batch of 20 or fewer samples	< RL	Report samples that are ND or >10x contamination; re-prepare and rerun all others
Laboratory Control Sample (LCS)	1 for every batch of 20 or fewer samples.	%Recovery: 90-110	Low recovery: reprep and reanalyze all samples. High recovery: Reprep and reanalyze samples with results >LOQ. Report results <LOQ. High RPD: Report ND samples, rerun all others
Matrix Spike (MS)/ Matrix Spike Duplicate (MSD)	1 pair for every batch of 20 or fewer samples.	%Recovery: 80-120 %RPD: ≤ 25	Flag results as possible matrix interference.
Initial Calibration Curve (ICAL)	Callibrate pH meter daily, prior to sample analysis, using buffers 4.0, 7.0, 10.0 SU	Slope: 92-102	
Initial Calibration Verification (ICV)	Not applicable to this analysis		
Continuing Calibration Verification (CCV)	Not applicable to this analysis		
Calibration Blanks (ICB/CCB)	Not applicable to this analysis		
Surrogates	Not applicable to this analysis		
Internal Standards	Not applicable to this analysis		

QC Element	Frequency	Acceptance Limits	Corrective Action
Method Detection Limit (MDL) Study	Not applicable to this analysis		
Limit of Detection (LOD)	Not applicable to this analysis		
Limit of Quantitation (LOQ)	Not applicable to this analysis		
Mechanical Burettes, Pipettes and Reagent Dispensers	Check calibration prior to first use then quarterly	See QA SOP for Pipettes & Dispensors for details	See SOP for Pipettes & Dispensors (QA 1.6) for details
Demonstration of Capability (DOC)	Each new analyst; annually thereafter	4 consecutive LCS within C&T recovery and RPD limits, or acceptable PT results	Retrain analyst and reanalyze DOC.

Note: The QC limits listed above are not specified in the method or based on control limits but are based on historical PT acceptance limits, because analysis is extremely technique dependent

ANIONS
By Ion Chromatography
EPA 300.0, EPA 9056, EPA 9056A

5.0 QC REQUIREMENTS & DEFINITIONS

5.1 Requirements

QC Element	Frequency	Acceptance Limits	Corrective Action
Method Blank	1 for every batch of 20 or fewer samples	<1/2 LOQ	Report samples that are ND or >10x contamination; rerun all others
Laboratory Control Sample (LCS) or Blank Spike (BS)/ Blank Spike Duplicate (BSD)	1 for every batch of 20 or fewer samples	*300.0:* %Recovery: 90 – 110 or tighter *9056*: Based on laboratory control charts *9056A*: %Recovery: 80 – 120 or tighter *QSM4.2*: %Recovery: 80-120%, or tighter *QSM5.0*: %Recovery within DoD limits. %RPD≤15	Low recovery: reprep and reanalyze all samples. High recovery: Reprep and reanalyze samples with results >LOQ. Report results <LOQ. High RPD: Report ND samples, rerun all others

Matrix Spike (MS)/ Matrix Spike Duplicate (MSD) OR Sample Spikes (SSPIKE) / Sample Duplicate (SDUP)	*300.0*: Spike 1 of every 10 or fewer samples (ie: run sample spikes on 2 different samples for a batch of 11-20 samples). No requirement for duplicate. *9056 / 9056A*: 1 spike and 1 duplicate per batch (≤20 samples). *QSM4.2*: One MS/MSD per batch (≤20 samples), plus additional duplicate. *QSM5.0*: One MS/MSD or SSPIKE/SDUP per batch (≤ 20 samples)	*300.0*: Limits based on statistical control charts *9056*: Limits based on statistical control charts *9056A*: %Recovery: 80 – 120 %RPD ≤ 15 for mid-range concentrations *QSM4.2/5.0*: %Recovery within LCS limits. %RPD≤15	Flag results as possible matrix interference.
Initial Calibration Curve (ICAL)	Prior to sample analysis or whenever CCVs fail and maintenance does not correct the problem	Minimum 6 points for Quadratic curve. Correlation Coefficient (r) ≥ 0.995	Perform instrument maintenance and reanalyze curve
Initial Calibration Blank (ICB)	After the ICAL curve and before the ICV	< ½ RL/LOQ	Identify and correct source of carryover. Reanalyze ICB before continuing.
Initial Calibration Verification (ICV)	After ICAL curve and prior to sample analysis	*300.0 / 9056 / 9056A*: %D ≤ 10 *QSM4.2/5.0*: %D ≤ 10	Perform maintenance and rerun; if still out, reanalyze curve.
Continuing Calibration Verification (CCV)	Beginning of each sequence, after every ten samples (excluding MB, LCS/BS/BSD), and at end of the sequence	*300.0*: %D ≤ 10 *9056*: %D ≤ 5 *9056A*: %D ≤ 10 *QSM4.2/5.0*: %D ≤ 10	Perform maintenance and rerun; if still out, reanalyze curve. See Section 9 below for sample guidance.
Continuing Calibration Blank (CCB)	After each CCV	<1/2 RL/LOQ	Report samples that are ND or >10x contamination; rerun all others
Internal Standards	Not applicable to this analysis		

Surrogates	Not applicable to this analysis		
Method Detection Limit (MDL) Study	When new instrument installed, or significant change made to process	≤1/3 LOQ; see MDL SOP for additional details	See MDL SOP
Limit of Detection (LOD)	Analyze on each instrument, quarterly (DoD QSM requirement)	Spike at 2 - 4x MDL and <LOQ; analytes detected	See MDL SOP
Limit of Quantitation (LOQ)	Analyze on one instrument, quarterly (DoD QSM requirement)	Spike at or above (up to 2x) the lowest ICAL standard. Recovery within 50-150%.	See LOQ SOP
"Linear" Calibration Range (LCR) study	LCR determined whenever a new instrument is installed or major repair is performed (clarification notes in AZ Info Update #114)	Include high point above normal calibration range; correlation coefficient R ≥ 0.995; Verification %D ≤10	Instrument maintenance and repeat, or re-establish calibration range
Performance Testing (PT) Sample	Semiannually	Results within study limits	Any failures must be investigated, corrected, and a new PT analyzed and passed before end of the semi-annual time-frame. Also, 2 of the most recent 3 PTs must have passed.
Demonstration of Capability (DOC)	Each new analyst; annually thereafter	*Initial*: 4 consecutive LCS within C&T recovery and RPD limits *Continuing*: Acceptable PT results or 4 consecutive LCS within C&T recovery and RPD limits	Retrain analyst and reanalyze DOC.

TOTAL ORGANIC CARBON
In Water Samples by SMWW 5310C

5.0 QC REQUIREMENTS & DEFINITIONS

5.1 Requirements

QC Element	Frequency	Acceptance Limits	Corrective Action
Method Blank	1 for every batch of 20 or fewer samples	< LOQ	Report samples that are ND or >10x contamination; rerun all others
Laboratory Control Sample (LCS) or Blank Spike (BS)/ Blank Spike Duplicate (BSD)	1 for every batch of 20 or fewer samples	%Recovery: 90 – 110 %RPD: statistically derived limit	Low recovery: reprep and reanalyze all samples. High recovery: Reprep and reanalyze samples with results ≥LOQ. Report results <LOQ. High RPD: Report ND samples, rerun all others
Matrix Spike (MS)/ Matrix Spike Duplicate (MSD)	1 for every batch of 20 or fewer samples	%Recovery & %RPD: statistically derived limits	Flag results as possible matrix interference.
Initial Calibration Curve (ICAL)	Prior to sample analysis or whenever CCVs fail and maintenance does not correct the problem	Minimum 5 points: Correlation Coefficient (r) ≥ 0.995	Perform instrument maintenance and reanalyze curve
Initial Calibration Verification (ICV)	After ICAL curve and prior to sample analysis	%D ≤ 10	Perform maintenance and rerun; if still out, reanalyze curve.
Continuing Calibration Verification (CCV)	After every ten samples (excluding MB, LCS/BS/BSD), and at end of the sequence	%D ≤ 10	Perform maintenance and rerun; if still out, reanalyze curve. See Section 9 below for sample guidance.

Initial Calibration Blank (ICB) Continuing Calibration Blank (CCB)	After each ICV & CCV	C&T Requirement: < ½ RL	Report samples that are ND or >10x contamination; rerun all others
Instrument Performance Check (Inorganic Carbon Removal)	Annually or when new type of instrument is installed or significant change made to conditions (purge flow rate, purge time)	Add inorganic carbon (Na_2CO_3) to representative samples. Results with and without I.C. should agree to within the statistically determined %RPD limit for SDUPs and MSD's.	Modify instrument conditions to obtain complete removal of inorganic carbon.
Method Detection Limit (MDL) Study	When new instrument installed, or significant change made to process	<1/3 LOQ; see MDL SOP for additional details	See MDL SOP
Limit of Detection (LOD)	Analyze on each instrument, quarterly (DoD QSM requirement)	Spike at 1-4x MDL and <LOQ; analytes detected	See MDL SOP
Limit of Quantitation (LOQ)	Analyze on one instrument, quarterly (DoD QSM requirement)	Spike at or above (up to 2x) the lowest ICAL standard. Recovery within 50-150%.	See LOQ SOP
Demonstration of Capability (DOC)	Each new analyst; annually thereafter	*Initial*: 4 consecutive LCS within C&T recovery and RPD limits *Continuing*: Acceptable PT results or 4 consecutive LCS within C&T recovery and RPD limits	Retrain analyst and reanalyze DOC.

FERROUS IRON
by SMWW 3500Fe-B

5.0 QC REQUIREMENTS & DEFINITIONS

5.1 Requirements

QC Element	Frequency	Acceptance Limits	Corrective Action
Method Blank	1 for every batch of 20 or fewer samples	< RL *QSM 4.2/5.0:* < ½ RL	Report samples that are ND or >10x contamination; re-prepare and rerun all others
Laboratory Control Sample (LCS) - OR – Blank Spike (BS) / Blank Spike Duplicate (BSD)	1 for every batch of 20 or fewer samples. If insufficient sample was submitted for the MS/MSD, substitute a BS/BSD pair for the LCS/MS/MSD	*C&T Requirement:* %Recovery: 90 – 110 *QSM4.2/5.0:* Not specified. Use in-house limits.	Low recovery: reprep and reanalyze all samples. High recovery: Reprep and reanalyze samples with results >LOQ. Report results <LOQ.
Matrix Spike (MS)/ Matrix Spike Duplicate (MSD)	1 pair for every batch of 20 or fewer samples.	%Recovery & %RPD within statistically determined limits. *QSM 4.2 / 5.0:* Not specified. Use in-house LCS limits.	Flag results as possible matrix interference.
Initial Calibration Curve (ICAL)	*C&T Requirement:* When new equipment is installed, after major instrument maintenance, or when ICV/CCVs fail. Minimum 5 points + a blank *QSM4.2/5.0:* Not specified	*C&T Requirement:* Correlation Coefficient r $\geq$ 0.995 *QSM4.2/5.0:* Not specified	Perform instrument maintenance and reanalyze curve
Initial Calibration Verification (ICV)	*C&T Requirement:* Daily, prior to sample analysis *QSM4.2/5.0:* Not specified	*C&T Requirement:* %D $\leq$ 10 *QSM4.2/5.0:* Not specified	Perform maintenance and rerun; if still out, reanalyze curve.

QC Element	Frequency	Acceptance Limits	Corrective Action
Continuing Calibration Verification (CCV)	*C&T Requirement:* After every 10 field samples (excludes MB, LCS/BS/BSD), and at end of the sequence *QSM4.2/5.0:* Not specified	*C&T Requirement:* %D ≤ 10 *QSM4.2/5.0:* Not specified	Perform maintenance and rerun; if still out, reanalyze curve. See Section 9 below for sample guidance.
Calibration Blanks (ICB/CCB)	*C&T Requirement:* After each ICV and CCV *QSM4.2/5.0:* Not specified	*C&T Requirement:* <RL/LOQ *QSM4.2/5.0:* Not specified	Report samples that are ND or >10x contamination; rerun all others
Mechanical Pipettes and Reagent Dispensers	Check calibration quarterly	See QA SOP for Pipettes & Dispensors for details	See SOP for Pipettes & Dispensors (QA 1.6) for details
Surrogates	Not applicable to this analysis		
Internal Standards	Not applicable to this analysis		
Method Detection Limit (MDL) Study	When new instrument installed, or significant change made to process	≤1/3 LOQ; see MDL SOP for additional details	See MDL SOP (QA 4.4)
Limit of Detection (LOD)	Analyze on each instrument, quarterly (DoD requirement)	Spike at 2-4x MDL and <LOQ; analyte must be detected	See MDL SOP (QA 4.4)
Limit of Quantitation (LOQ)	Analyze on one instrument, quarterly (DoD requirement)	Spike at or above (up to 2x) the lowest ICAL standard. Recovery within 50-150%.	See LOQ SOP (QA 4.6)
Demonstration of Capability (DOC)	Each new analyst; annually thereafter	*Initial*: 4 consecutive LCS within C&T recovery and RPD limits; *Ongoing*: Another 4 LCS or acceptable PT results	Retrain analyst and reanalyze DOC.

Dissolved Gases
RSK-175 Modified

5.0 QC REQUIREMENTS & DEFINITIONS

5.1 Requirements

QC Element	Frequency	Acceptance Limits	Corrective Action
Method Blank	1 for every batch of 20 or fewer samples	< RL/LOQ *QSM5.0:* <1/2 RL/LOQ	Report samples that are ND or >10x contamination; rerun all others
Blank Spike (BS)/ Blank Spike Duplicate (BSD)	1 pair for every batch of 20 or fewer samples	%Recovery & %RPD within acceptance limits *QSM5.0*: %Recovery within limits listed in Appendix C, Table 42	Low recovery: reprep and reanalyze all samples. High recovery: Reprep and reanalyze samples with results ≥LOQ. Report results <LOQ. High RPD: Report ND samples, rerun all others
Matrix Spike (MS)/ Matrix Spike Duplicate (MSD)	1 pair for every batch of 20 or fewer samples (if sufficient sample volume was submitted)	%Recovery & %RPD within acceptance limits *QSM5.0*: Within LCS limits	Flag results as possible matrix interference.
Initial Calibration (ICAL)	Prior to sample analysis or whenever CCVs fail and maintenance does not correct the problem Minimum 5 points	%RSD ≤ 30 *QSM5.0:* %RSD ≤ 20 Or Linear Correlation Coefficient (r^2) ≥ 0.99	Perform instrument maintenance and reanalyze curve
Initial Calibration Verification (ICV)	Immediately following ICAL, prior to sample analysis	%D ≤ 20 *QSM5.0:* %D ≤ 20	Perform maintenance and rerun; if still out, reanalyze curve.
Continuing Calibration Verification (CCV)	At the beginning of each sequence, prior to sample analysis, after every 10 field samples, and at the end of the sequence	%D ≤ 20 *QSM5.0:* %D ≤ 20	Rerun to confirm problem. If still out, perform maintenance and run a new ICAL. Rerun affected samples; see Section 10.2 below for sample guidance.

Instrument Blanks	After the opening CCV, to demonstrate lack of carryover. Also run after suspected high-level samples to clean instrument.	Those run after the CCV should be <RL	Perform instrument maintenance; rerun any samples associated with contaminated blank
Surrogate	Not required for this analysis		
Internal Standards	Not applicable to this procedure		
Method Detection Limit (MDL) Study	When new instrument installed, or significant change made to process	≤1/3 LOQ; see MDL SOP for additional details	See MDL SOP
Limit of Detection (LOD)	Analyze on each instrument, quarterly (DoD QSM requirement)	Spike at 2-4x MDL and <LOQ; analytes detected	See MDL SOP
Limit of Quantitation (LOQ)	Analyze on one instrument, quarterly (DoD QSM requirement)	Spike at or above (up to 2x) the lowest ICAL standard. Recovery within 50-150%	See LOQ SOP
Demonstration of Capability (DOC)	Each analyst; upon completion of training & annually thereafter	*Initial:* 4 consecutive LCS within recovery and RPD limits *Continuing:* Another 4 consecutive LCS, or acceptable PT results	Retrain analyst and reanalyze DOC.

Volatile Organic Compounds by GC/MS
in Soil &Solid Wastes, Surface & Ground Water by EPA 8260B and 8260C
and in Wastewater by EPA 624

5.0 QC REQUIREMENTS & DEFINITIONS

5.1 Requirements

QC Element	Frequency	Acceptance Limits	Corrective Action
Tune Check	Beginning of each 12 hour "tune shift", before the CCV and samples. *8260B*: 5 – 50ng BFB *8260C*: ≤50ng BFB *8260B/ 8260C:* Recommends 3 scans (apex plus one to either side). Requires background subtraction to eliminate column bleed or instrument background ions.	BFB ion abundances within criteria listed in Appendix_8	Retune instrument and rerun check; if still out, perform instrument maintenance and retune instrument, then rerun tune check. CCV and samples may not be run until BFB passes.
Continuing Calibration Verification (CCV)	Beginning of each 12 hour shift, immediately following the BFB Tune std and before any samples	***C&T Normal Requirements*** *(see Appendix_8 for discussion):* ▪ minRRF as required by method being reported (see Appendix_17), ▪ For those not specified in Appendix_17, RRF≥0.05, except those with raised RLs RRF≥0.05/RL; ▪ CCC %D≤20, ▪ Non-CCC %D≤30, except poor performers, %D≤40 ***8260B***: ▪ SPCC minRRF as required by method (see Appendix_17), ▪ CCC %D≤20, ▪ Non-CCC, non-SPCC not addressed ▪ ISTD RT within 30 seconds of ICAL mid-	Perform maintenance and rerun; if still out, reanalyze curve. See Section 7 below for sample guidance.

QC Element	Frequency	Acceptance Limits	Corrective Action
		point ***8260C***: ▪ minRRF as required by method (see Appendix_17) ▪ %D ≤20 ▪ If >20% of the compound list fails the %D requirement, corrective action must be taken ▪ Compounds failing the %D limit may be reported as ND if the minRRF was met ***EPA 624***: ▪ No minimum RRF requirements listed ▪ %D as listed in Table 5 of the method (see Appendix_16) ***QSM 4.2/ 5.0***: ▪ %D ≤ 20	
"Closing CCV" (QSMv5 only)	*QSM5.0:* After every 12 hours of analysis time and at the end of the sequence	***QSM 5.0:*** %D ≤ 50 8260C minRRF as required by method (see Appendix_17)	**For QSMv5.0 samples only:** *High Response:* ▪ Report ND samples without reanalysis. *For samples with hits:* ▪ Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or ▪ Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.

QC Element	Frequency	Acceptance Limits	Corrective Action
			Low Response: See 2nd and 3rd bullets above
Method Blank	1 for every batch of 20 or fewer samples	***C&T Normal Requirement***: ▪ <LOQ/RL ***QSM 4.2/ 5.0***: ▪ <1/2 LOQ ▪ common lab contaminants (i.e. MeCl2, Acetone) <LOQ	Report samples that are ND or >10x contamination; rerun all others
Laboratory Control Sample (LCS) - or - Blank Spike/ Blank Spike Duplicate (BS/BSD)	1 for every batch of 20 or fewer samples. All compounds within calibration range. If insufficient sample is available for an MS/MSD, substitute a BS/BSD for the LCS/MS/MSD set. 8260C: Recommends use of ICAL standard	***C&T Normal Requirements:*** ▪ %Recovery & %RPD within statistically derived limits; ***8260B/ 8260C***: ▪ Not specified ***QSM 4.2/ 5.0***: ▪ Within DoD recovery limits. If not listed, use in-house limits. Marginal exceedances not allowed for project compounds of concern	*Low recovery (<15%)*: Rerun all samples requiring the failing analyte. *High recovery*: Rerun samples with results ≥LOQ. Report results <LOQ. *High RPD*: Report ND samples, rerun all others Failures must be random; if the same analyte fails repeatedly, the problem must be corrected.

QC Element	Frequency	Acceptance Limits	Corrective Action
Matrix Spike/ Matrix Spike Duplicate (MS/MSD)	1 pair for every batch of 20 or fewer samples If insufficient sample is available for an MS/MSD, substitute a BS/BSD for the LCS/MS/MSD set. *EPA 624:* Requires only one matrix spike per 20 samples.	***C&T Normal Requirement:*** ▪ %Recovery & %RPD within statistically derived limits ***8260B/ 8260C:*** ▪ Not specified ***QSM 4.2:*** ▪ %Recovery within DoD LCS limits. ▪ %RPD ≤ 30 ***QSM 5.0:*** ▪ %Recovery within DoD LCS limits. ▪ %RPD ≤ 20	Review to ensure failure is not due to analytical error. Flag results as possible matrix interference. *Note:* if the client does not want to see spike results for MS/MSD performed on samples from a different site, and the project has been configured correctly, LIMS will not give you the option to print the MS/MSD forms if performed on samples from a different project
Surrogates	Added to every standard, QC, and sample	***C&T Normal Requirement:*** ▪ %Recovery & %RPD within statistically derived limits ***EPA 624/ 8260B/ 8260C:*** ▪ %Recovery within statistically generated limits. ***QSM 4.2:*** ▪ %Recovery within QSM Table G-3 limits. If not listed, use in-house limits. ***QSM 5.0:*** ▪ %Recovery within QSM Appendix C limits. If not listed, use in-house limits.	*Low recovery:* Rerun all samples unless failure is due to a known matrix interference (ie: carbon) or site history. *High recovery:* Report results <LOQ. Rerun samples with hits >LOQ unless failure is due to a known matrix interference (ie: carbon), site history, or obvious chromatographic interference *QSM 4.2/ 5.0:* High recovery: Report samples that are completely ND for target compounds associated with the failing surrogate. Low recovery: Rerun
Internal Standards	Add to every sample, batch QC, and standard	***8260B:*** ▪ %Recovery: 50 - 200 ▪ RT within ±30 seconds	Reanalyze affected samples.

QC Element	Frequency	Acceptance Limits	Corrective Action
		(0.5 minutes) of mid-point of the ICAL ***8260C***: ▪ %Recovery: 50 - 200 ▪ RT within ±10 seconds (0.167minutes) of mid-point of the ICAL ***EPA 624***: ▪ Not discussed ***QSM 4.2***: ▪ %Recovery: 50 - 200 ▪ RT within ±30 seconds (0.167minutes) of mid-point of the ICAL ***QSM 5.0***: ▪ %Recovery: 50 - 200 ▪ RT within ±10 seconds (0.167minutes) of mid-point of the ICAL	
Retention Times	Evaluate for each sample analyte and internal standard	***C&T Requirement:*** ▪ RT within 0.05 minutes (3 seconds) of the ICAL midpoint or opening CCV (on days that an ICAL is not run) ***8260B***: ▪ Target analytes within 0.06 RRT ▪ ISTD RT within ±30 seconds (0.5 minutes) of mid-point of the ICAL ▪ Target compound RT within 0.80 to 1.20 relative to its internal standard *8260C:* ▪ Target analytes within 0.06 RRT ▪ RT within ±10 seconds (0.167minutes) of mid-point of the ICAL ▪ Target compound RT	*C&T Requirement:* RRTs may be updated based on the most recent CCV *QSM 4.2/ 5.0:* RRTs may be updated based on the daily CCV.

QC Element	Frequency	Acceptance Limits	Corrective Action
		within 0.80 to 1.20 relative to its internal standard ***EPA 624***: ▪ ± 30 seconds ***QSM 4.2/ 5.0***: ▪ Target analytes within 0.06 RRT of ICAL midpoint or daily CCV	
Initial Calibration Curve (ICAL)	When instrument is first installed, after major instrument maintenance (detector cleaned, column changed, trap changed), after instrument conditions are changed, or whenever CCVs fail and maintenance does not correct the problem. Minimum 5 points + a blank. 6 points (minimum) for quadratic. Lowest point at or below RL.	***8260B***: ▪ CCC Avg RRF %RSD ≤ 30 (to use curve at all). ▪ For quantitation, Average RRF: %RSD ≤15, or ▪ Regression Coefficient (r) ≥ 0.995 or r^2 ≥ 0.99 ▪ Minimum RRF as required by method (see Appendix_17), ▪ C&T additional requirement: Non-SPCC RRF≥0.05, except those with raised RLs RRF≥0.05/RL; ***8260C***: ▪ Average RRF: %RSD ≤20, or ▪ Regression Coefficient (r) ≥ 0.995 or r^2 ≥ 0.99 ▪ Minimum RRF as required by method (see Appendix_17), ▪ C&T additional requirement: For targets not specified in Appendix_17, RRF≥0.05, except those with raised RLs RRF≥0.05/RL ▪ Requantitation of the lowest point should be within %D≤30; ***EPA 624***: ▪ Average RRF: %RSD ≤35 ▪ Regression Coefficient	Perform instrument maintenance and reanalyze curve.

QC Element	Frequency	Acceptance Limits	Corrective Action
		(r) ≥ 0.995 or r^2 ≥ 0.99 ***QSM 4.2***: ▪ As listed under 8260B requirement above (but does not discuss non-SPCC min RRF) ***QSM 5.0***: ▪ Avg RRF %RSD ≤15 ▪ Regression Coefficient (r) ≥ 0.995 or r^2 ≥ 0.99	
Initial Calibration Verification (ICV)	Mid-level standard run after ICAL curve and before any samples *2009 TNI-NELAP:* Requires 2nd source (either different manufacturer or 2nd lot) *8260B:* Not specifically discussed. LCS uses 2nd source. *8260C:* Immediately after the ICAL, using a second source (prepared using standards "different from the calibration standards" *EPA 624:* Not discussed *QSM 4.2/ 5.0:* After each ICAL	***C&T Requirement:*** ▪ Must meet CCV acceptance criteria for the method being reported. ***8260C:*** ▪ %D ≤ 30 ***QSM 4.2/ 5.0***: ▪ %D ≤ 20	Perform maintenance and rerun; if still out, reanalyze curve.
Method Detection Limit (MDL) Study	When a new instrument is installed, instrument conditions are changed, or other significant change made to process or equipment	<1/3 RL/LOQ; see MDL SOP for additional details	See MDL SOP
Limit of Detection (LOD)	Immediately following MDL then quarterly on each instrument (DoD QSM requirement)	Spike at 2 - 4x MDL and <LOQ; analytes must be detected at 3x background noise level. All qualitative criteria (3x signal to noise; secondary ions) must be met.	See MDL SOP

QC Element	Frequency	Acceptance Limits	Corrective Action
Limit of Quantitation (LOQ)	Analyze on one instrument, quarterly (DoD QSM requirement)	Spike between 1 - 2x RL/LOQ. %Recovery: 50-150 (or C&T LCS statistical recovery limits, whichever is wider).	See LOQ SOP
Mechanical Pipettes and Reagent Dispensers	Check calibration quarterly at minimum	See QA SOP for Pipettes & Dispensors for details	See QA SOP for Pipettes & Dispensors for details
Performance Testing (PT) Samples	Semiannually for each matrix (TNI/NELAP requirement).	Each analyte within study limits	Any failures must be investigated. A remedial PT may have to be analyzed.
Demonstration of Capability (DOC)	Each new analyst; annually thereafter	*Initial*: 4 consecutive LCS within C&T recovery and RPD limits. *Continuing*: Acceptable PT results or 4 consecutive LCS within C&T recovery and RPD limits.	Retrain analyst and reanalyze DOC.

Analyses Method, LOD, and LOQ

Analysis	Method	Matrix	Parameter	LOD	LOQ	TAT	Reporting Units
QuantArray	QuantArray	water	QuantArray-Chlorinated	100 cells/sample	500 cells/sample for DHC, BVC, TCE,VCR and 5000 cells/sample all other targets	1-2 weeks	cells/mL
QuantArray	QuantArray	soil/sediment	QuantArray-Chlorinated	100 cells/sample	500 cells/sample for DHC, BVC, TCE,VCR and 5000 cells/sample all other targets	1-2 weeks	cells/g
QuantArray	QuantArray	Bio-Trap	QuantArray-Chlorinated	100 cells/sample	500 cells/sample for DHC, BVC, TCE,VCR and 5000 cells/sample all other targets	1-2 weeks	cells/bd

Analyses QA/QC

Method	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
QuantArray	Assay Calibration (Standard Curve)	Primary – initial	Standard curve R2 >0.95	Rerun assay / check reagents.
QuantArray		Secondary – every plate (assay)	CT value within +/- 20% of known value	
QuantArray	Laboratory (sample) Duplicate	All field samples	CT value within +/- 20%	Rerun assay; if still not within 20%, flag J (estimate)
QuantArray	Field duplicate	At client's request & with sample submission	Not applicable	Not applicable
QuantArray	Assay Negative Control (Blank)	1 per analytical assay plate	values for positive samples are set above any fluorescence for the negative control	Rerun assay; may have to reoptimize assay
QuantArray	DNA extraction negative control	1 per analytical batch	CT < or = Assay Negative Control	Rerun assay or reextract samples if problem persists
QuantArray	Positive Control	1 per QuantArray plate	CT value within +/- 20% of known value	Rerun assay / check reagents

PAES Worksheet

Matrix: **Groundwater**
Analytes: **Carbon Dioxide**

Analytical Reference Table

Matrix	Analytical Group	Prep and Analytical Method Reference	Containers	Sample Volume	Preservation	Holding Time (prep/analysis)
Groundwater	Permanent Gases	Lab SOP	Two 40mL amber glass vial w/ butyl septa	80mL	Benzalkonium chloride (BAK); Cool to < 6 degrees C	14 days from collection

Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action(CA)	Person Responsible for CA	SOP Reference
Dissolved Gases GC/FID/TCD	Minimum five-point initial calibration (ICAL) for all target analytes	Initial calibration prior to sample analysis. Re-analyze calibration following major instrument maintanence and/or failures of CCV.	Coefficient of determination (r2) is $\geq$ 0.995; linear or quad fit types.	Make necessary instrument adjustments, check calibration standards. Repeat ICAL.	Analyst/Lab Manager	Lab SOP
	Initial Calibration Verification (ICV); must be from 2nd source; alternate source then used for the ICAL.	Immediately following the initial calibration.	All analytes within 15% of expected value; 85-115 percent recovery limits.	Analyze ICV a second time. If error persists, make necessary instrument adjustments, check calibration standards. Repeat ICAL.	Analyst/Lab Manager	Lab SOP
	Continuing Calibration Verification (CCV); from a second source; alternate source then used for the ICAL.	Beginning and end of each analytical shift and every 15 analyzed field samples.	All analytes within 15% of expected value; 85-115 percent recovery limits.	Analyze CCV a second time. If error persists, make necessary instrument adjustments, check calibration standards. Repeat ICAL and re-analyze all samples since the last successful CCV.	Analyst/Lab Manager	Lab SOP
	Initial and Continuing Calibration Blank (ICB/CCB).	Follows each ICV/CCV.	No analytes detected > RDL/PQL/LOQ. No analytes detected > 1/2 RDL/PQL/LOQ for DoD projects.	Analyze CCB a second time. If error persists, re-analyze all samples since the last successful CCB.	Analyst/Lab Manager	Lab SOP

Laboratory QC Samples Table

QC Sample ID	Frequency/Number	Acceptance Criteria	Corrective Action(CA)	Person Responsible for CA	Data Quality Indicator (DQI)	SOP Reference
Method Blank (MB)	One per analytical batch of 20 field samples.	No analytes detected > RDL/PQL/LOQ. No analytes detected > 1/2 RDL/PQL/LOQ for DoD projects.	Analyze MB a second time. If error persists, halt sample analysis until the error is corrected. Re-analyze samples if necessary.	Analyst/Lab Manager	Bias/Prep or Analysis Contamination	Lab SOP
Laboratory Control Sample and DUP (LCS/LCSD)	One per analytical batch of 20 field samples.	All analytes within 20% of expected value; 80-120 percent recovery limits; 0-20 relative percent difference.	Re-analyze. If error persists, halt sample analysis until the error is corrected. Repeat initial calibration if necessary.	Analyst/Lab Manager	Accuracy/Bias	Lab SOP
Matrix Spike and Duplicate (MS/MSD)	Per request for a given project or sampling event.	All analytes within 30% of expected value; 70-130 percent recovery limits; 0-20 relative percent difference.	If all other quality control samples are within method acceptance criteria, note matrix affects in case narrative and continue.	Analyst/Lab Manager	Precision/Accuracy/ Matrix affects	Lab SOP
Laboratory Duplicate	Not Applicable to the method. Suggest collection of field Duplicate(s).					

Reporting Limits Summary Table

Analyte	Units	Practical Quantitation Limit (PQL/RDL/LOQ)
Carbon Dioxide	mg/L or ppm	5.00

PAES Worksheet

Matrix: **Groundwater/Bubblestrip Collection**
Analytes: **Hydrogen**

Analytical Reference Table

Matrix	Analytical Group	Prep and Analytical Method/ Reference	Containers*	Sample Volume	Preservation	Holding Time (prep/analysis)
Groundwater w/ Bubblestrip Collection	Hydrogen, Light Hydrocarbons and Permanent Gases	Lab SOP	One 20cc Headspace vial, set to atmospheric pressure with UHP Nitrogen and a stopper type septa.	15cc volume removed from the bubble cell and transferred to the headspace vial.	None	14 days from collection

* Suggest collecting, at a minimum, one BAK preserved container per sample, in case the equilibrated bubble cell becomes unavailable during collection.

Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action(CA)	Person Responsible for CA	SOP Reference
Dissolved Gases GC/RGD	Minimum five-point initial calibration (ICAL) for all target analytes	Initial calibration prior to sample analysis. Re-analyze calibration following major instrument maintanence and/or failures of CCV.	Coefficient of determination (r2) is $\geq$ 0.995; linear or quad fit types.	Make necessary instrument adjustments, check calibration standards. Repeat ICAL.	Analyst/Lab Manager	Lab SOP
	Initial Calibration Verification (ICV); must be from 2nd source; alternate source then used for the ICAL.	Immediately following the initial calibration.	All analytes within 15% of expected value; 85-115 percent recovery limits.	Analyze ICV a second time. If error persists, make necessary instrument adjustments, check calibration standards. Repeat ICAL.	Analyst/Lab Manager	Lab SOP
	Continuing Calibration Verification (CCV); from a second source; alternate source then used for the ICAL.	Beginning and end of each analytical shift and every 15 analyzed field samples.	All analytes within 15% of expected value; 85-115 percent recovery limits.	Analyze CCV a second time. If error persists, make necessary instrument adjustments, check calibration standards. Repeat ICAL and re-analyze all samples since the last successful CCV.	Analyst/Lab Manager	Lab SOP
	Initial and Continuing Calibration Blank (ICB/CCB).	Follows each ICV/CCV.	No analytes detected > RDL/PQL/LOQ. No analytes detected > 1/2 RDL/PQL/LOQ for DoD projects.	Analyze CCB a second time. If error persists, re-analyze all samples since the last successful CCB.	Analyst/Lab Manager	Lab SOP

Laboratory QC Samples Table

QC Sample ID	Frequency/Number	Acceptance Criteria	Corrective Action(CA)	Person Responsible for CA	Data Quality Indicator (DQI)	SOP Reference
Method Blank (MB)	One per analytical batch of 20 field samples.	No analytes detected > RDL/PQL/LOQ. No analytes detected > 1/2 RDL/PQL/LOQ for DoD projects.	Analyze MB a second time. If error persists, halt sample analysis until the error is corrected. Re-analyze samples if necessary.	Analyst/Lab Manager	Bias/Prep or Analysis Contamination	Lab SOP
Laboratory Control Sample and DUP (LCS/LCSD)	One per analytical batch of 20 field samples.	All analytes within 20% of expected value; 80-120 percent recovery limits; 0-20 relative percent difference.	Re-analyze. If error persists, halt sample analysis until the error is corrected. Repeat initial calibration if necessary.	Analyst/Lab Manager	Accuracy/Bias	Lab SOP
Matrix Spike and Duplicate (MS/MSD)	Not Applicable to the method/matrix.					
Laboratory Duplicate	Not Applicable to the method. Suggest collection of field Duplicate(s).					

Reporting Limits Summary Table

Analyte	Units	Practical Quantitation Limit (PQL/RDL/LOQ)
Hydrogen	nM	0.60

PAES Worksheet

Matrix: **Groundwater**
Analytes: **Acetic, Propionic, Pyruvic, Butyric and Lactic Acids**

Analytical Reference Table

Matrix	Analytical Group	Prep and Analytical Method/ Reference	Containers	Sample Volume	Preservation	Holding Time (prep/analysis)
Groundwater	Volatile Fatty Acids; Electron Donors	Lab SOP	Two 40mL clear glass vial w/ silicon/clear septa	80mL	None; Cool to < 6 degrees C	21 days from collection

Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action(CA)	Person Responsible for CA	SOP Reference
Varian FID or equilavent	Minimum five-point initial calibration (ICAL) for all target analytes	Initial calibration prior to sample analysis. Re-analyze calibration following major instrument maintanence and/or failures of CCV.	Coefficient of determination (r2) is $\geq$ 0.995; linear or quad fit types.	Make necessary instrument adjustments, check calibration standards. Repeat ICAL.	Analyst/Lab Manager	AM21G-5.2.1
	Initial Calibration Verification (ICV); must be from 2nd source; alternate source then used for the ICAL.	Immediately following the initial calibration.	All analytes within 20% of expected value; 80-120 percent recovery limits.	Analyze ICV a second time. If error persists, make necessary instrument adjustments, check calibration standards. Repeat ICAL.	Analyst/Lab Manager	AM21G-5.2.2
	Continuing Calibration Verification (CCV).	Beginning and end of each analytical batch; not to exceed 12 hours.	All analytes within 20% of expected value; 80-120 percent recovery limits.	Analyze CCV a second time. If error persists, make necessary instrument adjustments, check calibration standards. Repeat ICAL and re-analyze all samples since the last successful CCV.	Analyst/Lab Manager	AM21G-5.4.1
	Initial and Continuing Calibration Blank (ICB/CCB).	Follows each ICV/CCV.	No analytes detected > RDL/PQL/LOQ. No analytes detected > 1/2 RDL/PQL/LOQ for DoD projects.	Analyze CCB a second time. If error persists, re-analyze all samples since the last successful CCB.	Analyst/Lab Manager	AM21G-5.4.2

Laboratory QC Samples Table

QC Sample ID	Frequency/Number	Acceptance Criteria	Corrective Action(CA)	Person Responsible for CA	Data Quality Indicator (DQI)	SOP Reference
Method Blank (MB)	One per analytical batch of 20 field samples.	No analytes detected > RDL/PQL/LOQ. No analytes detected > 1/2 RDL/PQL/LOQ for DoD projects.	Analyze MB a second time. If error persists, halt sample analysis until the error is corrected. Re-analyze samples if necessary.	Analyst/Lab Manager	Bias/Prep or Analysis Contamination	AM21G-5.4.3
Laboratory Control Sample (LCS)	One per analytical batch of 20 field samples.	All analytes within 30% of expected value; 70-130 percent recovery limits.	Re-analyze. If error persists, halt sample analysis until the error is corrected. Repeat initial calibration if necessary.	Analyst/Lab Manager	Accuracy/Bias	AM21G-5.4.4
Matrix Spike and Duplicate (MS/MSD)	One per analytical batch of 20 field samples.	All analytes within 30% of expected value; 70-130 percent recovery limits; 0-20 relative percent difference.	If all other quality control samples are within method acceptance criteria, note matrix affects in case narrative and continue.	Analyst/Lab Manager	Precision/Accuracy/ Matrix affects	AM21G-5.4.5
Laboratory Duplicate	Not Applicable to the method. Suggest collection of field Duplicate(s).					

Reporting Limits Summary Table

Analyte	Units	Practical Quantitation Limit (PQL/RDL/LOQ)
Acetic Acid	mg/L or ppm	5.0
Propionic Acid	mg/L or ppm	5.0
Butyric Acid	mg/L or ppm	5.0
Pyruvic Acid	mg/L or ppm	5.0
Lactic Acid	mg/L or ppm	10.0

PAES Worksheet

Matrix: **Groundwater**
Analytes: **Methane, Ethane, Ethene (RSK175)**

Analytical Reference Table

Matrix	Analytical Group	Prep and Analytical Method Reference	Containers	Sample Volume	Preservation	Holding Time (prep/analysis)
Groundwater	Light Hydrocarbons	Lab SOP	Three 40mL glass vial w/ butyl septa	80mL	Tri-sodium phosphate (TSP); Cool to < 6 degrees C	14 days from collection

Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action(CA)	Person Responsible for CA	SOP Reference
Dissolved Gases GC/FID	Minimum five-point initial calibration (ICAL) for all target analytes	Initial calibration prior to sample analysis. Re-analyze calibration following major instrument maintanence and/or failures of CCV.	Coefficient of determination (r2) is $\geq$ 0.995; linear or quad fit types.	Make necessary instrument adjustments, check calibration standards. Repeat ICAL.	Analyst/Lab Manager	Lab SOP
	Initial Calibration Verification (ICV); must be from 2nd source; alternate source then used for the ICAL.	Immediately following the initial calibration.	All analytes within 15% of expected value; 85-115 percent recovery limits.	Analyze ICV a second time. If error persists, make necessary instrument adjustments, check calibration standards. Repeat ICAL.	Analyst/Lab Manager	Lab SOP
	Continuing Calibration Verification (CCV); from a second source; alternate source then used for the ICAL.	Beginning and end of each analytical shift and every 15 analyzed field samples.	All analytes within 15% of expected value; 85-115 percent recovery limits.	Analyze CCV a second time. If error persists, make necessary instrument adjustments, check calibration standards. Repeat ICAL and re-analyze all samples since the last successful CCV.	Analyst/Lab Manager	Lab SOP
	Initial and Continuing Calibration Blank (ICB/CCB).	Follows each ICV/CCV.	No analytes detected > RDL/PQL/LOQ. No analytes detected > 1/2 RDL/PQL/LOQ for DoD projects.	Analyze CCB a second time. If error persists, re-analyze all samples since the last successful CCB.	Analyst/Lab Manager	Lab SOP

Laboratory QC Samples Table

QC Sample ID	Frequency/Number	Acceptance Criteria	Corrective Action(CA)	Person Responsible for CA	Data Quality Indicator (DQI)	SOP Reference
Method Blank (MB)	One per analytical batch of 20 field samples.	No analytes detected > RDL/PQL/LOQ. No analytes detected > 1/2 RDL/PQL/LOQ for DoD projects.	Analyze MB a second time. If error persists, halt sample analysis until the error is corrected. Re-analyze samples if necessary.	Analyst/Lab Manager	Bias/Prep or Analysis Contamination	Lab SOP
Laboratory Control Sample and DUP (LCS/LCSD)	One per analytical batch of 20 field samples.	All analytes within 20% of expected value; 85-115 percent recovery limits; 0-20 relative percent difference.	Re-analyze. If error persists, halt sample analysis until the error is corrected. Repeat initial calibration if necessary.	Analyst/Lab Manager	Accuracy/Bias	Lab SOP
Matrix Spike and Duplicate (MS/MSD)	Per request for a given project or sampling event.	All analytes within 30% of expected value; 70-130 percent recovery limits; 0-20 relative percent difference.	If all other quality control samples are within method acceptance criteria, note matrix affects in case narrative and continue.	Analyst/Lab Manager	Precision/Accuracy/ Matrix affects	Lab SOP
Laboratory Duplicate	One duplicate every 10 field samples prepared.	Duplicate results should differ from its original by less than or equal to 20% RPD.	If RPD falls outside acceptance range, analyze a second duplicate from a different field sample. If one set of duplicates pass and the other does not, the analysis criteria has been achieved, report results. If both do not meet acceptance criteria, check the error. Flag the data and note in case narrative.	Analyst/Lab Manager	Precision	Lab SOP

Reporting Limits Summary Table

Analyte	Units	Practical Quantitation Limit (PQL/RDL/LOQ)
Methane	ug/l	0.50
Ethane	ug/l	0.20
Ethene	ug/l	0.20

Iron, Ferrous

DOC316.53.01049

1,10-Phenanthroline Method[1] **Method 8146**

0.02 to 3.00 mg/L Fe^{2+} **Powder Pillows or AccuVac® Ampuls**

Scope and application: For water, wastewater and seawater.

[1] Adapted from Standard Methods for the Examination of Water and Wastewater, 15th ed. 201 (1980).

Test preparation

Instrument-specific information

The tables in this section show all of the instruments that have the program for this test. Table 1 shows sample cell and orientation requirements for reagent addition tests, such as powder pillow or bulk reagent tests. Table 2 shows sample cell and adapter requirements for AccuVac Ampul tests.

To use either table, select an instrument, then read across to find the corresponding information for this test.

Table 1 Instrument-specific information for powder pillows

Instrument	Sample cell orientation	Sample cell
DR 6000 DR 3800 DR 2800 DR 2700	The fill line is to the right.	2495402
DR 5000 DR 3900	The fill line is toward the user.	
DR 900	The orientation mark is toward the user.	2401906

Table 2 Instrument-specific information for AccuVac Ampuls

Instrument	Adapter	Sample cell
DR 6000 DR 5000 DR 900	—	2427606
DR 3900	LZV846 (A)	
DR 3800 DR 2800 DR 2700	LZV584 (C)	2122800

Before starting

Samples must be analyzed immediately after collection and cannot be preserved for later analysis.
Install the instrument cap on the DR 900 cell holder before ZERO or READ is pushed.

For best results, measure the reagent blank value for each new lot of reagent. Replace the sample with deionized water in the test procedure to get the reagent blank value. Subtract the reagent blank value from the sample results automatically with the reagent blank adjust option.
Review the Safety Data Sheets (MSDS/SDS) for the chemicals that are used and use any recommended personal protective equipment.
Dispose of reacted solutions according to local, state and federal regulations. Use the Safety Data Sheets for disposal information for unused reagents. Consult the environmental, health and safety staff for your facility and/or local regulatory agencies for further disposal information.

Items to collect

Powder pillows

Description	Quantity
Ferrous Iron Reagent Powder Pillows, 25-mL	1
Sample cells. (For information about sample cells, adapters or light shields, refer to Instrument-specific information on page 1.)	2

Refer to Consumables and replacement items on page 6 for reorder information.

AccuVac Ampuls

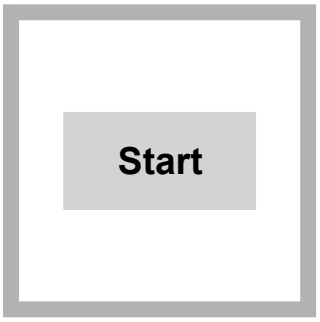
Description	Quantity
Ferrous Iron Reagent AccuVac Ampuls	1
Beaker, 50-mL	1
Sample cells (For information about sample cells, adapters or light shields, refer to Instrument-specific information on page 1.)	1
Stopper for 18-mm tubes and AccuVac Ampuls	1

Refer to Consumables and replacement items on page 6 for reorder information.

Sample collection

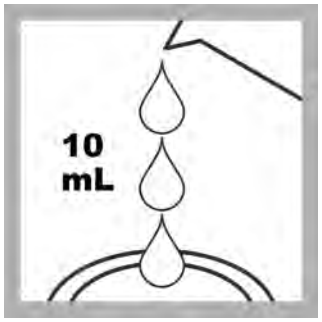
- Samples must be analyzed immediately after collection and cannot be preserved for later analysis.
- Collect samples in clean glass or plastic bottles with tight-fitting caps. Fill the bottle completely and immediately tighten the cap.
- Prevent agitation of the sample or exposure to air.

Powder pillow procedure



1. Start program **255 Iron, Ferrous**. For information about sample cells, adapters or light shields, refer to Instrument-specific information on page 1.

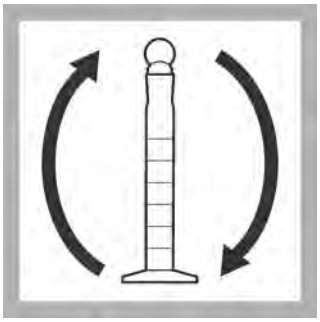
Note: *Although the program name may vary between instruments, the program number does not change.*



2. Prepare the blank: Fill the sample cell with 10 mL of sample.

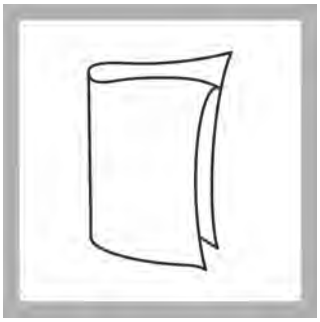
3. Prepare the sample: Fill a mixing cylinder to the 25-mL line with sample.

4. Add the contents of one Ferrous Iron Reagent Powder Pillow to the mixing cylinder.
An orange color shows if ferrous iron is present in the sample



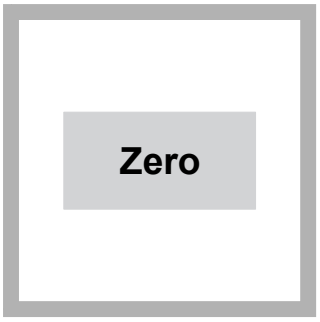
5. Close the cylinder. Invert the cylinder several times to mix.
Undissolved powder does not affect accuracy.

6. Start the instrument timer. A 3-minute reaction time starts.

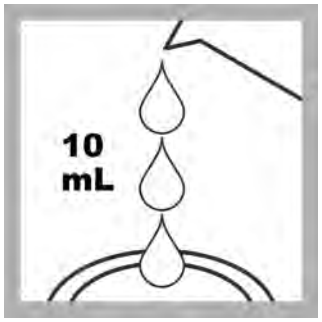


7. When the timer expires, clean the blank.

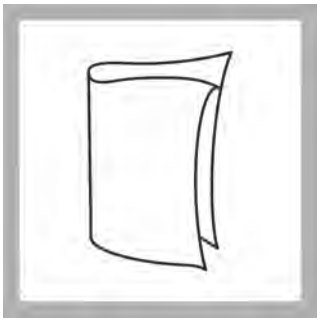
8. Insert the blank into the cell holder.



9. Push **ZERO**. The display shows 0.00 mg/L Fe^{2+}.

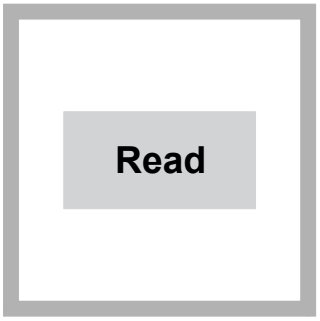


10. Fill a second sample cell with 10 mL of the reacted prepared sample.



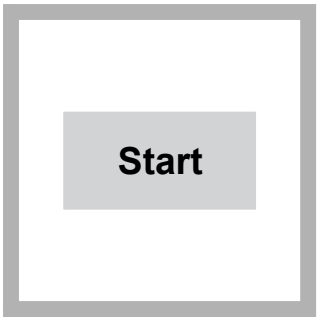
11. Clean the prepared sample.

12. Insert the prepared sample into the cell holder.



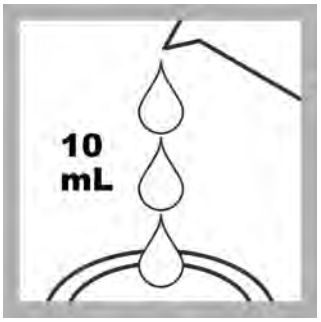
13. Push **READ**. Results show in mg/L Fe^{2+}.

AccuVac Ampul procedure



1. Start program **257 Iron, Ferrous AV**. For information about sample cells, adapters or light shields, refer to Instrument-specific information on page 1.

Note: *Although the program name may vary between instruments, the program number does not change.*

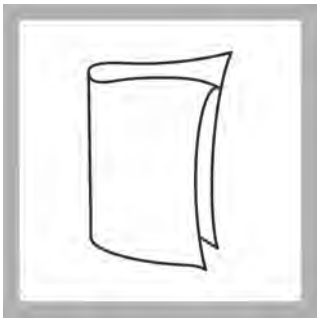


2. Prepare the blank: Fill the sample cell with 10 mL of sample.

3. Prepare the sample: Collect at least 40 mL of sample in a 50-mL beaker. Fill the AccuVac Ampul with sample. Keep the tip immersed while the Ampul fills completely.

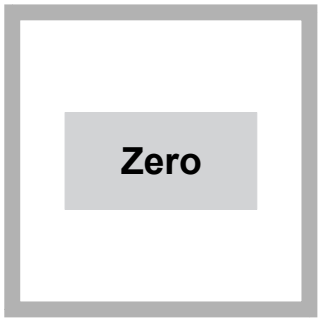
4. Quickly invert the Ampul several times to mix.

5. Start the instrument timer. A 3-minute reaction time starts.

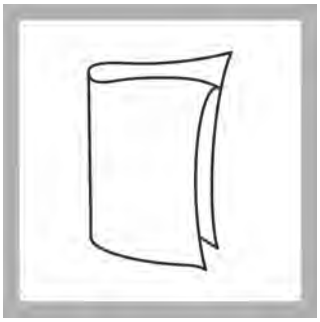


6. When the timer expires, clean the blank.

7. Insert the blank into the cell holder.



8. Push **ZERO**. The display shows 0.00 mg/L Fe^{2+}.



9. Clean the AccuVac Ampul.

10. Insert the prepared sample AccuVac Ampul into the cell holder.

11. Push **READ**. Results show in mg/L Fe^{2+}.

Accuracy check

Standard solution method

Use the standard solution method to validate the test procedure, reagents and instrument.

Items to collect:

- Ferrous Ammonium Sulfate, hexahydrate
- 1-L volumetric flask, Class A
- 100-mL volumetric flask, Class A
- 2-mL volumetric pipet, Class A and pipet filler
- Deionized water

1. Prepare a 100-mg/L Fe^{2+} ferrous iron stock solution as follows:
   a. Add 0.7022 g of ferrous ammonium sulfate, hexahydrate into a 1-L volumetric flask.
   b. Dilute to the mark with deionized water. Mix well.
2. Prepare a 2 mg/L ferrous iron standard solution as follows:
   a. Use a pipet to add 2.00 mL of the 100-mg/L Fe^{2+} ferrous iron stock solution into a 100-mL volumetric flask.
   b. Dilute to the mark with deionized water. Mix well. Prepare the standard solution immediately before use.
3. Use the test procedure to measure the concentration of the prepared standard solution.
4. Compare the expected result to the actual result.

   Note: *The factory calibration can be adjusted slightly with the standard adjust option so that the instrument shows the expected value of the standard solution. The adjusted calibration is then used for all test results. This adjustment can increase the test accuracy when there are slight variations in the reagents or instruments.*

Method performance

The method performance data that follows was derived from laboratory tests that were measured on a spectrophotometer during ideal test conditions. Users may get different results under different test conditions.

Program	Standard	Precision (95% Confidence Interval)	Sensitivity Concentration change per 0.010 Abs change
255	2.00 mg/L Fe^{2+}	1.99–2.01 mg/L Fe^{2+}	0.021 mg/L Fe^{2+}
257	2.00 mg/L Fe^{2+}	1.98–2.02 mg/L Fe^{2+}	0.023 mg/L Fe^{2+}

Summary of method

The 1,10-phenanthroline indicator in the Ferrous Iron Reagent reacts with ferrous iron (Fe^{2+}) in the sample to form an orange color in proportion to the iron concentration. Ferric iron (Fe^{3+}) does not react. The ferric iron concentration can be determined by subtracting the ferrous iron concentration from the results of a total iron test. The measurement wavelength is 510 nm for spectrophotometers or 520 nm for colorimeters.

Consumables and replacement items

Required reagents

Description	Quantity/test	Unit	Item no.
Ferrous Iron Reagent Powder Pillow, 25-mL	1	100/pkg	103769
OR			
Ferrous Iron Reagent AccuVac® Ampul	1	25/pkg	2514025

Required apparatus

Description	Quantity/test	Unit	Item no.
Beaker, 50-mL	1	each	50041H
Stoppers for 18 mm-tubes and AccuVac Ampuls	1	6/pkg	1448000

Recommended standards and apparatus

Description	Unit	Item no.
Balance, analytical, 80 g x 0.1 mg 100-240 VAC	each	2936701
Ferrous Ammonium Sulfate, hexahydrate, ACS	113 g	1125614
Flask, volumetric, Class A, 1000-mL	each	1457453
Pipet filler, safety bulb	each	1465100
Pipet, volumetric, Class A, 1.00-mL	each	1451535
Water, deionized	4 L	27256
Wipes, disposable	280/pkg	2097000

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Appendix B
Sampling Protocol

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Parameters	Method	Holding Time[8]		Minimum Volume		Water Sampling	
		Water	Soil	Water	Soil	Container	Preservative[9]
Acidity	SM 2310B	14 days	- -	100 mL	- -	250mL P	None
Alkalinity (as $CaCO_3$)	SM 2320B	14 days	NS[5]	100 mL	- -	250mL P	None
Ammonia Nitrogen	SM 4500NH3-D	28 days	- -	100 mL	- -	250mL P	H_2SO_4
Asbestos	Various	NS[5]	NS[5]	1 L	50 g	1L P	None
Bicarbonate Alkalinity	SM 2320B	14 days	- -	100 mL	- -	250mL P	None
Bioassay, %survival	NPDES	36 hr	- -	5 gallons	- -	5gal cube	None
Bioassay, Haz Waste screen	CCR Title 22	36 hr	36 hr	500 mL	200 g	1L G	None
Biochemical Oxygen Demand (BOD)	SM 5210B	48 hr	- -	600 mL	- -	1L P	None
Carbon, Total Organic	SM 5310C	28 days	- -	40 mL	- -	250mL G	H_2SO_4
	Walkley-Black	- -	NS[5]	- -	25 g	- -	- -
Carbon, Total Inorganic	SM 5310C	28 days	- -	40 mL	- -	250mL G	H_2SO_4
Carbonate Alkalinity	SM 2320B	NS[5]	- -	100 mL	- -	250mL P	None
Cation Exchange Capacity	EPA 9081	- -	6 mo	- -	10 g	- -	- -
Chemical Oxygen Demand (COD)	SM 5220D	28 days	- -	25 mL	- -	100mL P	H_2SO_4
COD, Filtered	SM 5220D	28 days	- -	25 mL	- -	100mL P	H_2SO_4
Chloride	EPA 300.0	28 days	- -	100 mL	- -	250mL P	None
Chlorine, Residual	SM 4500Cl-G	15 min	- -	100 mL	- -	250mL G	Foil wrapped
Coliform, Fecal		6 hr	- -	100 mL	- -	sterile 100mL P	$Na_2S_2O_3$
Color	SM 2120B	48 hr	- -	50 mL	- -	250mL G	None
Conductivity	SM 2510B	28 days	- -	100 mL	- -	250mL P	None
Corrosivity to Steel (NACE)	EPA 1110A	NS[5]	NS[5]	1 L	1000 g	1L G	None
Chromium, Hexavalent	EPA 7196A	24 hr[10]	30 days	100 mL	40 g	500mL P	None
	SM 3500Cr-D	24 hr[10]	- -	100 mL	- -	500mL P	None
	EPA 7199	24 hr[10]	- -	50 mL	- -	250mL P	None
Cyanide	SM 4500Cn-E	14 days	14 days	500 mL	5 g	500mL P	NaOH
	EPA 9010/9014	14 days	14 days	500 mL	5 g	500mL P	NaOH
Cyanide, Amenable	SM 4500Cn-E	14 days	14 days	500 mL	5 g	500mL P	NaOH
	EPA 9010/9014	14 days	14 days	500 mL	5 g	500mL P	NaOH
Cyanide, Reactive	SW846 Ch.7	NS[5]	NS[5]	25 mL	10 g	500mL P	None

Parameters	Method	Holding Time[8]		Minimum Volume		Water Sampling	
		Water	Soil	Water	Soil	Container	Preservative[9]
Density	ASTM or AOCS	NS[5]	- -	200 mL	- -	250mL P or G	None
Dissolved Organic Carbon	SM 5310C	28 days	- -	40 mL	- -	250mL G	H_2SO_4
Dissolved Oxygen	SM 4500O-G	15 min	- -	100 mL	- -	250mL G	None
Dissolved Sulfide	SM 4500S[2]-D	7 days	- -	50 mL	- -	500mL P	NaOH
Ferrous Iron (Fe2+)	SM 3500Fe-D	in field	- -	50 mL	- -	100mL P or G	HCL
Ferric Iron (Fe3+)	SM 3500Fe-D	24 hr	- -	See Notes	- -	2 x 100mL P	see Notes (6)
Flash Point	EPA 1010A	NS[5]	- -	60 mL	NA	250mL P	None
Fluoride	EPA 300.0	28 days	28 days	100 mL	10 g	250mL P	None
Free Liquids (Paint Filter Test)	EPA 9095B	NS[5]	NS[5]	100 mL	50 g	500mL wide G	None
Halogens, Total Organic	EPA 9020	28 days	28 days	200 mL	10 g	250mL P or G	H_2SO_4
Hardness, as $CaCO_3$	SM 2340B	6 mo.	- -	100 mL	- -	250mL P	HNO_3
Hexavalent Chromium	EPA 7196A	24 hr[10]	30 days	100 mL	40 g	500mL P	None
	SM 3500Cr-D	24 hr[10]	- -	100 mL	- -	500mL P	None
	EPA 7199	24 hr[10]	- -	50 mL	- -	250mL P	None
Ignitability	SW846 Ch.7	- -	NS[5]	- -	10 g	- -	None
Iron, Ferrous (Fe2+)	SM 3500FeD	24 hr	- -	50 mL	- -	100mL P	HCL
Iron, Ferric (Fe3+)	SM 3500FeD	24 hr	- -	See Notes	- -	2 x 100mL P	see Notes (6)
MBAS (Surfactants)	SM 5540C	48 hr	- -	250 mL	- -	1L P	None
Moisture	CLP-SOW	- -	NS[5]	- -	25 g	- -	None
Nitrate Nitrogen	EPA 300.0	48 hr	- -	100 mL	- -	250mL P	None
Nitrite Nitrogen	EPA 300.0	48 hr	- -	100 mL	- -	250mL P	None
Nitrate/ Nitrite Nitrogen	EPA 353.2	28 days	- -	100 mL	- -	250mL P	H_2SO_4
Nitrogen, Ammonia	SM 4500NH3-D	28 days	28 days	100 mL	10 g	250mL P	H_2SO_4
Nitrogen, Total Kjeldahl (TKN)	SM 4500NH3-C	28 days	28 days	50 mL	5 g	1L P	H_2SO_4
Oil & Grease, Petroleum (H.E.M.-SG)	EPA 1664A	28 days	- -	1 L	- -	1L G	HCL
Oil & Grease, Total (H.E.M.)		28 days	- -	1 L	- -	1L G	HCL
Organic Carbon, Total	SM 5310C	28 days	- -	40 mL	- -	250mL G	H_2SO_4
	Walkley-Black	- -	NS[5]	- -	25 g	- -	- -
Organic Lead	CA LUFT[7]	14 days	14 days	100 mL	50 g	500mL G	None

Parameters	Method	Holding Time[8]		Minimum Volume		Water Sampling	
		Water	Soil	Water	Soil	Container	Preservative[9]
Ortho-phosphate Phosphorus	SM 4500P-E	48 hr[11]	- -	50 mL	- -	100mL P	None
Oxygen Demand, Biochemical	SM 5210B	48 hr	- -	600 mL	- -	1L P	None
Oxygen Demand, Chemical	SM 5220D	28 days	- -	100 mL	- -	250mL P	H_2SO_4
Oxygen, Dissolved	SM 4500O-G	15 min	- -	100 mL	- -	250mL G	None
Paint Filter Test	EPA 9095	NS[5]	NS[5]	100 mL	50 g	500mL wide	None
Perchlorate	EPA 314.0	28 days	- -	100 mL	- -	250mL P	None
PH	SM 4500H+B	15 min		100 mL		250mL P	None
	EPA 9040C/ 9045D	24 hr	14 days	100 mL	50 g	250mL P	None
Phenolic Compounds	EPA 420.1	28 days	- -	500 mL	- -	1L G	H_2SO_4
Phosphate, ortho-	SM 4500P-E	48 hr	- -	50 mL	- -	100mL P	None
Phosphate, Total	SM 4500P-E	28 days	28 days	50 mL	10 g	250mL P	H_2SO_4
Reactive Cyanide	SW846 Ch.7	NS[5]	NS[5]	25 mL	10 g	500mL P	None
Reactive Sulfide	SW846 Ch.7	NS[5]	NS[5]	25 mL	10 g	500mL P	None
Residual Chlorine	SM 4500Cl-G	15 min	- -	50 mL	- -	100mL G	None
Resistivity	SM 2510B	28 days	- -	100 mL	- -	250mL P	None
Salinity	SM 2520B	NS[5]	- -	250 mL	- -	250mL G	wax seal
Silica	SM 4500SiO_2-C	28 days	28 days	50 mL	10 g	100mL P	None
Solids, Settleable	SM 2540F	48 hr	- -	1 L	- -	1L G	None
Solids, Total Dissolved	SM 2540C	7 days	- -	100 mL	- -	250mL P	None
Solids, Total Suspended	SM 2540D	7 days	- -	100 mL	- -	250mL P	None
Solids, Total Volatile	SM 2540E	7 days	NS[5]	100 mL	50 g	250mL P	None
Sulfate	EPA 300.0	28 days	- -	100 mL	- -	250mL P	None
Sulfide	SM 4500S^2-D	7 days	- -	50 mL	- -	500mL P	NaOH + ZnAc
Sulfide, Dissolved	SM 4500S^2-D	7 days	- -	50 mL	- -	500mL P	NaOH
Sulfide, Reactive	SW846 Ch.7	NS[5]	NS[5]	25 mL	10 g	500mL P	None
Sulfite	SM 4500SO_3-B	15 min	- -	100 mL	- -	500mL P	None
Surfactants (MBAS)	SM 5540C	48 hr	- -	250 mL	- -	1L P	None
Total Dissolved Solids (TDS)	SM 2540C	7 days	- -	100 mL	- -	250mL P	None
Total Inorganic Carbon	SM 5310C	28 days	28 days	40 mL	25 g	250mL G	H_2SO_4

Parameters	Method	Holding Time[8]		Minimum Volume		Water Sampling	
		Water	Soil	Water	Soil	Container	Preservative[9]
Total Kjeldahl Nitrogen (TKN)	SM 4500NH3-C	28 days	28 days	50 mL	5 g	1L P	H_2SO_4
Total Organic Carbon (TOC)	SM 5310C	28 days	- -	40 mL	- -	250mL G	H_2SO_4
	Walkley-Black	- -	NS[5]	- -	25 g	- -	- -
Total Organic Halogens (TOX)	EPA 9020B	28 days	28 days	200 mL	10 g	250mL G[12]	H_2SO_4
Total Suspended Solids (TSS)	SM 2540D	7 days	- -	100 mL	- -	250mL P	None
Total Volatile Solids (TVS)	SM 2540E	7 days	NS[5]	100 mL	50 g	250mL P	None
Tributyl Tin	GC/FPD	NS[5]	NS[5]	1 L	10 g	1L P or G	None
Turbidity	SM 2130B	48 hr	- -	100 mL	- -	250mL P	None
Viscosity	ASTM methods	NS[5]	- -	25 mL	- -	50mL P	None

General Minerals	Method	Holding Time[8]		Minimum Volume		Water Sampling	
		Water	Soil	Water	Soil	Container	Preservative[9]
Alkalinity (as $CaCO_3$)	SM 2320B	14 days	NS[5]	100 mL	- -	250mL P	None
Chloride, Sulfate	EPA 300.0	28 days	- -	100 mL	10 g	250mL P	None
Conductivity	SM 2510B	28 days	- -	100 mL	- -	250mL P	None
pH	SM 4500H+B	15 min	- -	100 mL	- -	250mL P	None
Total Dissolved Solids (TDS)	SM 2540C	7 days	- -	100 mL	- -	250mL P	None
Ca, Fe, Mg, Na, Zn	EPA 200.7	6 mo	6 mo	100 mL	- -	250mL P	HNO_3
Hardness (run with Metals)	SM 2340B	6 mo	6 mo	100 mL	- -	250mL P	HNO_3
Optional Analyses (included upon request):							
Surfactants (MBAS)	SM 5540C	48 hr	- -	250 mL	- -	1L P	None

Ion Chromatography	Method	Holding Time[8]		Minimum Volume		Water Sampling	
		Water	Soil	Water	Soil	Container	Preservative[9]
Bromide	EPA 300.0	28 days	- -	100 mL	10 g	250mL P	None
Chloride	EPA 300.0	28 days	- -	100 mL	10 g	250mL P	None
Fluoride	EPA 300.0	28 days	- -	100 mL	10 g	250mL P	None
Nitrate Nitrogen	EPA 300.0	48 hr	- -	100 mL	10 g	250mL P	None
Nitrite Nitrogen	EPA 300.0	48 hr	- -	100 mL	10 g	250mL P	None

Ion Chromatography	Method	Holding Time[8]		Minimum Volume		Water Sampling	
		Water	Soil	Water	Soil	Container	Preservative[9]
Sulfate	EPA 300.0	28 days	- -	100 mL	10 g	250mL P	None
Hexavalent Chromium	EPA 7199	24 hr[10]	- -	50 mL	10 g	250mL P	None
Perchlorate	EPA 314.0	28 days	- -	100 mL	10 g	250mL P	None

Notes:

5. NS: No holding time is specified in the regulations for this method.
6. Ferric Iron (Fe^{3+}) is the difference between total and ferrous iron.
   Requires submission of two polyethylene bottles, one preserved with HCl and one with HNO_3.
7. CA LUFT: California Department of Health Services Leaking Underground Fuel Tank Manual 1989
8. Holding time specified in 40CFR136 Table 2 (Clean Water Act/ NPDES 2012) and SW-846 Table 2-36 (1996)
9. Samples should be kept at $\leq 6^0$C from time of collection until analysis. Containers can be supplied by C&T.
   HCL: Hydrochloric Acid to pH < 2
   HNO3: Nitric Acid to pH < 2
   H_2SO_4: Sulfuric Acid to pH < 2
   NaOH: Sodium Hydroxide to pH > 12
   ZnAc: Zinc Acetate
10. Holding time can be extended to 28 days by preservation with EPA 218.6 buffer to pH 9.3 – 9.7.
11. Samples for Ortho-phosphate must be filtered within 15 minutes of collection and analyzed within 48 hours.
12. Samples for TOX (Total Organic Halides) should be collected with no headspace remaining in bottle.

Legend:

mg/L	milligrams per liter (ppm)
µg/L	micrograms per liter (ppb)
mg/Kg	milligrams per kilogram (ppm)
µg/Kg	micrograms per kilogram (ppb)
VOA	40mL Amber VOA Vial
G	Amber Glass
P	Polyethylene

VOLATILE ORGANICS

SAMPLING CONTAINERS & HOLDING TIMES

Curtis & Tompkins, Ltd.

Parameter	Matrix	Prep Method	Analytical Method	Holding Time[5]	Minimum Volume	Water Sampling Container	Water Sampling Preservative[7]
TPH/Gasoline [2]	Water	EPA 5030	EPA 8015	14 days	40 mL	3 x 40mL VOA	HCL[8]
		EPA 5030	8260mod	14 days	40 mL	3 x 40mL VOA	HCL[8]
	Soil	EPA 5035[8]	EPA 8015	14 days	5 g		
		EPA 5035[8]	EPA 8015	7 days	5 g		Frozen
Alcohols (Methanol, Ethanol)	Water	Direct Inject	EPA 8015	14 days	40 mL	2 x 40mL VOA	None
BTXE [1]	Water	EPA 5030	EPA 8021	14 days	40 mL	3 x 40mL VOA	HCL[8]
	Soil	EPA 5035[8]	EPA 8021	14 days	5 g		
Carbon Dioxide (dissolved)	Water	METHOD[4]	RSK-175	14 days	40 mL	3 x 20mL vial	None
Dissolved Gasses (except CO_2)	Water	METHOD[4]	RSK-175	14 days	40 mL	3 x 40mL VOA	HCL
Dissolved Gasses (CO_2)	Water	METHOD[4]	RSK-175	14 days	40 mL	3 x 40mL VOA	None
Gasoline Oxygenates	Water	EPA 5030	EPA 8260	14 days	40 mL	3 x 40mL VOA	HCL[8]
	Soil	EPA 5035[8]	EPA 8260	14 days	5 g		
Halogenated VOCs (old 8010 list)	Water	EPA 5030	EPA 8260	14 days	40 mL	3 x 40mL VOA	HCL[8]
	Soil	EPA 5035[8]	EPA 8260	14 days	5 g		
MTBE (Methyl tert-Butyl Ether)	Water	EPA 5030	EPA 8021	14 days	40 mL	3 x 40mL VOA	HCL[8]
		EPA 5030	EPA 8260	14 days	40 mL	3 x 40mL VOA	HCL[8]
	Soil	EPA 5035[9]	EPA 8021	14 days	5 g		
		EPA 5035[9]	EPA 8260	14 days	5 g		
TCLP-ZHE Extraction for Volatiles	Soil	EPA 1311	Various	14 days	25 g		
Volatile Organics	Water	EPA 5030	EPA 8260	14 days	40 mL	3 x 40mL VOA	HCL[8]
		EPA 624	EPA 624	14 days	40 mL	3 x 40mL VOA	HCL[8]
	TCLP Leachate	EPA 5030	EPA 8260	14 days	40 mL		None
	Soil	EPA 5035[8]	EPA 8260	14 days	5 g		
		EPA 5035[8]	EPA 8260	7 days	5 g		Frozen

Notes:

1. Benzene, Toluene, Ethylbenzene, and Xylenes; MTBE (Methyl tert-Butyl Ether) may be added upon request.
2. Total Petroleum Hydrocarbons as Gasoline: JP-4, Aviation Gas, Mineral spirits, or Stoddard solvent may be added upon request. Reporting limits may be higher for fuels other than gasoline.

Legend:

mg/L milligrams per liter (ppm)
µg/L micrograms per liter (ppb)
mg/Kg milligrams per kilogram (ppm)

3. Total Petroleum Hydrocarbons as Diesel; motor oil, commercial jet fuel, JP-5, hydraulic oil, or Bunker C fuel oil May be added upon request. Reporting limits may be higher for fuels other than diesel.
4. CA LUFT: California Department of Health Services Leaking Underground Fuel Tank Manual 1989
5. Holding time specified in 40CFR136 Table 2 (Clean Water Act/ NPDES 2012) and SW-846 Table 2-36 (1996)
6. X / Y: X days from sample collection to extraction, then Y days from extraction to analysis.
7. Samples should be kept at $\leq 6^0$C from time of collection until analysis. Containers can be supplied by C&T.
   HCL: Hydrochloric Acid to pH < 2
   ZnAc: Zinc Acetate
8. Free chlorine should be neutralized with 0.008% $Na_2S_2O_3$ at time of sampling.
9. Prep method EPA 5035 using Encore or similar sampling devices should be used for collecting soil. Three aliquots of each sample should be submitted for analysis. Samples should be frozen or chemically preserved within 48 hours of collection. Freezing extends the holding time to 7 days; chemical preservation extends the holding time to 14 days but may create matrix interferences.
10. 100g minimum for TCLP Extraction; 50g required for each analysis.
11. California LUFT Manual allows a 14 day holding time for extraction of TPH-Diesel/Motor Oil from water samples, however for projects located outside California (or associated with a Federal or Department of Defense project), the holding time is 7 days.

µg/Kg	micrograms per kilogram (ppb)
VOA	40mL Amber VOA Vial
G	Amber Glass
P	Polyethylene
Vial	20mL Amber RSK Vial

Sampling Instructions

The following sampling instructions are used for collecting water or groundwater samples for DNA analysis by DGGE and/or CENSUS. The recommended sampling container is a 1L Poly bottle with a screw cap. Amber glass bottles can be used but are not recommended due to the likelihood of breakage during shipment. Microbial Insights, Inc. can provide the proper sampling supplies upon request.

Once the proper sampling bottle is obtained be sure not to contaminate the inside of the sample bottle with skin, dirt or any form of debris (this helps to ensure the accuracy of the data results). Wearing latex gloves (or similar) is recommended when sampling.

The required volume of water to conduct DNA based analyses from groundwater samples is 1L.

* Note: It is important to collect as close to the required amounts as possible to ensure the ability to properly conduct the analysis requested. Hold time is 24-48 hours for this analysis.

To Submit Sample:

1. Once the required amount of groundwater has been collected into the proper sampling container, seal the container tightly with a screw cap lid.
2. Properly affix a label with the sample name, date and analysis.
3. Be sure to fill out the Chain of Custody (COC) form correctly and accurately and ship it along with the samples. A COC form is required for QA/QC purposes.
4. Once the bottles have been correctly labeled, place them in the designated cooler. Be sure to fill the remaining space in the cooler with blue ice or regular ice that has been double bagged in Ziploc bags. Use sufficient ice to keep the entire shipment around 4°C, especially during the summer months.
5. All paperwork to be sent with the samples should be placed within a waterproof pouch or Ziploc bag and placed on top of the samples or affixed to the inside lid of the cooler.
6. Seal the cooler lid with a strong packaging tape.

Shipping Instructions

Packaging Samples:

1. Samples should be shipped in a cooler with ice or blue ice for next day delivery. If regular ice is used, the ice should be double bagged.
2. A chain of custody form must be included with each shipment of samples. Access our chain of custody at www.microbe.com .

Shipment for Weekday Delivery:

Samples for weekday delivery should be shipped to:

Sample Custodian
Microbial Insights, Inc.
10515 Research Drive
Knoxville, TN 37932
(865) 573-8188

Shipment for Saturday Delivery:

Coolers to be delivered on Saturday must be sent to our FedEx Drop Location. To ensure proper handling the following steps must be taken:

1. FedEx shipping label should be marked under (6) Special Handling, check Hold Saturday,
2. The cooler must be taped with FedEx SATURDAY tape.
3. The shipping label must be filled out with the Drop Location address below. Our laboratory name must be on the address label.
4. You MUST ***notify by email*** customerservice@microbe.com with the tracking number of the package on Friday (prior to 4pm Eastern Time) to arrange for Saturday pickup. Please make sure you write "Saturday Delivery" in the subject line of the message. Without proper labeling and the tracking number, there is no guarantee that the samples will be collected.

Samples for Saturday delivery should be shipped to:

Microbial Insights, Inc.
FedEx Drop Location
10601 Murdock Drive
Knoxville, TN 37932
(865) 300-8053

PAES Worksheet

Matrix: **Groundwater**
Analytes: **Carbon Dioxide**

Analytical Reference Table

Matrix	Analytical Group	Prep and Analytical Method Reference	Containers	Sample Volume	Preservation	Holding Time (prep/analysis)
Groundwater	Permanent Gases	Lab SOP	Two 40mL amber glass vial w/ butyl septa	80mL	Benzalkonium chloride (BAK); Cool to < 6 degrees C	14 days from collection

Matrix: **Groundwater/Bubblestrip Collection**
Analytes: **Hydrogen**

Analytical Reference Table

Matrix	Analytical Group	Prep and Analytical Method/ Reference	Containers*	Sample Volume	Preservation	Holding Time (prep/analysis)
Groundwater w/ Bubblestrip Collection	Hydrogen, Light Hydrocarbons and Permanent Gases	Lab SOP	One 20cc Headspace vial, set to atmospheric pressure with UHP Nitrogen and a stopper type septa.	15cc volume removed from the bubble cell and transferred to the headspace vial.	None	14 days from collection

Matrix: **Groundwater**
Analytes: **Acetic, Propionic, Pyruvic, Butyric and Lactic Acids**

Analytical Reference Table

Matrix	Analytical Group	Prep and Analytical Method/ Reference	Containers	Sample Volume	Preservation	Holding Time (prep/analysis)
Groundwater	Volatile Fatty Acids; Electron Donors	Lab SOP	Two 40mL clear glass vial w/ silicon/clear septa	80mL	None; Cool to < 6 degrees C	21 days from collection

Washington State Department of Ecology

Environmental Assessment Program

Standard Operating Procedure for the Collection and Field Processing of Metals Samples

Version 1.5

Author - William J. Ward
Date -

Reviewer - Jim Ross
Date -

QA Approval - William R. Kammin, Ecology Quality Assurance Officer
Date -

EAP029

Recertified: 10/15/10

APPROVED:

Signatures on File

Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)
2/1/2007		Editorial; formatting	All	Bill Ward
		Comments	All	Dave Hallock
2/2/2007	1.1	Edits based on comments	All	Bill Ward
3/21/2007	1.1	Editorial Review	All	Bill Kammin
4/2/2007	1.2	Edits based on comments	All	Bill Ward
4/16/2007	1.2	Final Review	All	Jim Ross
4/25/2007	1.3	Edits based on comments	All	Bill Ward
10/14/2010	1.4	Minor revisions to blank samples	5 & 8	Bill Ward
10/15/10	1.4	Recertified	All	Bill Kammin
4/9/13	1.5	Added new chemical awareness language. Attached the MSDS sheet	5	Bill Ward

Environmental Assessment Program

Standard Operating Procedure for the Collection and Field Processing of Metals Samples

1.0 Purpose and Scope

1.1 This document is the Environmental Assessment Program (EAP), Environmental Monitoring and Trends Section, Freshwater Monitoring Unit, Standard Operating Procedure (SOP) for collecting freshwater metals samples for laboratory analysis. The sample collection and field processing methods generally follow those under Method 1669 (EPA, 1996).

2.0 Applicability

2.1 This SOP is intended for the collection of freshwater metals samples to be analyzed by one or more of the following methods:

2.2 Dissolved Metals Method – Modified version of EPA Method 200.8 (Using inductively coupled plasma - mass spectrometry (ICP-MS))

2.3 Total Recoverable Metals Method – Method EPA 202.2 (Hotplate Assisted Digestion) and a modified version of EPA 200.7 Method (ICP).

2.4 Total Mercury Method – Method EPA 245.7 (Free Bromide Digestion) and EPA Method 245.1 (Cold Vapor Absorbance)

3.0 Definitions

3.1 EAP – Environmental Assessment Program.

3.2 Ecology – Washington State Department of Ecology.

3.3 EIM – Environmental Information Management System. A searchable database developed and maintained by the Washington State Department of Ecology.

3.4 FEP – fluorinated ethylene propylene resin

3.5 Field Logbook – A weather resistant logbook containing “Rite in the Rain” ® writing paper used to document any and all field activities, sample data, methods and observations for each and all collection sites.

3.6 MQO’s – Measurement Quality Objectives

3.7 MSDS – Material Safety Data Sheets provides both workers and emergency personnel with the proper procedures for handling or working with a particular substance. MSDS’s include information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment and spill/leak procedures.

3.8 QA – Quality Assurance

4.0 Personnel Qualifications/Responsibilities

4.1 Field operations require training specified in EAP's Field Safety Manual (Ecology, 2006) such as First Aid, CPR, and Defensive Driving.

4.2 Boat operations require that staff meet specific training requirements as described in EAP's Field Safety Manual, such as an EAP Boating Course and an approved Boating Safety Course.

4.3 Because the procedure requires the use of hazardous materials, training is required as per the Ecology Chemical Hygiene Plan and Hazardous Material Handling Plan (Section 1) (WA State Department of Ecology 2006), which include Laboratory Safety Orientation, Job-Specific Orientation and Chemical Safety Procedures. The Standard Operating Procedures in Section 16 of the Chemical Hygiene Plan and Hazardous Material Handling Plan for handling chemicals must also be followed.

5.0 Equipment, Reagents, and Supplies

Metals Sampler W/sample bottle

5.1 Metals sampler
5.2 Sampling ropes 1 @ 10 ft., 1 @ 35 ft. and 2 @ 55 ft.
5.3 Extension pole with three prong **stainless** clamp
5.4 Cooler containing ice
5.5 Hand vacuum pump with hose
5.6 500mL Teflon FEP bottles pre-filled with DI water by the lab
5.7 125 mL narrow mouth poly bottle containing H2S04 preservative for hardness sample
5.8 Disposable 0.45 micron cellulose nitrate filter unit (pre-cleaned Nalgene #450-0045, type S)
5.9 Small Teflon vials containing 5 ml concentrated nitric acid preservative (see Attachment A for MSDS). *Danger* this acid causes severe burns by all exposure routes.
5.10 Powder free vinyl disposable gloves

6.0 Summary of Procedure

6.1 Sampling procedures generally follow EPA Method 1669. Samples are collected as single grabs in a 500ml Teflon FEP bottle using the stainless steel metals sampler or by hand. Care must be used at all times when collecting and processing metals samples to avoid contaminating the inside of the sample bottle or cap with debris or ambient air. Also, samples need to be preserved with acid and placed in ice in a cooler as soon as possible after collection. The holding time prior to analysis for all metals, except mercury, is six months. The holding time for mercury is 28 days.

6.2 Metals Sampler Method. This method is typically used to collect samples from a bridge or from the stream bank through the use of a rope.

6.2.1 Invert the Teflon sample bottle, remove the cap, pick up the metals sampler, and rinse the sampler with the deionized water that empties out of the bottle.

6.2.2 After the bottle empties, set the sampler down and replace the bottle cap.

6.2.3 Then fit the sample bottle into the base of the stainless steel metals sampler.

6.2.4 Remove the bottle cap and place it in the clean plastic bag it shipped in.

6.2.5 Lower the sampler bottle cap lifting arm until the sampler cap covers the bottle opening (make sure the lifting arm can move up freely).

6.2.6 Attach the sampling rope.

6.2.7 Move to a well mixed location such as the deepest part of the active channel where a representative sample may be collected.

6.2.8 Carefully lower the sampler to the water surface, taking care to not dislodge bridge debris onto it. Allow the bottom of the sampler to touch the water surface, and then raise the sampler off the water for a few moments to allow any debris from the bottom of the sampler to drop off and float away. Note: This minimizes the sampling of any debris from the bottom of the sampler.

6.2.9 Lower the sampler about 15 cm (6 inches) into the water. Allow the current to re-orient the sampler so the sample bottle is on the upstream side of the sampler. Then rapidly lower the sampler about 0.5 meters to completely submerge it. This minimizes the sampling of surface film. Note: At about 25 cm under the water surface, the sampler should automatically raise the bottle cap and allow the bottle to fill. Also, it may take more than 45 seconds for the bottle to fill.

6.2.10 Retrieve the filled bottle taking care to not dislodge bridge debris onto it or the sampler.

6.2.11 Remove the filled sample bottle from the sampler, cap it with the original cap from the clean plastic bag, and place the bottle in the Ziploc bag it shipped in.

6.2.12 Repeat the procedure to obtain a second metals sample.

6.2.13 Return to the van with the samples and sampling gear.

6.3 Hand Dip Method. This method is typically used to collect samples from a small or shallow stream, or near the bank of a large stream.

6.3.1 Move to a well mixed location such as the deepest part of the active channel or another location where a representative sample may be collected. *Note: Do not contaminate the sample location by wading upstream of it or collect a sample from an eddy that had been waded.*

6.3.2 Grab the base of the sample bottle with one hand, invert the Teflon sample bottle, remove the cap, and let the deionized water empty out of the bottle.

6.3.3 Reach upstream and plunge the bottle into the water about 15 cm (6 inches) and then tip the bottle mouth up toward the water surface.

6.3.4 Allow the bottle to fill and then take it out of the water.

6.3.5 Replace the cap in a way that avoids contamination to the inside of the bottle and place the bottle in the Ziploc bag it shipped in.

6.3.6 Repeat the procedure to obtain a second metals sample.

6.3.7 Return to the van with the samples and sampling gear.

6.3.8 Extension Pole Method. This method is typically used to reach a more representative or undisturbed sample location from the stream bank or when wading in a lake or slow moving stream.

6.3.9 Secure the metals sample bottle in the extension pole clamp.

6.3.10 Move to a well mixed location where a representative sample may be reached with the pole. *Note: Do not contaminate the sample location by wading upstream of it or collect a sample from an eddy that had been waded.*

6.3.11 Invert the Teflon sample bottle, remove the cap, and let the deionized water empty out of the bottle. Also, put the cap into the Ziploc bag the bottle shipped in and put the bag in a location that will prevent contamination to the inside of the cap

6.3.12 Position the bottle over the desired sample location.

6.3.13 Invert the bottle and in one quick motion plunge the mouth of the bottle into the water about 15 cm (6 inches). Then slowly move the bottle upstream with the bottle mouth tipped toward the water surface until the bottle has filled (in lakes slowly move the tipped bottle away from the bottle entry point until it completely fills).

6.3.14 Take the filled bottle out of the water and then replace the bottle cap in a way that avoids contamination to the inside of the cap and bottle.

6.4 Field Processing - Total Recoverable Metals and Total Mercury

6.4.1 Put on vinyl gloves.

6.4.2 Remove the disposable filter unit from the large Ziploc bag and set the bag and filter unit aside.

6.4.3 Remove the cap from the first sample bottle (do not set the cap down)

6.4.4 If necessary, gently squeeze the side of the sample bottle to displace about 5 ml of sample to make room for the Nitric acid preservative.

6.4.5 Carefully uncap the small Teflon vial containing 1:1 Nitric acid and add the acid to the sample. Screw the cap on the sample and then re-cap the Nitric acid vial.

6.4.6 Attach the Total Metals and Total Recoverable Mercury sample tag to the sample bottle.

6.4.7 Place the tagged sample in its original Ziploc bag along with the empty (capped) Teflon vial, eliminate air from the Ziploc bag, seal it and then put it in the large Ziploc bag that contained the filter unit.

6.5 Field Processing - Dissolved Metals

6.5.1 Attach the hand pump hose to the filter unit.

6.5.2 Remove the cap from the second sample bottle; lift up one side of the filter unit lid about 3 cm (1 inch), and pour the sample into the top of the unit. Note: Avoid touching or contaminating the inside of the filter unit.

6.5.3 Cap the empty sample bottle and put it into the large Ziploc bag that also contains the tagged total metals sample.

6.5.4 Hold onto the filter unit with one hand and use the other hand to squeeze and release the hand pump lever to create a vacuum to filter the sample.

6.5.5 Filter as much of the sample as possible (at least half).

6.5.6 Empty deionized water from an unused Teflon bottle and put the cap on the bottle opening.

6.5.7 Unscrew the bottom of the filter apparatus, remove the cap from the top of the unused Teflon sample bottle (do not set the cap down), pour the filtered sample into the Teflon bottle, and put the cap on the bottle opening.

6.5.8 Carefully uncap the small Teflon vial containing 1:1 Nitric acid, lift the cap off the bottle containing the filtered sample, and add the acid to the sample. Screw the cap on the sample and then re-cap the Nitric acid vial.

6.5.9 Attach the Dissolved Metals sample tag to the sample bottle.

6.5.10 Place the tagged sample in its original Ziploc bag along with the empty (capped) Teflon vial.

6.5.11 Eliminate air from the Ziploc bag, seal it, and put it in the large Ziploc bag that contains the tagged total metals sample and the empty Teflon bottle.

6.5.12 Eliminate air from the large Ziploc bag and place the bagged samples on ice in a cooler.

6.6 Field Processing - Hardness

6.6.1 Hardness samples are sub-sampled from the 1 L bottle used to collect nutrient samples or the 1 L bottle used to collect pH/conductivity samples (See Stream Sampling SOP). The 1 L total suspended solids (TSS) or 0.5 L general chemistry samples may also be used if the other grab samples are unavailable.

6.6.2 Pour approximately 100 mL of the field grab sample into the 125 mL hardness sample bottle (wide mouth poly bottle containing H2S04 preservative).

6.6.3 Cap and invert the hardness sample bottle to ensure that the acid gets mixed into the sample. *Note: Avoid contact with the acid.*

6.6.4 Label the hardness sample and place the sample in ice in a cooler.

7.0 Records Management

7.1 All hardcopy documentation of the data, such as completed Field Logbook and Field Data Report Forms are kept and maintained by the project lead. These documents are organized in binders or in expanding files. After about six years, hardcopies are boxed and moved to EAP archives.

7.2 Data collected for Ecology's Ambient River and Stream Monitoring Program will be entered into our Access-based database, reviewed and verified following the Quality Control and Quality Assurance procedures (see 8.1 below), uploaded into EIM, and posted on our web page http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html .

7.3 Data collected for special project studies will be reviewed, verified, and stored based on the QAPP for the project.

8.0 Quality Control and Quality Assurance

8.1 The data QA program for field sampling consists of three parts: (1) adherence to the SOP procedures for sample/data collection and periodic evaluation of sampling personnel, (2) consistent instrument calibration methods and schedules, and (3) the collection of field quality control (QC) samples based on the study Quality Assurance

Project Plan requirements. Our QA program is described in detail in Hallock and Ehinger (2003).

8.2 True Process Field Blank Samples. These field QC samples are subject to the sample site collection and dissolved metals sample processing conditions. The expected value for this analyzed result is the reporting limit. Higher results would indicate that sample contamination had occurred during field processing or laboratory analysis.

8.2.1 Load the sampler with a metals bottle (do not empty the special DI water out of the bottle). Go to the sample site, remove the bottle cap, and put the cap in a dry Ziploc bag to avoid any contamination. Lower the Metals Sampler to the water surface (do not immerse anything into the stream), retrieve the sampler, and cap the bottle.

8.2.2 Return to the van and follow the Dissolved Metals processing procedure (see procedure 6.5 above), refill the original sample bottle, and attach the dissolved metals QC tag.

9.0 Safety

9.1 Safety is the primary concern when collecting samples. Since most sample sites are located on highway bridges, road and pass conditions should always be checked before departure (especially in winter). If roadside hazards, weather, accidents, construction, etc. make sample collection dangerous, then skip that station. Note the reason on the Field Data Report Form and notify your supervisor of the hazard when you return to the office. If the hazard is a permanent condition, relocation of the station may be necessary. Review Ecology's Safety Program Manual periodically to assist with these safety determinations.

10.0 References

10.1 Ecology, 2006. Environmental Assessment Program Safety Manual. Olympia, WA.

10.2 Ecology, 2006. Chemical hygiene plan and hazardous material handling plan. Olympia, WA.

10.3 Ecology, 2007. Standard Operating Procedures for the Collection and Processing of Stream Samples. Olympia, WA.

10.4 EPA, 1996. Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels. Washington, D.C.

10.5 Hallock, D. and W. Ehinger, 2003. Quality Assurance Monitoring Plan: Stream Ambient Water Quality Monitoring. Washington State Department of Ecology, Olympia, WA. 27 pp. Publication No. 03-03-200. www.ecy.wa.gov/biblio/0303200.html

Attachment A

Fisher Scientific

Part of Thermo Fisher Scientific

Material Safety Data Sheet

Creation Date 12-Mar-2009 **Revision Date** 27-Sep-2011 **Revision Number** 3

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name **Nitric acid, Trace Metal Grade**

Cat No. **A509-212; A509-500; A509P212; A509P500; A509SK212**

Synonyms Azotic acid; Engraver's acid; Aqua fortis

Recommended Use Laboratory chemicals

Company Fisher Scientific One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. HAZARDS IDENTIFICATION

DANGER!

Emergency Overview

Oxidizer: Contact with combustible/organic material may cause fire. Causes severe burns by all exposure routes. May cause pulmonary edema.

Appearance Clear Colorless, Light yellow **Physical State** Liquid **odor** strong Acrid

Target Organs Eyes, Respiratory system, Skin, Teeth, Kidney, Gastrointestinal tract (GI)

Potential Health Effects

Acute Effects
Principle Routes of Exposure

Eyes Causes severe burns. May cause blindness or permanent eye damage.
Skin Causes severe burns. May be harmful in contact with skin.
Inhalation Causes severe burns. May cause pulmonary edema. May be harmful if inhaled.
Ingestion Ingestion causes burns of the upper digestive and respiratory tract. May be harmful if swallowed.

Chronic Effects Chronic exposure to corrosive fumes/gases may cause erosion of the teeth followed by jaw necrosis. Bronchial irritation with chronic cough and frequent attacks of pneumonia are common. Gastrointestinal disturbances may also be seen. May cause adverse kidney effects. Experiments have shown reproductive toxicity effects on laboratory animals.

See Section 11 for additional Toxicological information.

Aggravated Medical Conditions Preexisting eye disorders. Skin disorders.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Haz/Non-haz

Component	CAS-No	Weight %
Nitric acid	7697-37-2	65 - 70
Water	7732-18-5	30 - 35

4. FIRST AID MEASURES

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.

Inhalation Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Immediate medical attention is required.

Ingestion Do not induce vomiting. Call a physician or Poison Control Center immediately.

Notes to Physician Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Flash Point Not applicable
Method No information available.

Autoignition Temperature No information available.
Explosion Limits
Upper No data available
Lower No data available

Suitable Extinguishing Media Substance is nonflammable; use agent most appropriate to extinguish surrounding fire..

Unsuitable Extinguishing Media No information available.

Hazardous Combustion Products No information available.

Sensitivity to mechanical impact No information available.
Sensitivity to static discharge No information available.

Specific Hazards Arising from the Chemical
Oxidizer: Contact with combustible/organic material may cause fire. Corrosive Material. Causes severe burns by all exposure routes. Thermal decomposition can lead to release of irritating gases and vapors.

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear

NFPA **Health** 4 **Flammability** 0 **Instability** 0 **Physical hazards** OX

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions Wear self-contained breathing apparatus and protective suit. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. Ensure adequate ventilation. Do not get in eyes, on skin, or on clothing.

Environmental Precautions Should not be released into the environment.

Methods for Containment and Clean Up Soak up with inert absorbent material. Keep in suitable and closed containers for disposal. Keep away from clothing and other combustible materials.

7. HANDLING AND STORAGE

Handling Use only under a chemical fume hood. Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Keep away from clothing and other combustible materials. Do not breathe vapors/dust. Do not ingest. Contents under pressure.

Storage Keep containers tightly closed in a dry, cool and well-ventilated place. Do not store near combustible materials

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Measures Use only under a chemical fume hood. Ensure that eyewash stations and safety showers are close to the workstation location.

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH
Nitric acid	TWA: 2 ppm STEL: 4 ppm	(Vacated) TWA: 2 ppm (Vacated) TWA: 5 mg/m^3 (Vacated) STEL: 4 ppm (Vacated) STEL: 10 mg/m^3 TWA: 2 ppm TWA: 5 mg/m^3	IDLH: 25 ppm TWA: 2 ppm TWA: 5 mg/m^3 STEL: 4 ppm STEL: 10 mg/m^3

Component	Quebec	Mexico OEL (TWA)	Ontario TWAEV
Nitric acid	TWA: 2 ppm TWA: 5.2 mg/m^3 STEL: 4 ppm STEL: 10 mg/m^3	TWA: 2 ppm TWA: 5 mg/m^3 STEL: 4 ppm STEL: 10 mg/m^3	TWA: 2 ppm STEL: 4 ppm

NIOSH IDLH: *Immediately Dangerous to Life or Health*

Personal Protective Equipment

Eye/face Protection	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin and body protection	Wear appropriate protective gloves and clothing to prevent skin exposure.
Respiratory Protection	Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid
Appearance	Clear Colorless, Light yellow
odor	strong Acrid
Odor Threshold	No information available.
pH	1.0 (0.1M)
Vapor Pressure	0.94 kPa (20°C)
Vapor Density	No information available.
Viscosity	No information available.
Boiling Point/Range	120.5°C / 248.9°F
Melting Point/Range	-41°C / -41.8°F
Decomposition temperature	No information available.
Flash Point	Not applicable
Evaporation Rate	No information available.
Specific Gravity	1.40
Solubility	No information available.
log Pow	No data available
Molecular Weight	63.02
Molecular Formula	HNO3

10. STABILITY AND REACTIVITY

Stability	Oxidizer: Contact with combustible/organic material may cause fire.
Conditions to Avoid	Incompatible products. Combustible material. Excess heat.
Incompatible Materials	Strong bases, Reducing agents, Organic materials, Aldehydes, Alcohols, Cyanides, Metals, Powdered metals, Ammonia
Hazardous Decomposition Products	Nitrogen oxides (NOx)
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions .	None under normal processing..

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Nitric acid	Not listed	Not listed	130 mg/m^3 (Rat) 4 h 7 mg/L (Rat) 1 h

Irritation Causes severe burns by all exposure routes

Toxicologically Synergistic Products No information available.

Chronic Toxicity

Carcinogenicity There are no known carcinogenic chemicals in this product

Sensitization No information available.

Mutagenic Effects No information available.

Reproductive Effects Experiments have shown reproductive toxicity effects on laboratory animals.

Developmental Effects No information available.

Teratogenicity Teratogenic effects have occurred in experimental animals..

Other Adverse Effects See actual entry in RTECS for complete information.

Endocrine Disruptor Information No information available

12. ECOLOGICAL INFORMATION

Ecotoxicity

Do not empty into drains.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Nitric acid	Not listed	72 mg/L LC50 96 h	Not listed	Not listed

Persistence and Degradability No information available

Bioaccumulation/ Accumulation No information available

Mobility .

Component	log Pow
Nitric acid	-2.3

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. TRANSPORT INFORMATION

DOT

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	II

TDG

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	II

IATA

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	II

IMDG/IMO

UN-No	UN2031
Proper Shipping Name	NITRIC ACID
Hazard Class	8
Subsidiary Hazard Class	5.1
Packing Group	II

15. REGULATORY INFORMATION

All of the components in the product are on the following Inventory lists:

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	CHINA	KECL
Nitric acid	X	X	-	231-714-2	-		X	X	X	X	X
Water	X	X	-	231-791-2	-		X	-	X	X	X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.

N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Nitric acid	7697-37-2	65 - 70	1.0

SARA 311/312 Hazardous Categorization

Acute Health Hazard	Yes
Chronic Health Hazard	No
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	Yes

Clean Water Act

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Nitric acid	X	1000 lb	-	-

Clean Air Act
Not applicable

OSHA

Component	Specifically Regulated Chemicals	Highly Hazardous Chemicals
Nitric acid	-	TQ: 500 lb

CERCLA
This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Nitric acid	1000 lb	1000 lb

California Proposition 65
This product does not contain any Proposition 65 chemicals.

State Right-to-Know

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Nitric acid	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ): Y
DOT Marine Pollutant N
DOT Severe Marine Pollutant N

U.S. Department of Homeland Security

This product contains the following DHS chemicals:

Component	DHS Chemical Facility Anti-Terrorism Standard
Nitric acid	2000 lb STQ

Other International Regulations

Mexico - Grade No information available

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS Hazard Class

C Oxidizing materials
E Corrosive material

16. OTHER INFORMATION

Prepared By Regulatory Affairs
Thermo Fisher Scientific
Tel: (412) 490-8929

Creation Date 12-Mar-2009

Print Date 27-Sep-2011

Revision Summary (M)SDS sections updated 3

Disclaimer

The information provided on this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.

End of MSDS

Appendix C
Field Logs and COCs

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LOCUS TECHNOLOGIES WATER SAMPLING LOG

SITE: _____

WELL\SAMPLE DESIGNATION_____ DATE _____

SAMPLE SOURCE_____ PROJECT# _____

AMBIENT CONDITIONS_____ _____

GRAB SAMPLE INFORMATION (use notes section for meter reading, flow rate, vol. purged etc.)

GRAB SAMPLE METHOD:_____ CONTINUOUS PUMPER ____YES____NO PUMP CYCLING____YES____NO pH meter:_____ FLOW RATE: _____ METER READING _____

WATER LEVEL INFORMATION **MEASURING POINT___TOC___** **INSTRUMENT USED_____**

W.L. BEFORE PURGE_____TIME_____ W.L. AFTER PURGE_____ TIME_____

W.L. FOR 80% RECOVERY_____ W.L. TIME OF SAMPLE_____ DATE_____ TIME_____

MONITORING WELL PURGE INFORMATION **MONITORING WELL PURGE METHOD_____**

PURGE DEVICE I.D._____

WELL DEPTH_____ DIAMETER_____ #CASING VOLUMES (PROTOCOL)_____

SCREENED INTERVAL_____ PUMP SETTING_____

PURGE VOLUME CALCULATION_____

TIME PURGE BEGINS_____ ACTUAL AMOUNT PURGED_____ pH INSTRUMENT_____

TIME	TEMP.	COND.	pH	PURGE WATER APPEARANCE/ODOR	TURBIDITY

WATER SAMPLING INFORMATION

MONITORING WELL SAMPLING METHOD_____ APPROXIMATE DEPTH OF GRAB _____

SAMPLING DEVICE ID_____ SAMPLING TIME_____ DATE_____

BOTTLE TYPE	NO.	VOLUME	ANALYSIS	LAB	PRESERVATION	FILTRATION

DECONTAMINATION INFORMATION

PURGE DEVICE ID_____ SAMPLING DEVICE ID_____

PREVIOUSLY USED IN WELL_____ PREVIOUSLY USED IN WELL_____

SITE_____ SITE_____

DECON METHOD/STEAM TIME_____ DECON METHOD/STEAM TIME_____

RINSEATE SAMPLE_____YES_____NO I D_____ RINSEATE SAMPLE_____YES_____NO ID_____

QA/QC INFORMATION

IN SAMPLE SHIPMENT: TRAVEL BLANK____YES_____NO ID_____ QA/QC SPIKE_____YES____NO ID____

DUPLICATE____YES____NO ID_____ FIELD BLANK____YES____NO ID_____ INTER-LAB SPLIT____YES___NO ID___

NOTES

Curtis and Tompkins

2323 Fifth Street
Berkeley, CA
(510) 486-0900

Chain of Custody/Analysis Request

COC #:

Page 1 of 1

Lab Use Only

Project No:

Job No:

Client Contact: (name, co., address)

-

Samplers:

Project Number:

Site Name:

Location of Site: Sunnyvale CA

Analysis Turnaround Time:

24 Hour - ☐ 28 Days - ☐
7 Days - ☐ 72 Hour - ☐
14 Days - ☐ 10 Day - ☐
21 Days - ☐ Other - ☐

Sample Identification			Sample Date	Sample Time	Sample Type	Sample Matrix	# of Cont.	Preservation Used	Use for MS/MSD	Filtered Sample	Unfiltered Sample	8010 MS	-	-											Lab Sample Numbers
Location ID		Field Sample ID																							

Special Instructions:

Relinquished by:	**Company:**	**Date/Time:**	**Received by:**	**Company:**
Relinquished by:	**Company:**	**Date/Time:**	**Received by:**	**Company:**
Relinquished by:	**Company:**	**Date/Time:**	**Received by:**	**Company:**

Appendix D
Instrumentation User's Guides

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USER MANUAL
DOCUMENT #626973-01REF

ProDSS

USER MANUAL

a xylem brand

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Introduction

Thank you for purchasing the YSI Professional Digital Sampling System (ProDSS).

ProDSS features include:

- Digital smart probes that are automatically recognized by the instrument when connected
- Waterproof (IP-67) case
- Long-life rechargeable lithium-ion battery pack
- Color display and backlit keypad
- User-selectable cable options
- USB connectivity
- Global Positioning System (GPS) (optional)
- Depth sensor (optional)
- Large memory with extensive site list capabilities
- Rugged enclosure with rubber over-molded case and miltary-spec (MS) connectors

Safety information

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all precautionary statements. Failure to do so could result in serious injury to the operator or damage to the equipment. Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

NOTICE: The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Precautionary symbols

NOTE: *Information that requires special emphasis*

NOTICE: Indicates a situation which, if not avoided, may cause damage to the instrument

⚠ **CAUTION:** Indicates a potentially hazardous situation that may result in minor or moderate injury

⚠ **WARNING:** Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury

Product components

Carefully unpack the instrument and accessories and inspect for damage. If any parts or materials are damaged, contact YSI Customer Service at 800-897-4151 (+1 937 767-7241) or the authorized YSI distributor from whom the instrument was purchased.

Battery use and battery life

The ProDSS uses a rechargeable lithium-ion (Li-Ion) battery pack as a power source. The battery comes pre-installed in the ProDSS and does not need to be replaced until the battery charge capacity is deemed unacceptable by the user. The battery is shipped at ~50% full capacity and charging the battery is not required before first use.

Battery life depends on use, enabled parameters, LCD brightness, and GPS use. As with all lithium-ion batteries, battery life will decline over time and use. This decay is typical and should be expected.

A new ProDSS battery is expected to last for the following durations (25 °C (77 °F), auto sampling, GPS on, keypad backlight off):

- ProDSS instrument only - 48 hours
- ProDSS with fully loaded cable assembly and 25% (Default) LCD brightness - 20 hours
- ProDSS with fully loaded cable assembly and 100% LCD brightness - 14 hours

To increase battery life, enable manual sampling mode (Sampling on page 20). Manual sampling mode powers the sensor/s on to take a measurement and then powers down to conserve battery life. Battery life may also depend on the battery charging practices used. For maximum battery life, keep the battery 40% to 80% charged. Also, a larger discharge (e.g. to 50%) is better than a small discharge (e.g. to 90%) between recharges.

Charging the battery pack

A USB cable is included with the ProDSS to charge the instrument battery pack and connect the instrument to a PC. The instrument battery pack can be charged from the AC power adapter, directly from a computer USB connection or from an external, portable USB battery pack (sold separately, see ProDSS accessories on page 76).

Plug the USB connector into the AC power adapter, computer USB connector or external USB battery pack, then plug the micro USB connector into the ProDSS instrument (Figure 1).

NOTE: *The ProDSS internal charge controller only allows the battery pack to be charged if the temperature is between 0 and 45 °C (32 and 113 °F).*

⚠ **WARNING:** Charge the battery pack in an open area away from flammable materials, liquids, and surfaces. Read Rechargeable Lithium-Ion battery pack safety warnings and precautions on page 79.

The ProDSS will charge faster when plugged into an AC outlet for charging rather than a PC's USB port. For the instrument to recognize that it is using AC power, you must start charging the ProDSS while on. After the instrument recognizes it is being charged, it can be turned off to finish charging.

When using the AC adapter, it takes approximately 14 hours to charge the ProDSS battery when the instrument is turned off during the charge. The amount of time required to completely charge the battery pack when the ProDSS is initially turned on during the charge is approximately 9 hours.

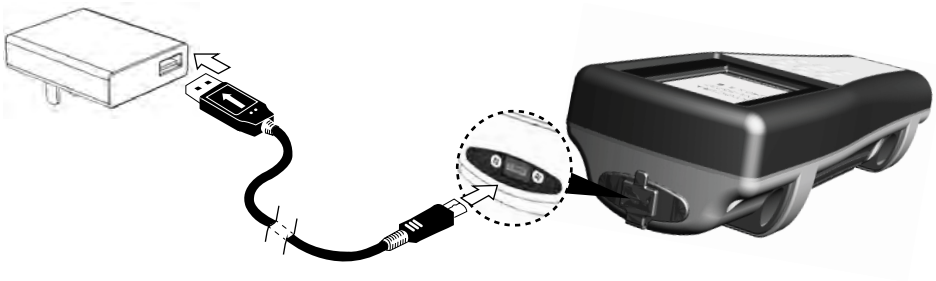

Figure 1 Connecting the ProDSS to AC power supply

Battery replacement

NOTE: *The battery pack is pre-installed in the ProDSS instrument.*

⚠ **WARNING:** Do not charge or handle a battery pack that is hot to the touch. Failure to follow the safety warnings and precautions can result in personal injury and/or instrument damage not covered under warranty. Read Rechargeable Lithium-Ion battery pack safety warnings and precautions on page 79.

1. Remove the battery pack cover by unscrewing (counter-clockwise) the four screws with a flat or Phillips head screwdriver (Figure 2 on page 7).

   NOTE: *The retaining screws are captured into the battery pack cover and are not removable.*

2. If replacing an existing battery pack, remove the Li-Ion battery pack and battery pack gasket/cradle. With two fingers, grasp the battery pack connector and pull the connector straight up to disconnect and remove.

   NOTE: *Properly dispose of the old battery pack (Battery Disposal on page 80).*

   NOTE: *A new gasket/cradle is included with a new battery pack to prevent water leaking into the instrument case. When replacing the battery pack, use the new battery pack gasket/cradle supplied with the replacement battery pack.*

3. Inspect the replacement battery pack and battery pack gasket/cradle for damage. Contact YSI customer service if the new battery pack and/or replacement gasket/cradle is damaged.
4. Correctly align and seat the battery pack gasket/cradle and battery pack into the instrument.
5. Align the battery pack connector wire terminals with the three instrument pins, then connect the battery pack to the instrument.

   NOTICE: Make sure that the three wire terminal connectors and three instrument pins are correctly aligned before connecting the battery pack connector. Incorrect installation can damage the battery pack connectors or instrument pins.

6. Install the battery pack cover, then tighten the cover screws. Make sure that the cover sealing surface is correctly aligned and free of any contamination or damage.

   NOTICE: Overtightening the cover screws can damage the battery cover.

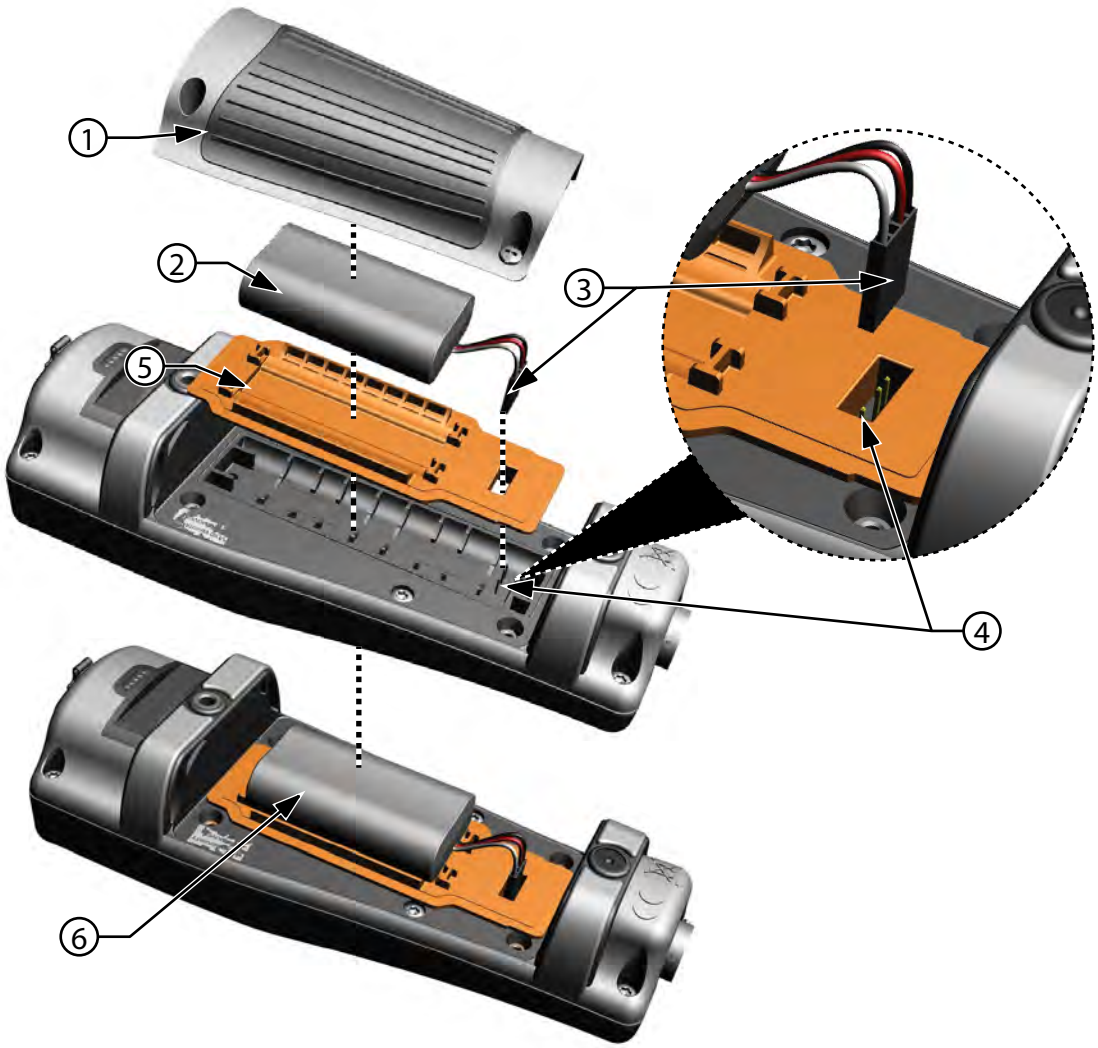

Figure 2 Battery replacement

1 Battery pack cover	**4** Instrument pin connectors
2 Battery pack	**5** Battery pack gasket/cradle*
3 Battery pack connector	**6** Battery pack gasket/cradle installed

*Color shown for reference

Connect the handheld to the cable assembly

The ProDSS cable connectors are keyed for positive mating and to prevent connector damage (Figure 3). The ProDSS instrument retains its IP-67 rating when the cable is disconnected. However, the connectors are not wet-mateable and should be clean and dry before connecting.

Align the keys on the cable assembly connector with the slots on the instrument connector. Push together firmly, then twist the outer ring clockwise until it locks into place.

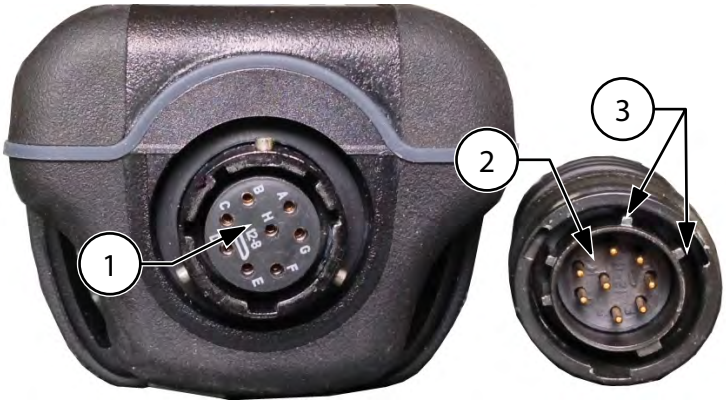

Figure 3 Keyed connectors

1	Handheld female connector	**3**	Keyed area of connectors
2	Cable male connector		

ProDSS sensor installation/removal

NOTICE: The ProDSS bulkhead and sensor connectors are not wet-mateable. Make sure that the sensor and bulkhead connectors are clean and dry before sensor installation.

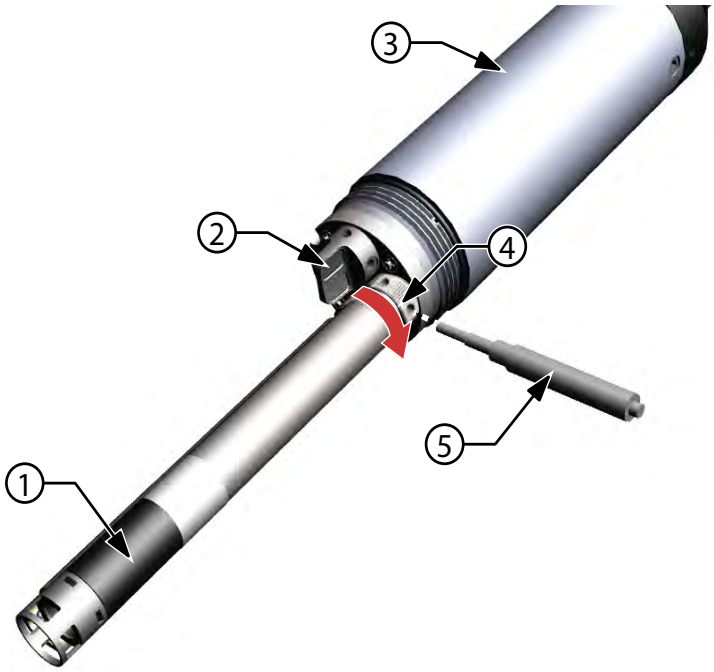

Figure 4 Sensor installation

1	Sensor	**4**	Sensor retaining nut
2	Port plug	**5**	Sensor installation/removal tool
3	Bulkhead		

Sensor installation

The ports on the ProDSS bulkhead are universal; therefore, you can install any sensor into any port. For highest accuracy, always install a conductivity/temperature sensor to compensate all measurement data for temperature and dissolved oxygen data for conductivity.

1. Remove and discard the dust plugs shipped with the instrument (Figure 5 on page 10).
2. Inspect the bulkhead port for contamination. If the port is wet, clean it with compressed air.
3. Apply a thin coat of Krytox o-ring lubricant to the sensor o-rings. Wipe off any excess o-ring grease with a lint-free cloth.
4. Carefully align the sensor and bulkhead connectors by inserting the sensor into the port then gently rotating the sensor until the connectors align. Once aligned, push the sensor toward the bulkhead until the sensor seats in the port.
5. Carefully finger-tighten the retaining nut clockwise.

   NOTICE: If any resistance is felt, loosen the retaining nut completely to prevent cross-threading. Incorrect installation may cause damage to the sensor or bulkhead that is not covered by the warranty.

6. Use the sensor installation/removal tool to tighten the retaining nut clockwise until snug, about a 1/4 to 1/2 additional turn of the retaining nut.

   NOTICE: Do not over-tighten the retaining nut. Over-tightening can cause damage to the sensor or bulkhead not covered by the warranty.

Sensor removal

To remove a sensor, insert the sensor installation/removal tool into the retaining nut, then rotate the retaining nut counterclockwise to loosen. After the retaining nut has been completely unscrewed from the bulkhead, pull the sensor straight out of the port and place it on a clean surface.

NOTICE: Install a port plug if not reinstalling a sensor in the exposed port. Exposure to water can cause damage or corrosion to the bulkhead connectors not covered by the warranty.

Port plugs

Figure 5 Port plugs

1 Shipping dust cover*	**2** Port plug

*Color shown for reference

To protect the bulkhead connectors from damage, install a port plug into any port without an installed sensor. Port plugs and a tube of o-ring lubricant are included in the maintenance kit that ships with all ProDSS cables. Refer to the accessories section if an additional maintenance kit is needed (Ordering on page 73).

NOTICE: The shipping dust covers installed on the bulkhead when purchased (not sensor installation/removal tool compatible) are not o-ring sealed and must be replaced with a port plug before field use.

NOTICE: Do not submerge the bulkhead without a sensor or port plug installed in all ports.

Installation

1. Apply a thin coat of Krytox o-ring lubricant to the o-rings on the plug port.
2. Remove any excess lubricant from the o-rings and port plug with a lint-free cloth.
3. Insert the port plug into the empty port and press until firmly seated.
4. Finger-tighten the port plug clockwise to install. If necessary, use the sensor installation tool to make sure that the plug is fully seated into the port.

   NOTICE: The o-rings will not be visible if a port plug is correctly installed.

   NOTICE: Do not over-tighten the port plug. Over-tightening can cause damage to the port plug or bulkhead not covered by the warranty.

Sensor guard and weight installation

1. Carefully slide the sensor guard over the bulkhead and attached sensors/port plugs. Push the sensor guard toward the bulkhead until the sensor guard threads align with the bulkhead threads.
2. Carefully finger-tighten the sensor guard clockwise.

NOTICE: If any resistance is felt, loosen the sensor guard completely to prevent cross-threading. Incorrect installation may cause damage to the sensor guard or bulkhead that is not covered by the warranty.

NOTICE: Do not submerge the bulkhead without a sensor or port plug installed in all ports.

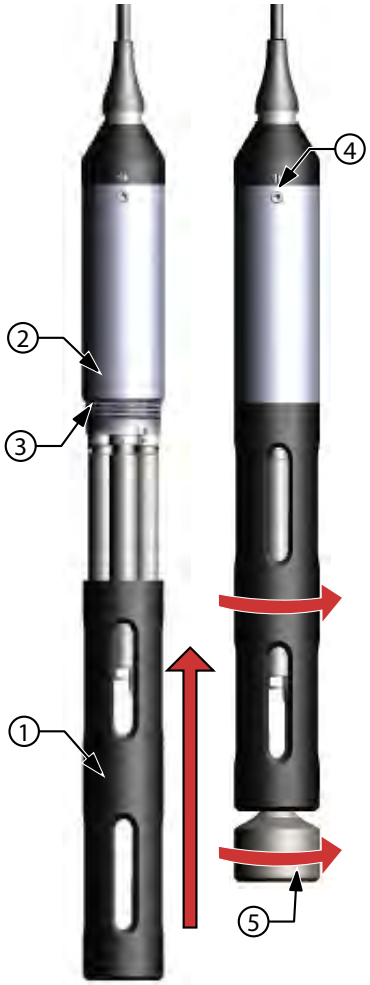

Figure 6 Sensor guard and weight installation

1 Sensor guard	**4** Depth sensor (if equipped)
2 Bulkhead	**5** Weight
3 Bulkhead threads	

Sensor guard weights

To help stabilize the sensors when profiling at deeper depths, a sensor guard weight is supplied with cables 10 meters and longer. To attach the weight, carefully hand-tighten it clockwise on to the bottom of the sensor guard (Figure 6 on page 11).

NOTICE: If any resistance is felt, loosen the sensor guard weight completely to prevent cross-threading. Incorrect installation may cause damage to the sensor guard.

The bottom of the weight is threaded so that additional weights can be added if needed. See ProDSS accessories on page 76.

NOTE: *Do not have any weights installed on the sensor guard when calibrating using the calibration cup.*

Keypad and navigation

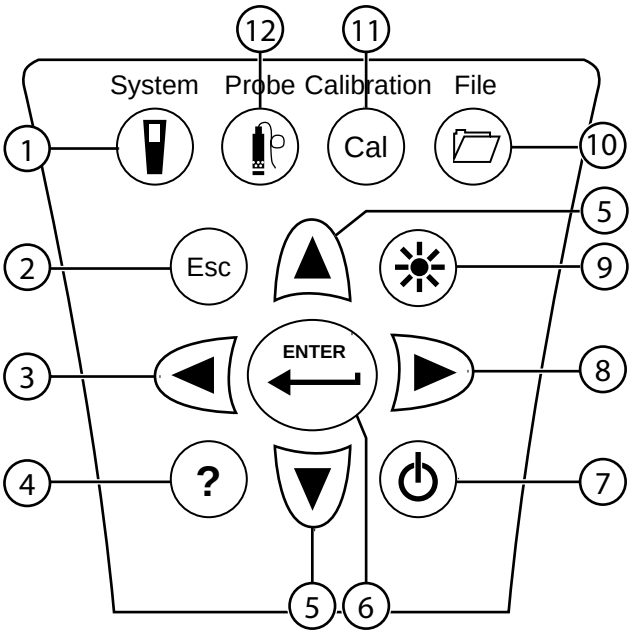

Figure 7 Keypad description

1 **System:** Opens the system menu. Use to adjust system settings	**7** **ON/OFF:** Turn on or turn off the instrument
2 **Exit/Escape key:** Exits to the Run screen. When in an alpha/numeric entry screen, returns to previous menu	**8** **Right arrow key:** Navigate right in an alpha/numeric entry screen. On the Run screen, push to show graphical representations of the displayed measurements. Push the right or left arrow to return to the Run screen. In the View Data screen, push to view additional parameters in the data set
3 **Left arrow key:** Navigate left in an alpha/numeric entry screen. Push to return to previous menu in all screens except alpha/numeric entry. On the Run screen, push to show graphical representations of the displayed measurements. Push the right or left arrow to return to the Run screen	**9** **Backlight:** Turns the keypad backlight on or off for use in low light conditions
4 **Help:** Shows context sensitive help	**10** **File:** Opens the file menu. Use to view logged data and GLP files, backup data to a USB stick, and delete data
5 **Up/down arrow keys:** Scroll through menus or enter numbers and letters	**11** **Calibrate:** Opens the calibration menu. Use to calibrate all parameters except temperature
6 **Enter key:** Push to confirm selections. On the Run screen, push to log a single data point or start continuous data logging	**12** **Probe:** Opens the sensor menu. Use to setup sensors, change the measurements shown on the run screen, and turn on/off Auto Stable and GPS

Startup

Push the ⏻ key to turn on the handheld. If the handheld does not turn on, make sure that the battery pack is correctly installed and charged. Push and hold the ⏻ key for 1.5 seconds to turn the handheld off.

Navigation

The ProDSS contains menus to change user-defined options, functions, and parameters. Use the arrow keys (▲ and ▼) to highlight different options within menus and sub-menus, then push the ENTER key to select the option. Push the ◀ key to return to the previous menu.

> ***NOTE:*** *When in an alpha/numeric screen, the ◀ key is for alpha/numeric navigation only. Push the Esc key to return to the previous menu.*

Push the Esc key to return to the Run screen. To enable or disable an option, highlight the option, then push the ENTER key. Enabled functions appear as a circle with a dot ◉ or a box with a check mark ☑ . Disabled functions appear as a circle only ○ or an empty box ☐.

Alpha/numeric entry

When required, an alpha or alpha/numeric entry screen will be shown. When finished entering information, highlight **ENTER**, then push the ENTER key to save the entry (Figure 8).

> ***NOTE:*** *When in an alpha/numeric screen, the ◀ key is for alpha/numeric navigation only. Push the Esc key to return to the previous menu.*

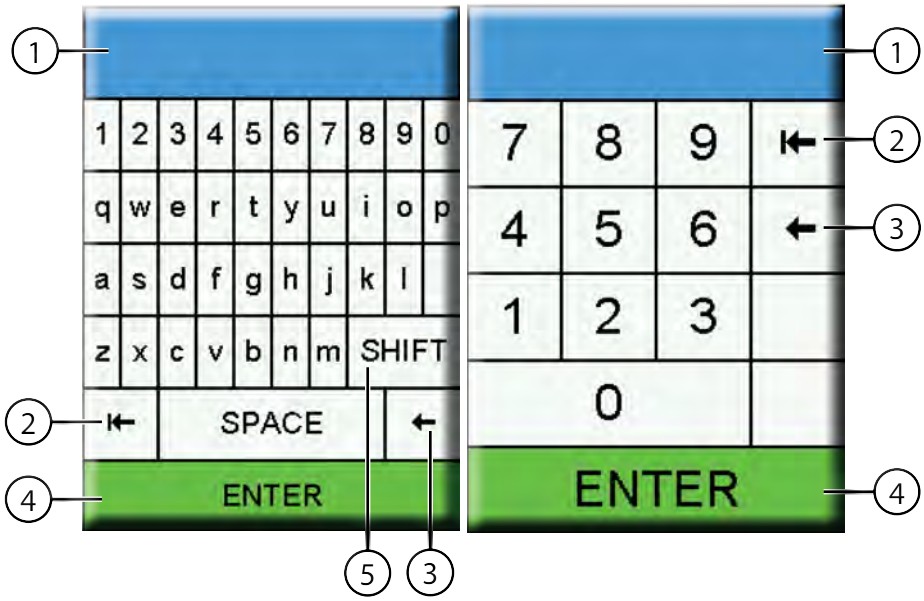

Figure 8 Alpha/numeric and numeric entry screens

1	User entry field	**4**	Enter selection
2	Delete entire entry	**5**	Upper/lowercase
3	Backspace		

Main display description

The main display (Run screen) shows the current measurements as defined in the Sensor Display menu (Sensor Display on page 25). If more measurements are selected than can be displayed on the Run screen, a scroll bar will be shown. Use the ▲ and ▼ arrow keys to view the additional measurements (Figure 9).

The message area shows status messages, error messages, and information about selected functions.

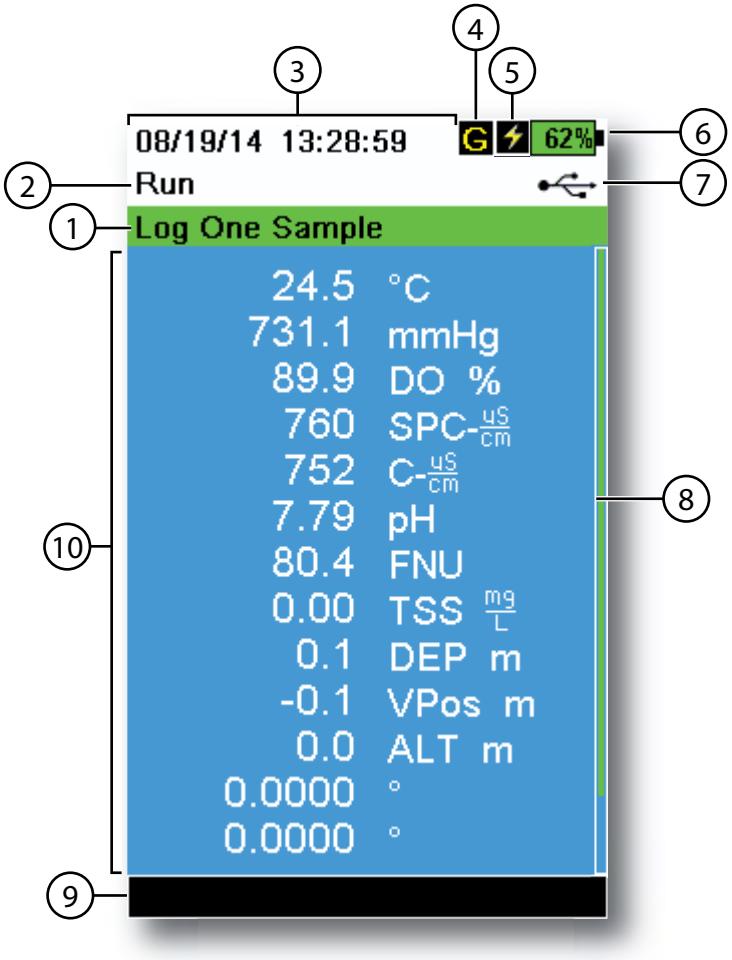

Figure 9 Main display example

1	Log or sampling (update measurements) prompt on Run screen (single or continuous)	**6**	Battery charge %
2	Current screen/menu	**7**	USB/PC connection indicator
3	Date/Time	**8**	Scroll bar
4	GPS signal indicator	**9**	Message area
5	Battery charging indicator	**10**	Displayed measurements

System menu

Push the System key to view and adjust instrument settings. Highlight a sub-menu then push the ENTER key to view the sub-menu options (Figure 10).

Pre-defined or user-selected options are noted within brackets (**[ ]**). See Alpha/numeric entry on page 14.

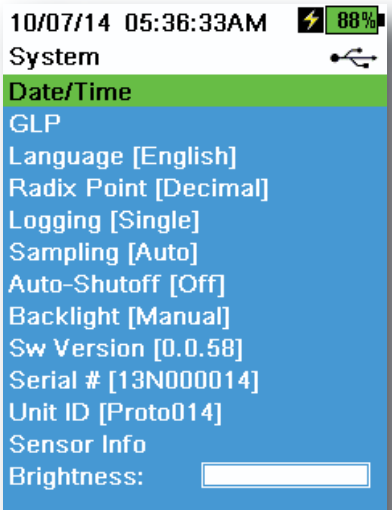

Figure 10 System menu

Use the System menu to:

- Set the date and time (Date/Time on page 17)
- Change the user-defined Good Laboratory Practices (GLP) options (GLP menu on page 17)
- Change the instrument language setting (Language on page 19)
- Change the radix point (Radix Point on page 19)
- Change logging options (Logging on page 19)
- Change sampling options (Sampling on page 20)
- Set the handheld auto-shutoff time (Auto-Shutoff on page 20)
- Set the backlight mode (Backlight on page 21)
- View the software version (Alpha/numeric entry on page 14)
- View the handheld serial number (Serial # on page 21)
- View and adjust the Unit ID (Unit ID on page 21)
- View the sensor specific information (Sensor info on page 22)
- Adjust the display brightness (Brightness on page 22)

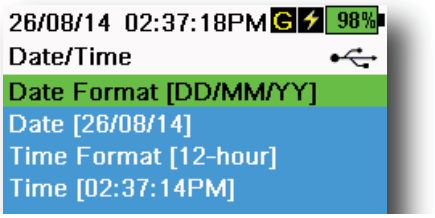

Figure 11 Date/Time

Date/Time

→ **Date/Time**

For accurate logging and GLP data, correctly set the date and time options (Figure 11). Select any of the following options to set the Date/Time in the ProDSS.

Date/Time options:

- Set YY/MM/DD, MM/DD/YY, DD/MM/YY or YY/DD/MM date format
- Set the correct date
- Select 12 or 24 hour time format
- Set the correct time

GLP menu

Detailed sensor calibration information is stored in the Good Laboratory Practice (GLP) file for later review.

One GLP file is used to store all calibration records. The instrument's internal memory can save up to 400 individual calibration records. After 400 records, the instrument will overwrite previously stored calibration records, starting with the oldest.

To prevent the permanent loss of GLP records, periodically download the GLP file to a computer using the KorDSS software.

NOTE: *GLP files uploaded to the PC will overwrite a previously downloaded GLP file if it has the same file name. To prevent data loss, move or rename previously downloaded GLP files before downloading the GLP file.*

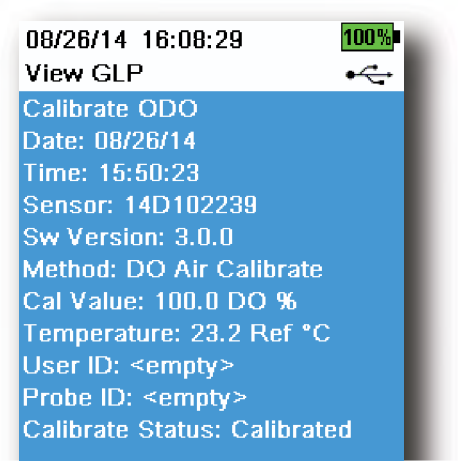

Figure 12 GLP record example (single point % DO calibration)

GLP saved information

See Figure 12.

- Sensor calibrated
- Date/time stamp
- Sensor ID
- Sensor software version
- Calibration method (Conductivity and ODO calibrations)
- Calibration value
- Temperature
- User ID (optional)
- Probe ID (optional)
- User fields #1 and #2 (optional)
- Calibration status

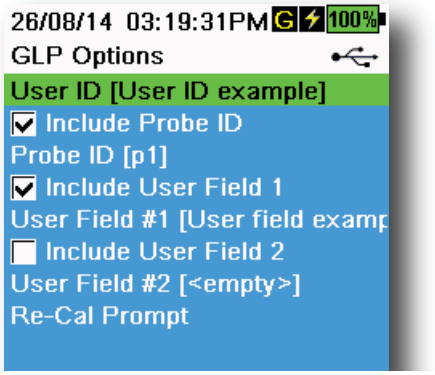

Figure 13 GLP Options

GLP Options

→ **GLP** → **Options**

User ID, Probe ID, or User Field #1 or 2 can be user-defined for positive GLP file identification of:

- The person calibrating the instrument.
- The sensor/cable serial number used during calibration (or other, user-defined Probe ID).
- Other user-specific identification (User Field #1 and #2) (Figure 13).

NOTE: *User Field can be used to describe the condition of the probe. For example, new sensor or new ODO cap.*

Figure 14 Re-Cal Prompts

Re-Cal Prompts

→ **GLP** → **Options** → **Re-Cal Prompts**

Re-Cal Prompts provide a reminder to recalibrate a probe in the user-defined number of days (Figure 14).

The Re-Cal prompt will be displayed in the message area of the main display when the set time has elapsed (Figure 9 on page 15).

Select the desired sensor Re-Cal prompt, then enter the desired number of days before the Re-Cal prompt occurs.

Set the sensor value to zero (0) days (default) to turn off Re-Cal prompts.

NOTE: *When enabled and the set amount of time since the last calibration has passed, the Re-Cal prompt will be shown when the instrument is turned on.*

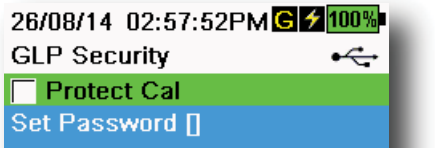

Figure 15 GLP Security

GLP Security

→ **GLP** → **Security**

The Calibration menu can be password protected to prevent accidental or unauthorized sensor calibration (Figure 15).

1. From the GLP menu, select **Security**, then enter the default password "ysi123".
2. Select **Set Password []** and change the default password.
3. Select the **Protect Cal** check box to password protect the Calibration menu.

NOTE: *Write down and keep the password in a safe place. Contact YSI Technical Support if you lose the password* (Technical support on page 81).

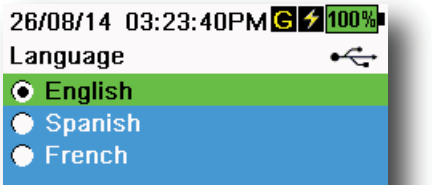

Figure 16 Language

Language

→ **Language**

The ProDSS is shipped with English enabled. If a different language is desired and selected, the ProDSS will take approximately 10 to 20 seconds to enable the new language (during the first installation only).

Optional languages:

- French
- German
- Italian
- Japanese
- Norwegian
- Portuguese
- Simplified Chinese
- Spanish
- Traditional Chinese

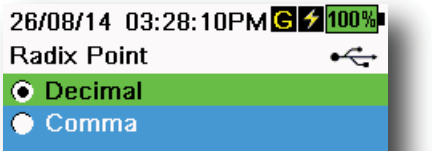

Figure 17 Radix Point

Radix Point

→ **Radix Point**

The radix point can be changed to display a comma or a decimal in numeric displays (e.g. 1.00 becomes 1,00 when Comma is selected) (Figure 17).

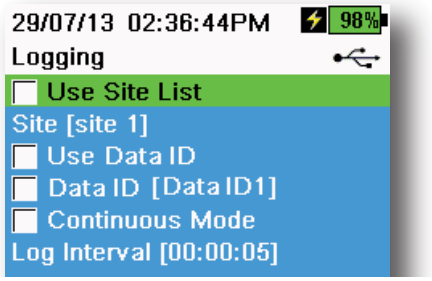

Figure 18 Logging

Logging

→ **Logging**

The Logging menu allows user-defined site and Data ID lists to be added to the logged data. Add a Site or Data ID, then select the applicable check box to log data to that site and/or Data ID (Figure 18).

Continuous Mode (Interval logging): Select the Continuous Mode check box and enter the user-defined Log Interval (in HH:MM:SS - hours:minutes:seconds) to log samples continuously at the specified time interval. The Run screen will display **Start Logging...** when in Continuous Mode.

One sample logging: Clear the Continuous Mode check box. The Run screen will display **Log One Sample**. A sample will be logged each time the ENTER key is pushed when in the Run screen.

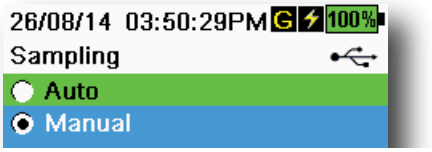

Figure 19 Sampling

Sampling

→ **Sampling**

Auto sampling mode continuously updates measurements on the display (Figure 19).

Manual mode helps conserve battery power. The user-defined Sample Period determines the measurement time limit.

When in Manual mode, the instrument will take measurements for the duration of the Sample Period then "lock" or hold the readings on the display (sample period default 50 seconds, user-defined between 15 to 60 seconds).

Once the measurements are locked, push the ENTER key to log the held data, or the Esc key and then the ENTER key to take a new measurement.

Enter the desired Sample Period time.

NOTE: *When both Continuous Logging Mode and Manual Sampling mode are enabled, the ProDSS will power the sensors on and take measurements for 15 seconds before logging a data set.*

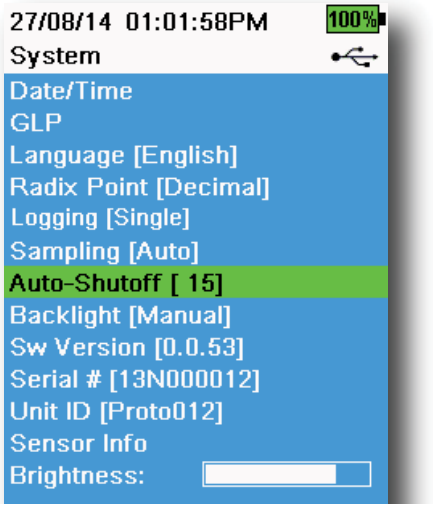

Figure 20 Auto-Shutoff

Auto-Shutoff

→ **Auto-Shutoff**

To conserve battery power, auto-shutoff powers off the instrument after a user-defined time period (in minutes) (Figure 20). Set to 0 (zero) to disable Auto-Shutoff.

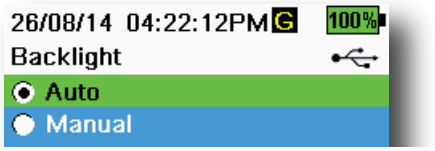

Figure 21 Backlight

Backlight

→ **Backlight**

In Automatic mode, the instrument display will dim 60 seconds after the last key was pushed. Once any key is pushed, the instrument display will return to the user-defined brightness setting and the keypad backlight will turn on. The screen will dim and the keypad backlight will turn off after another 60 seconds of inactivity.

In manual mode, the instrument display remains at the user-defined brightness until manually changed and the keypad backlight is turned on and off by the Backlight key (Figure 21).

NOTE: *In bright conditions, set the backlight to Manual mode.*

Software (Sw) Version

→ **Sw Version**

Sw Version (System menu on page 16)

Sw Version shows the ProDSS software version number. The latest instrument software version is available at ysi.com. Instrument software can be updated through the KorDSS PC software program when connected to the internet or if the firmware file has been transferred to the PC. See the KorDSS help section for more information.

Serial

→ **Serial #** (System menu on page 16)

Serial # shows the serial number of the ProDSS handheld instrument. Note the serial number when contacting YSI support.

Unit ID

→ **Unit ID** (System menu on page 16)

Unit ID identifies the instrument in the KorDSS PC software program that was included with the instrument.

Select **Unit ID** to change the default ID.

Sensor info

→ **Sensor info** (System menu on page 16)

Sensor info shows measurement data, and hardware/software information for each component of the system: instrument, sensor, and bulkhead. Use the ▲ and ▼ arrow keys to scroll through the components.

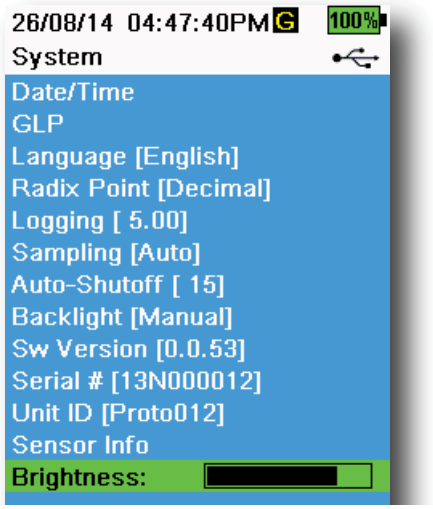

Figure 22 Display Brightness

Brightness

→ **Brightness**

The screen brightness can be adjusted to accommodate lighting conditions and to conserve battery power (Figure 22).

Select **Brightness** then use the ◀ and ▶ arrow keys to adjust the screen brightness.

> ***NOTE:*** *In bright conditions, set the screen brightness to 75% or greater.*

Sensor menu

Use the Probe key to access the Sensor menu and change sensor settings (if applicable), enable the measurement units displayed on the Run screen, set Auto Stable parameters, and if equipped, turn on/off GPS.

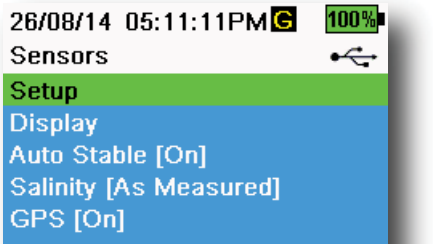

Figure 23 Probe (Sensor) menu

Push the key to access the sensor menu (Figure 23). Highlight a sub-menu then push the ENTER key to view sub-menu options.

Pre-defined or user-selected sensor settings are noted within brackets (**[]**).

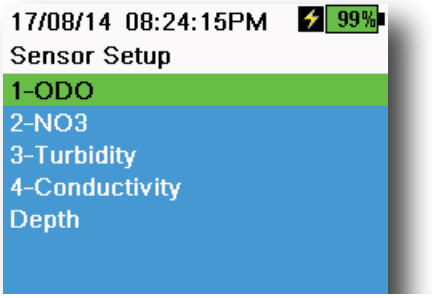

Figure 24 Sensor Setup

Sensor Setup

→ **Setup**

The Sensor Setup menu will show all sensors installed on the bulkhead (Figure 24). If a sensor is installed on the bulkhead and is not listed on the Sensor Setup menu (**<None>** displayed), check the sensor and cable connections (ProDSS sensor installation/removal on page 9).

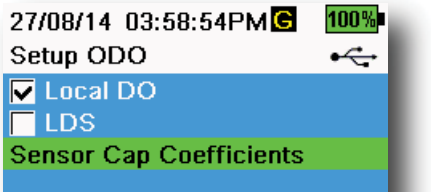

Figure 25 Setup ODO

Setup ODO

→ **Setup** → **ODO**

Local DO: Enable or disable localized DO% measurements. When enabled, the calibration value is set to 100% regardless of altitude or barometric pressure. When enabled, an L will be shown next to DO% on the run screen. DO mg/L measurements are unaffected when Local DO is enabled (Figure 25).

LDS: Last Digit Supression (LDS) rounds the DO value to the nearest tenth, e.g. 8.27 mg/L becomes 8.3 mg/L.

Sensor Cap Coefficients: The sensor cap coefficients must be updated after sensor cap replacement. Update the sensor cap coefficients using the KorDSS software and the coefficient sheet provided with the new sensor cap.

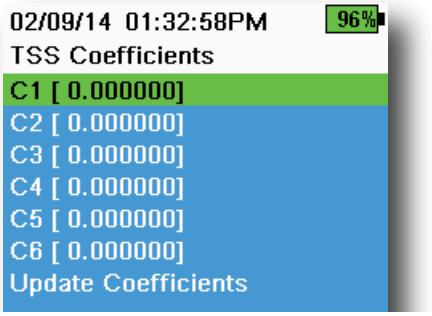

Figure 26 TSS coefficients

Setup Turbidity

→ **Setup** → **Turbidity**

TSS Coefficients: The Total Suspended Solids (TSS) coefficients are calculated in KorDSS by entering turbidity and TSS correlation data.

Measure turbidity and take a grab sample for laboratory analysis of TSS to obtain a value pair for the correlation. At least two and up to six value pairs can be entered into KorDSS.

The TSS coefficients can be entered manually or updated through the KorDSS software (Figure 26).

For highest accuracy, obtain 6 values pairs and calculate new coefficients for each unique sampling site.

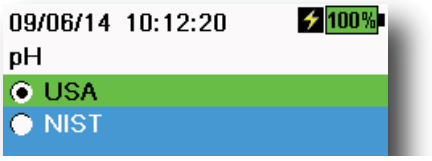

Figure 27 Setup pH

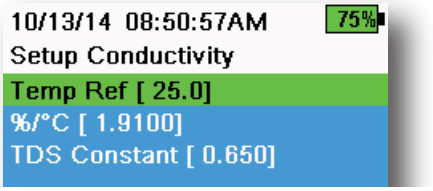

Figure 28 Setup Conductivity

Setup pH

→ **Setup** → **pH**

Select USA auto-buffer recognition (4.01, 7.00, and 10.00) or NIST auto-buffer recognition (4.01, 6.86, and 9.18) (Figure 27).

Setup Conductivity

→ **Setup** → **Conductivity**

Temp Ref (Temperature reference): Reference temperature used to calculate temperature compensated specific conductance. All specific conductance values are compensated to the Temp Ref temperature. The default value is 25 °C (77 °C) (Figure 28). Enter a new value between 15.00 °C (59 °F) and 25.00 °C (77 °F).

%/°C (Percent per degree Celsius): Temperature coefficient used to calculate temperature compensated specific conductance. The default is 1.91% based on KCl standards. Enter a new value between 0 and 4%.

TDS Constant: Multiplier used to calculate an estimated Total Dissolved Solids (TDS) value from conductivity. The multiplier is used to convert specific conductance in mS/cm to TDS in g/L. The default value is 0.65. Enter a new value between 0 and 0.99.

This multiplier is highly dependent on the nature of the ionic species present in the water sample. To be assured of moderate accuracy for the conversion, you must determine a multiplier for the water at your sampling site. Use the following procedure to determine the multiplier for a specific sample:

1. Determine the specific conductance of a water sample from the site.
2. Filter a portion of water from the site.
3. Carefully measure a volume of the filtered water. Completely evaporate to yield a dry solid.
4. Accurately weight the remaining solid.
5. Divide the weight of the solid (in grams) by the volume of water used (in liters) to yield the TDS value in g/L for the site.
6. Divide the TDS value in g/L by the specific conductance of the water in mS/cm to yield the conversion multiplier.

   NOTE: *Make sure to use the correct units.*

   NOTE: *If the nature of the ionic species at the site changes between sampling studies, the TDS values will be in error. TDS cannot be calculated accurately from specific conductance unless the make-up of the chemical species in the water remains constant.*

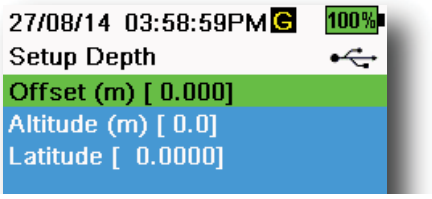

Figure 29 Setup Depth

Setup Depth

→ **Setup** → **Depth**

For ProDSS bulkheads with the depth sensor:

The ProDSS cable assemblies with a depth sensor in the bulkhead can measure virtual vented depth (Figure 6 on page 11). The virtual vented depth measurement allows for real time compensation for atmospheric pressure using the instrument's barometer.

Depth offset: Depth offset can be used if referencing water elevation against a known datum. If a depth offset is entered (in meters), the output value will shift by the value of the offset (Figure 29).

Altitude/Latitude: To compensate for atmospheric pressure based on elevation and gravitational pull, enter the local altitude in meters relative to sea level and latitude in degrees where the ProDSS is sampling.

Latitude effect: Varying latitudes cause a 200 mm change in depth from equator to pole.

Altitude effect: Varying altitudes cause approximately 90 mm change from sea level to 8000 m. A 100 m change causes 1.08 mm of change to the readings.

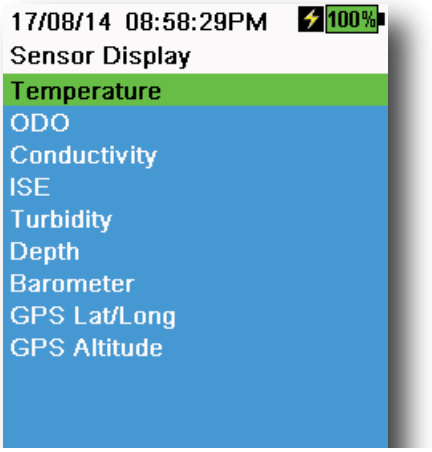

Figure 30 Sensor Display

Sensor Display

→ **Display** (Figure 30)

The Sensor display menu determines the measurements that are shown on the Run screen (Figure 3 Main display example on page 28). The Run screen will only show measurements for sensors that are attached to the cable bulkhead.

If more measurements are selected than can be displayed on one screen, a scroll bar will be shown. Use the ▲ and ▼ keys to scroll through the measurements.

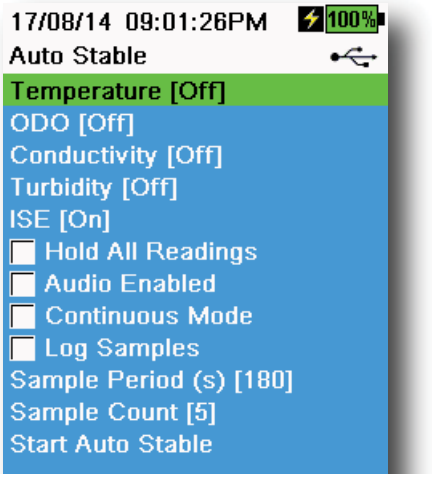

Figure 31 Auto Stable

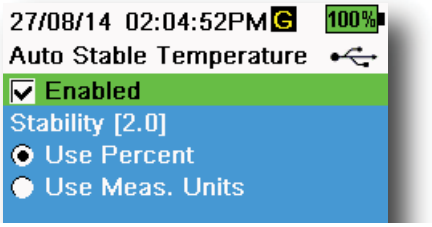

Figure 32 Auto Stable stability threshold

Auto Stable

→ **Auto Stable**

Auto Stable indicates when a measurement is stable. Sensors with Auto Stable enabled will have A S flash beside the measurement on the Run screen.
A S will flash green when the measurement is stable.

Select a sensor to enable or disable Auto Stable. Set the stability threshold parameters (Figure 31).

The Auto Stable stability threshold can be set by percent of measurement or in the units of measurement selected in the Sensor Display menu.

Enter the stability value, then select **Use Percent** or **Use Meas. Units** (Figure 32).

This threshold is used to compare the last reading with the previous. The smaller the number entered in % or units, the longer it will take for the instrument to reach the auto stable criteria.

Example: For temperature in °C, if unit threshold is set to 0.2 and the temperature reading changes by more than 0.2 degrees, A S will continue to be red until the reading does not change by more than 0.2 °C over the defined sample period and sample count.

Hold All Readings: After all sensors have reached their stability criteria, the measurements will be held or 'locked' on the display. If disabled, the sensor measurements will continue to change in real time.

Audio Enabled: An audio alert will sound when stability is reached.

Continuous Mode: The ProDSS will continuously check sensor values against the stability criteria even after the sample period and sample count have been met.

Log Samples: Logs the sample/s defined by the Sample Period to memory.

Sample Period: Time interval between the sensor measurements (sample) that are used to determine stability. Set the interval in seconds (1 to 900).

Sample Count: Number of consecutive samples required for stability (1 to 10).

Select **Start Auto Stable** to enable.

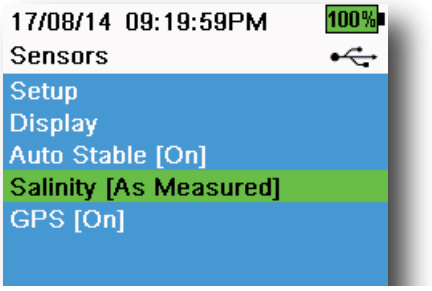

Figure 33 Salinity

Salinity

→ **Salinity** (Figure 33)

Salinity is determined by calculations derived from the conductivity and temperature sensors.

Because salinity is an important factor in determining dissolved oxygen, YSI does not recommend calibrating or taking dissolved oxygen measurements without the conductivity/temperature sensor installed in the bulkhead.

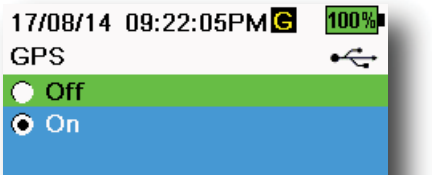

Figure 34 GPS

GPS (optional)

→ **GPS**

GPS turns the ProDSS Global Positioning System On or Off. The G symbol is shown when a GPS signal is received (Figure 34).

When enabled, the GPS coordinates will be saved with the GLP file and logged data.

Calibration menu

Push the (Cal) key to access the Calibration menu (Figure 35). Highlight a sub-menu then push the (ENTER) key to view sub-menu options.

Pre-defined or user-selected parameters are noted within brackets (**[]**). See Alpha/numeric entry on page 14.

Refer to the Calibration section for sensor specific calibration procedures (Calibration on page 33).

NOTE: *Attached sensors are listed according to the bulkhead port in which they are installed.*

NOTE: *User ID, Probe ID, and User Field #1 and #2 must be enabled in the GLP menu to appear in the Calibration menu* (GLP Options on page 18).

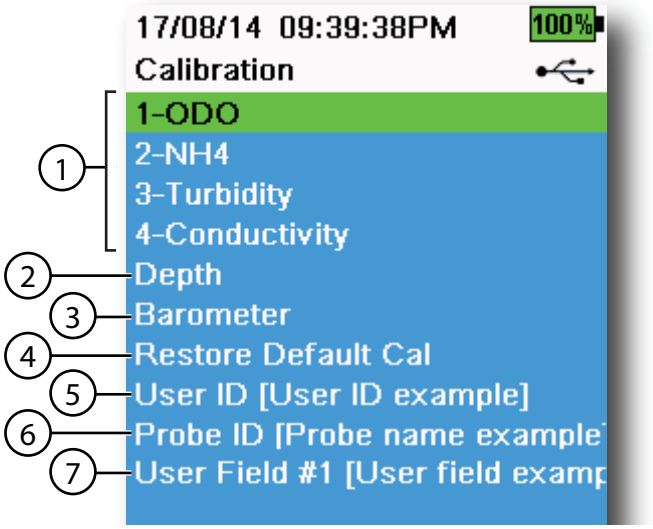

Figure 35 Calibration menu

1	Sensors connected to bulkhead	**5**	User ID
2	Optional Depth sensor calibration	**6**	Probe ID
3	Barometer calibration	**7**	User Field #1
4	Restore Default Calibration - restores all calibrations to factory default		

Files menu

Push the key to access the Files menu (Figure 36). Highlight a sub-menu then push the key to view sub-menu options.

Use the Files menu to view, delete or backup logged data or the GLP file. Data can be filtered by a specific date and time range and by user-created site and Data ID lists (Logging on page 29).

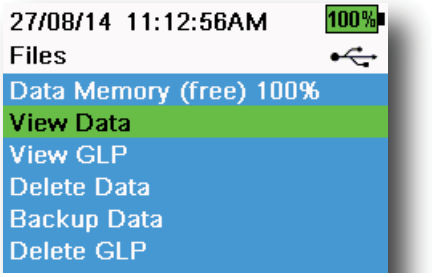

Figure 36 Files menu

Data Memory (free) % shows the remaining memory available. Download or delete data to free available internal memory.

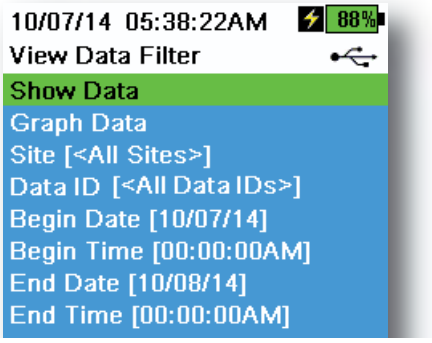

Figure 37 View Data Filter

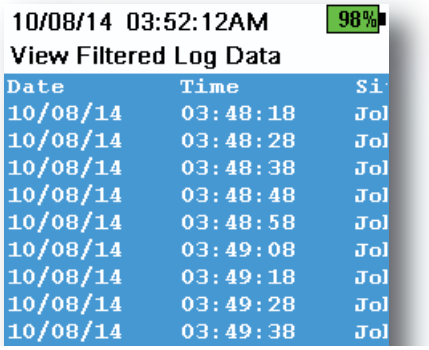

Figure 38 View Filtered Log Data

View Data Filter

→ **View Data**

Enter the desired filter criteria, then select **Show Data** or **Graph Data** to view the tabular or graphical data. If necessary, use the ▲ and ▼ arrow keys to scroll through the data (Figure 37 and Figure 38).

Site: View data from one site or all sites.

Data ID: View data from one ID or all IDs.

Begin/End: View data within specific date and time ranges.

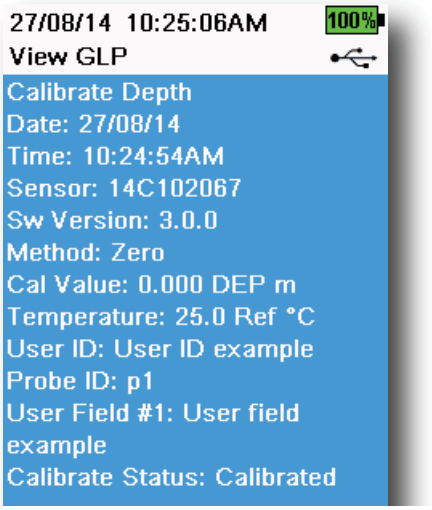

Figure 39 View GLP

View GLP

→ **View GLP**

Select **View GLP** to show the stored sensor calibrations (Figure 39).

Use the arrow keys to scroll through the GLP file data.

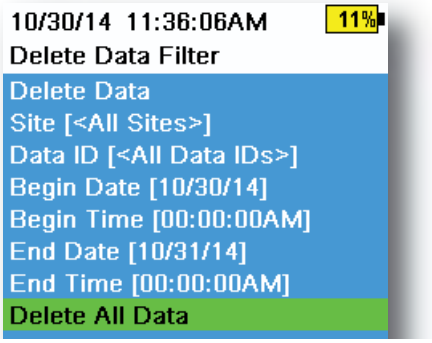

Figure 40 Delete Data Filter

Delete Data

→ **Delete Data**

Enter the desired filter criteria, then select **Delete Data** to *permanently* delete the data (Figure 40).

> ***NOTE:*** *If filter criteria are not selected, all logged data will be permanently deleted.*

Select **Delete All Data** to *permanently* delete *all* logged data from the ProDSS.

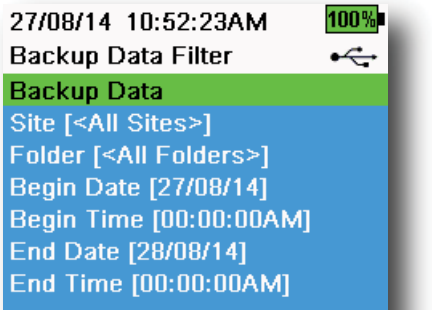

Figure 41 Backup Data

Backup Data

→ **Backup Data**

A USB female to micro USB male adapter is included to directly backup files from the handheld to a standard USB storage device. The data is exported as a CSV file.

Enter the desired filter criteria then connect the handheld to the USB storage device using the supplied adapter. Select **Backup Data** to export the data to an USB storage device (Figure 41 and Figure 42).

NOTE: *The USB storage device must be formatted as FAT32, not NTFS or exFAT. The handheld will only support FAT32.*

Figure 42 Micro USB female connector

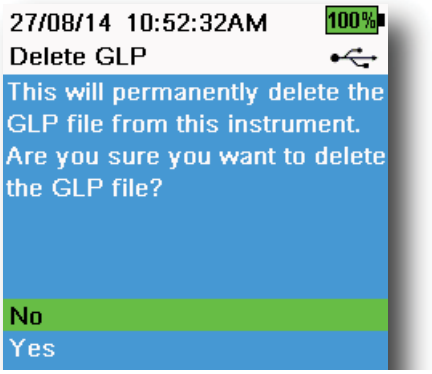

Figure 43 Delete GLP

Delete GLP

→ **Delete GLP**

To permanently delete the GLP file from the instrument, select **Yes**, then push the ENTER key (Figure 43).

Taking measurements

For the highest accuracy, calibrate the instrument before taking measurements (Calibration on page 33).

1. Create site and Data ID lists for logged data (if applicable) (Logging on page 19).
2. Set the logging method (single or interval) (Logging on page 19).
3. Set the Auto Stable parameters (if applicable) (Auto Stable on page 26).
4. Verify that the sensors and/or port plugs are correctly installed in all bulkhead ports (on page 8).
5. Install the sensor guard (Figure 6 on page 11).
6. Insert the sensors into the sample.

   NOTE: *Make sure to submerge the sensors completely. If using a depth sensor, submerge to where the cable assembly attaches to the bulkhead.*

7. Move the bulkhead in the sample to release any air bubbles and to provide a fresh sample to the sensors.
8. Wait for the sensor/s to stabilize in the sample.
9. If logging, select **Log One Sample** or **Start Logging** (Logging on page 19).

Calibration

ProDSS sensors (except temperature) require periodic calibration to maintain accurate measurements. Calibration procedures follow the same basic steps with variations for specific parameters.

Before calibration

- Enter GLP user-defined data if applicable to user requirements (User ID, Probe ID, User Field #1/2) (GLP menu on page 17).
- Setup sensor options, settings, and coefficients as applicable (Probe menu on page 37).

NOTICE: Install a gray port plug in all exposed ports. Exposure to water can cause damage or corrosion to the bulkhead connectors not covered by the warranty.

Calibration setup (pH, ORP, ISE, conductivity, turbidity)

NOTE: *Make sure the calibration cup, sensor guard, and all sensors are clean.*

NOTE: *If using the calibration cup, make sure to install the sensor guard before placing the sensors into the calibration cup.*

NOTE: *The sensor guard and calibration cup should be used for the turbidity and DO calibration. All other calibrations can be performed in other laboratory glassware.*

NOTE: *Make sure to use a clean probe guard during calibration to prevent contamination of the calibration environment.*

1. Install a clean, dry sensor and sensor guard (if used) onto the bulkhead (Figure 4 on page 9).

   NOTICE: Install a gray port plug in any exposed port. All sensors must have either a sensor or port plug installed.

2. Fill the calibration cup with a moderate amount of water and tighten the calibration cup onto the bulkhead. Use the water to rinse the cup and the sensor to be calibrated. Discard the rinse.
3. Thoroughly rinse the calibration cup with a small amount of the calibration standard for the sensor to be calibrated. Discard the standard.
4. Refill the calibration cup with fresh calibration standard to approximately the first line for pH, ORP, and turbidity calibration. Fill to the second line for conductivity calibration (Figure 44 on page 34).

   NOTE: *Volumes will vary. Make sure that the temperature sensor and the sensor to be calibrated are submerged in calibration solution, except when performing a DO% saturation calibration.*

   NOTE: *Be careful to avoid cross-contamination with other standards.*

   NOTE: *These rinsing recommendations are only suggested guidelines for highest data accuracy. Make sure to follow your organization Standard Operating Procedures (SOPs) for instrument calibration and operation.*

5. Immerse the sensor(s) in the standard and tighten the calibration cup onto the bulkhead.
6. Calibrate the sensor(s).

Alternately, pH, ORP, and conductivity calibrations can be completed in a beaker or other container using the same basic procedure described above. Make sure that the temperature sensor and the sensor to be calibrated are completely submerged. When submerging the conductivity sensor, make sure that the calibration solution covers the vent hole on the side of the conductivity sensor and there is at least 25.4 mm (1 in) distance between the sides and bottom of the calibration container and the conductivity probe.

Calibration cup installation

1. Make sure the calibration cup gasket is correctly seated (Figure 44). Loosely install the retaining nut on the calibration cup.
2. Slide the calibration cup over the sensors and sensor guard.
3. Tighten the retaining nut.

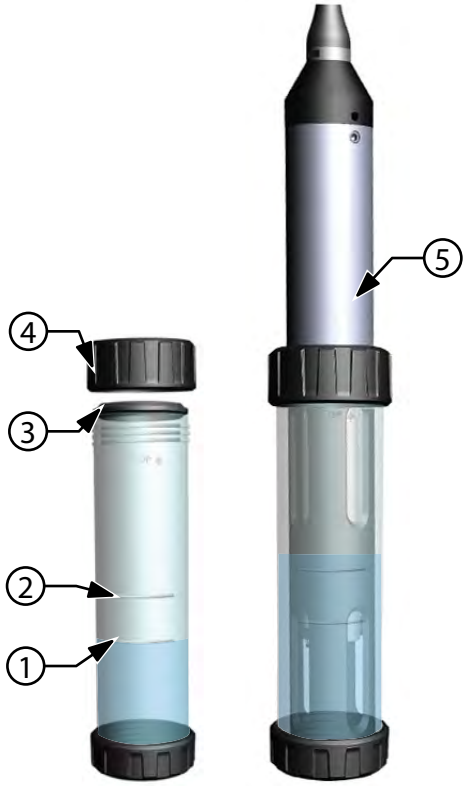

Figure 44 Calibration cup standard volume

1	Fill line one (used for Turbidity, pH, and ORP calibration solution)	**4**	Retaining nut
2	Fill line two (used for conductivity calibration solution)	**5**	Calibration cup installed
3	Gasket		

Conductivity

A conductivity/temperature sensor must be installed on the bulkhead for accurate temperature compensation and measurements of all other parameters (Figure 4 on page 9). Temperature calibration is not available or required for accurate temperature measurements.

The conductivity/temperature sensor can measure and calculate conductivity, specific conductance (temperature compensated conductivity), salinity, non-linear function (nLF) conductivity, TDS, resistivity, and density. Calibration is only available for specific conductance, conductivity, and salinity. Calibrating one of these options automatically calibrates the other conductivity/temperature parameters listed above. For both ease of use and accuracy, YSI recommends calibrating specific conductance.

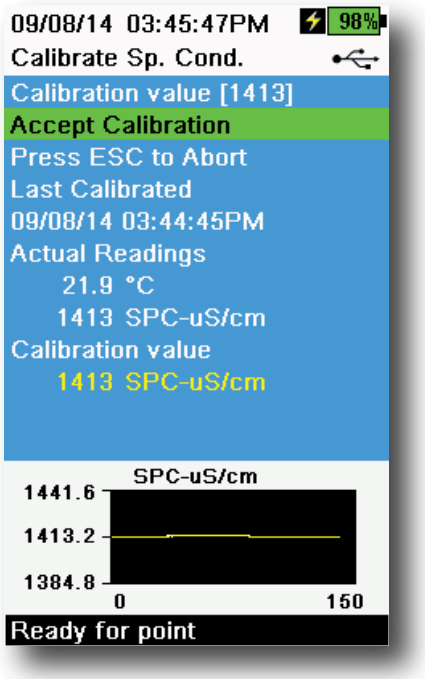

Figure 45 Calibrate specific conductance

Conductivity calibration

1. If necessary, clean the conductivity cell with the supplied soft brush. See Conductivity/temperature sensor maintenance on page 56.
2. Perform the Calibration setup (pH, ORP, ISE, conductivity, turbidity) on page 33.
3. Place the correct amount of conductivity standard (225 mL if using the calibration cup) into a clean and dry or pre-rinsed calibration cup.

   NOTE: *Select the appropriate calibration standard for the conductivity of the sampling environment. Standards greater than 1 mS/cm (1000 µs/cm) are recommended for the greatest stability. For fresh water applications, calibrate to 1,000 or 10,000 uS. For salt water applications, calibrate to 50,000 uS.*

4. Carefully immerse the sensors into the solution. Make sure the solution is above the vent holes on the side of the conductivity sensor.
5. Gently rotate and/or move the sensor up and down to remove any bubbles from the conductivity cell. Allow at least one minute for temperature equilibration before proceeding.
6. Push the (Cal) key, select **Conductivity**, then select **Specific Conductance**.

   NOTE: *Calibrating any conductivity calibration option will automatically calibrate the other options. Specific conductance is recommended for both ease of use and accuracy.*

7. Select **Calibration value** then enter the calibration value of the standard used. Note the measurement units the instrument is reporting and calibrating and be sure to enter in the correct calibration value for the units being used. For example, 10,000 uS = 10 mS. Make sure that the units are correct and match the units displayed on the handheld.
8. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 45). "Calibration successful!" will be displayed in the message area.

NOTE: *If the data is not stabilized after 40 seconds, gently rotate the sensor or remove/reinstall the calibration cup to make sure that no air bubbles are in the conductivity cell.*

NOTE: *If the actual measurement data is about 1/2 if the expected calibration value, the conductivity sensor is not completely submerged. Add more calibration standard to the calibration cup.*

NOTE: *If you get calibration error messages, check for proper sensor immersion, verify the calibration solutions is fresh, the correct value has been entered into the ProDSS, and/or try cleaning the sensor.*

9. Rinse the bulkhead and sensors in clean water then dry.

Barometer

The barometer is factory calibrated and should rarely need to be recalibrated. The barometer is used for DO calibration, %Local measurements, and for virtual depth measurements. Verify that the barometer is accurately reading "true" barometric pressure and recalibrate as necessary.

Laboratory barometer readings are usually "true" (uncorrected) values of air pressure and can be used "as is" for barometer calibration. Weather service readings are usually not "true", i.e. they are corrected to sea level and cannot be used until they are "uncorrected". Use this approximate formula:

True BP in mmHg=[Corrected BP in mmHg] - [2.5* (Local altitude in ft. above sea level/100)]

Example:

Corrected BP = 759 mmHg

Local altitude above sea level = 978 ft

True BP = 759 mmHg - [2.5*(978ft/100)] = 734.55 mmHg

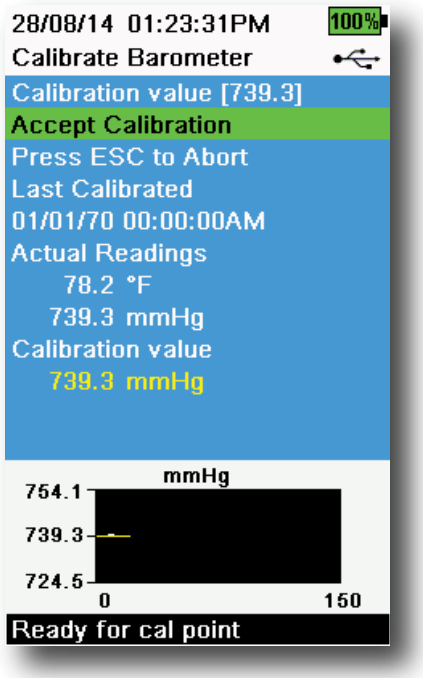

Figure 46 Calibrate Barometer

Barometer calibration

1. Push the (Cal) key, then select **Barometer**.

2. Select **Calibration value** then enter the correct "true" barometric pressure.

NOTE: *The measurement units during calibration are dictated by what is enabled in the sensor setup menu. Be sure to enter in the correct units.*

- BP in mmHg=25.4 x BP inHg
- BP in mmHg=0.750062 x BP mb
- BP in mmHg=51.7149 x BP psi
- BP in mmHg=7.50062 x BP kPa
- BP in mmHg=760 x BP atm

3. Select **Accept Calibration** (Figure 46). "Calibration successful!" will be displayed in the message area.

Dissolved oxygen

ODO calibration requires the current "true" barometric pressure. Make sure that the barometer is reading accurately and recalibrate the barometer as necessary.

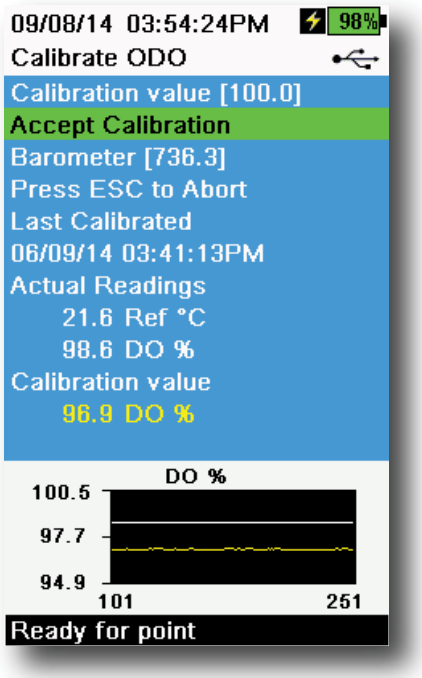

Figure 47 Calibrate ODO %

ODO% and ODO% local - water saturated air calibration

NOTE: *This method calibrates the instrument's DO% measurement or DO% Local measurement if DO% local is enabled in the sensor setup menu.*

NOTE: *Calibrating in DO% or DO% local automatically calibrates the mg/L and ppm measurement. There is no reason to calibrate both parameters. For both ease of use and accuracy, we recommend that you calibrate DO% or DO% Local and not mg/L.*

1. Place a small amount of clean water (1/8 inch) into the calibration cup.
2. Make sure there are no water droplets on the ODO sensor cap or temperature sensor.
3. Attach the sensor guard to the bulkhead and carefully place the guard/sensor into the calibration cup. Partially tighten the calibration cup to the bulkhead.

   NOTE: *Do not fully tighten the calibration cup to the bulkhead. Atmospheric venting is required for accurate calibration.*

   NOTE: *Make sure the ODO and temperature sensors are not immersed in water.*

4. Turn the instrument on and wait approximately 5 to 15 minutes for the air in the storage container to be completely saturated with water.
5. Push the (Cal) key, then select **ODO**. Select **DO%**. This will calibrate the instrument's DO% measurement or DO% Local measurement if DO% Local is enabled in the sensor setup menu.
6. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 47). "Calibration successful!" will be isplayed in the message area.

   NOTE: *If you see a calibration error message, verify the barometer reading and inspect the sensor cap. Clean and/or replace the sensor cap as needed.*

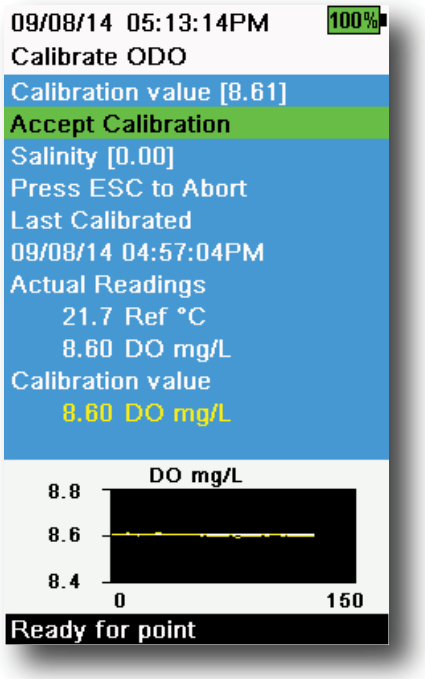

Figure 48 Calibrate ODO mg/L

ODO mg/L calibration

1. Place the ODO and conductivity/temperature sensor into a water sample that has been titrated by the Winkler method to determine the dissolved oxygen concentration in mg/L.
2. Push the (Cal) key, then select **ODO**. Select **DO mg/L**.
3. Select **Calibration value**.
4. Enter the dissolved oxygen concentration of the sample in mg/L.
5. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 48). "Calibration successful!" will be displayed in the message area.
6. Rinse the bulkhead and sensors in clean water then dry.

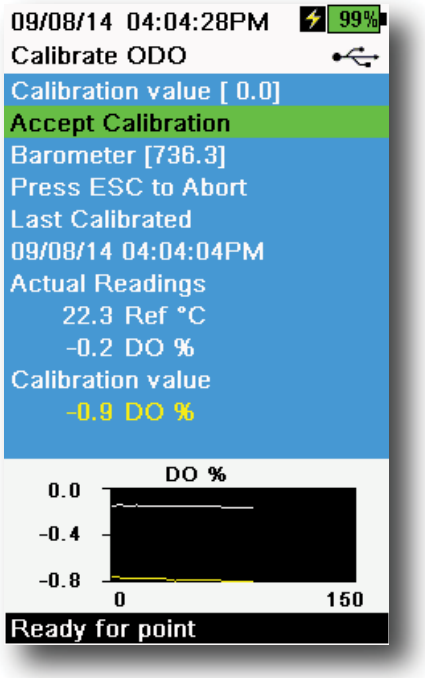

Figure 49 Calibrate ODO zero point

ODO zero point calibration

1. Place the ODO and Conductivity/Temperature sensors in a solution of zero DO.

   NOTE: *A zero DO solution can be made by dissolving approximately 8-10 grams of sodium sulfite into 500 mL of tap water. Mix the solution thoroughly. It may take the solution 60 minutes to be oxygen-free.*

2. Push the (Cal) key, then select **ODO**. Select **Zero**.
3. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 49). "Calibration successful!" will be displayed in the message area.
4. Thoroughly rinse the bulkhead and sensors in clean water then dry.
5. Perform a ODO % water-saturated air calibration after performing a zero point calibration.

pH/ORP

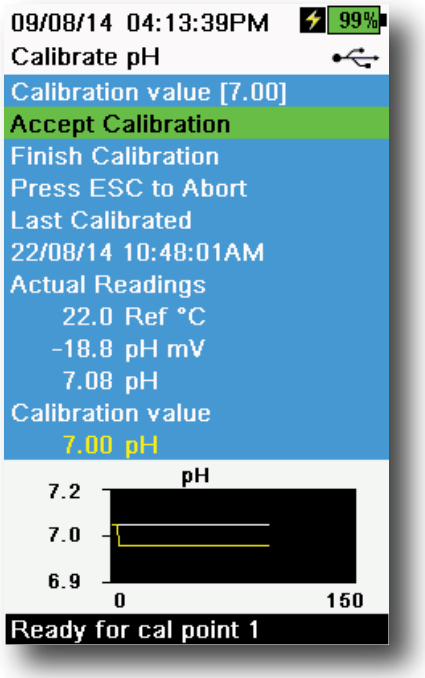

Figure 50 Calibrate pH 1-point

pH calibration 1-point

NOTE: *If performing a 1-point calibration, use buffer 7 (6.86) as your calibration point for highest accuracy.*

NOTE: *Observe the pH mV readings during calibration to understand the condition and response of the pH sensor. In buffer 7, pH mVs should be between -50 and +50. In buffer 4, the mVs should be a +165 to 185 away from the pH 7 mV value or a 59 mV per decade slope. In buffer 10, the mVs should be a -165 to -185 away from the pH 7 mV value or a -59 mV per decade slope.*

1. Perform the Calibration setup (pH, ORP, ISE, conductivity, turbidity) on page 33.
2. Fill the calibration cup to the appropriate level (170 mL) with pH 7 buffer solution (or 6.86 if using NIST buffers).
3. Carefully immerse the probe end of the sensors into the buffer solution.
4. Push the (Cal) key, then select **pH** or **pH/ORP**.

   NOTE: *If using a pH/ORP sensor, select* **pH/ORP**, *then* **pH**.

5. Allow at least one minute for temperature stabilization, then select **Calibration value**.
6. Enter the pH buffer value that corresponds to the measured temperature reading (example: the value of pH 7 buffer solution @ 20 °C (68 °F) is 7.02 - this value can be found on the bottle of most pH buffers).
7. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 50). "Ready for cal point 2" will be displayed in the message area.
8. Select **Finish Calibration** for a 1-point calibration or continue on to the 2-3 point calibration procedure (Calibration cup installation on page 34).

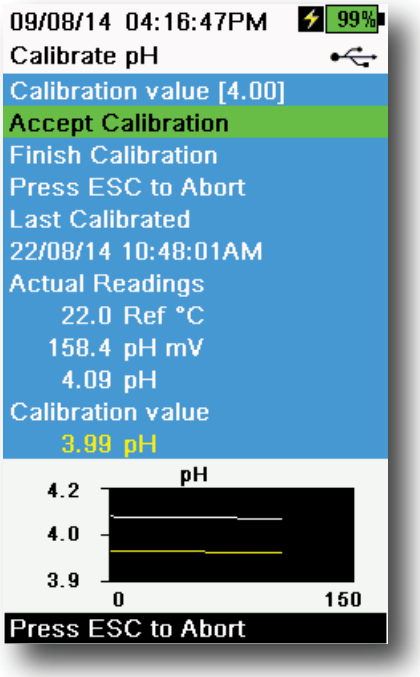

Figure 51 Calibrate pH 2- or 3-point

pH calibration 2- or 3-point

NOTE: *If performing a 2- or 3-point calibration, one point should be in buffer 7; however, the calibration points can be in any order.*

1. Perform steps 1-7 of the pH calibration 1-point procedure (pH calibration 1-point on page 39).
2. Rinse the sensor 2-3 times with a small amount of pH 4 or pH 10 buffer solution.
3. Rinse, then fill the calibration cup to the appropriate level with the buffer solution (approximately 170 mLs) that is the same value (pH 4 or pH 10) used to rinse the sensor.
4. Carefully immerse the sensors into the solution.
5. Allow at least one minute for temperature stabilization, then select **Calibration value**.
6. Enter the pH buffer value that corresponds to the buffer temperature reading (value may be located on pH buffer bottle).
7. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 51). "Ready for cal point 3" will be displayed in the message area.
8. Select **Finish Calibration** for a 2-point calibration or repeat the 2- or 3-point calibration procedure with the third buffer solution.

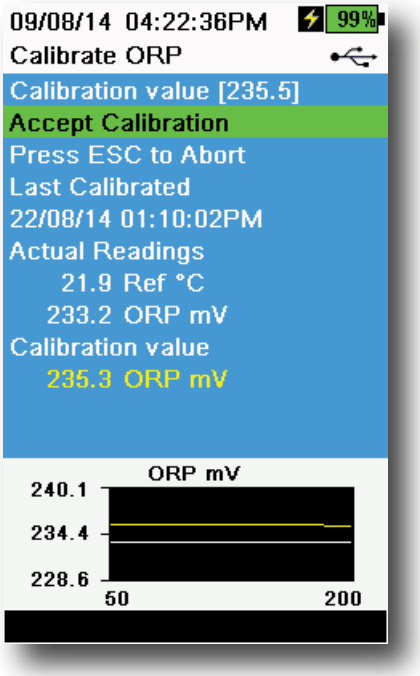

Figure 52 Calibrate ORP

ORP calibration

1. Obtain/prepare a standard with a known oxidation reduction potential (ORP) value.

   NOTE: *YSI recommends Zobell solution.*

2. Fill the solution to fill line 1 on the calibration cup (approximately 170 mLs).
3. Carefully immerse the sensors into the solution.
4. Push the (Cal) key, then select **pH/ORP**, then **ORP**.
5. Allow the temperature of the standard to stabilize then select **Calibration value**.
6. Enter the ORP calibration value that corresponds to the measured temperature reading (example: the value of YSI Zobell @ 20 ˚C is 237.5)
7. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 52). "Calibration successful!" will be displayed in the message area.

Depth

NOTE: *This calibration option is available only if your bulkhead is equipped with a depth sensor. The depth sensor is located where the cable connects to the bulkhead* (Figure 59 on page 54).

For the calibration, make sure that the depth sensor is clean and in air, not immersed in any solution. For highest accuracy, keep the bulkhead still and in one position while calibrating.

NOTE: *Cables 10 m and longer are supplied with a weight that can be attached to the sensor guard for sampling at water depths 10 m and greater.*

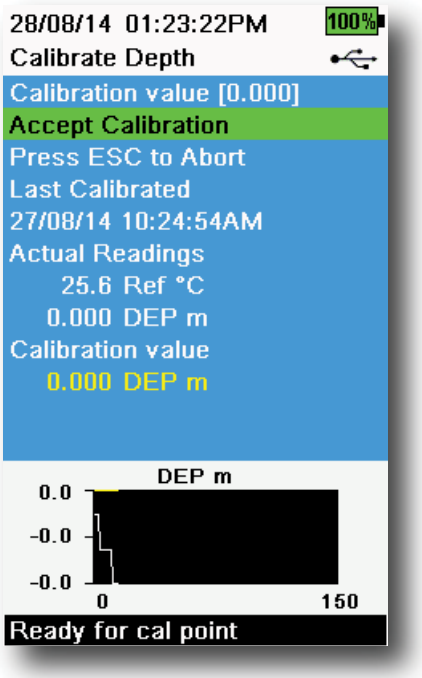

Figure 53 Calibrate Depth

Depth calibration

1. If applicable, enter the depth offset, altitude, and latitude (Figure 29 Setup Depth on page 25).

   NOTE: *Depth offset allows you to set the depth measurement to something other than zero. If the depth offset is used, the depth measurement will be adjusted by the offset after calibration. Enter the altitude and latitude of your sampling location to increase the accuracy of your depth measurement.*

2. Push the (Cal) key, then select **Depth**.
3. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 53). "Calibration successful!" will be displayed in the message area.

Turbidity

Before performing the calibration, review "Calibration setup (pH, ORP, ISE, conductivity, turbidity)" on page 33.

For proper calibration, you must use standards that have been prepared according to details in Standard Methods for the Treatment of Water and Wastewater (Section 2130 B).

Acceptable standards include:

- AMCO-AEPA standards prepared specifically for the ProDSS turbidity sensor manufactured by YSI (YSI turbidity standards)
- Formazin prepared according to Standard Methods, especially for calibration points greater than 1010
- Dilutions of 4000 FNU (NTU) formazin concentrate purchased from Hach
- Hach StablCal™ standards in various FNU (NTU) denominations

The use of standards other than those mentioned above will result in calibration errors and inaccurate field readings. It is important to use the same type of standard for all calibration points. (i.e. do not mix formazine and AMCO-AEPA standard for different points in a multi-point calibration).

Calibration limits

Because of the non-linear response of the turbidity sensor, calibration ranges may be limited. A 1-, 2- or 3-point calibration can be completed using the following limits:

1-point	2-point	3-point
0-1 FNU (NTU)	5-200 FNU (NTU)	400-4200 FNU (NTU)

Calibration standards

The following standards are available for the ProDSS turbidity sensor:

608000	0 (all turbidity sensors); 1 gallon
607200	12.4 FNU (NTU) (ProDSS); 1 gallon
607300	124 FNU (NTU) (ProDSS); 1 gallon
607400	1010 FNU (NTU) (ProDSS); 1 gallon

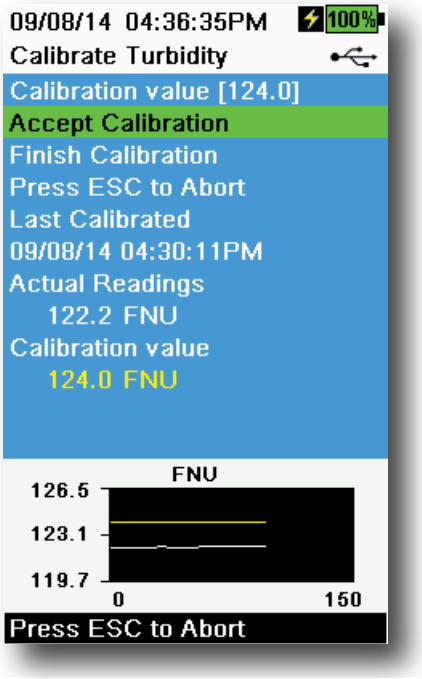

Figure 54 Calibrate turbidity

Turbidity calibration 1-, 2- or 3-point

NOTE: *The sensor guard must be installed for the turbidity sensor calibration.*

NOTE: *When performing a turbidity calibration, the first point must be zero.*Select **Calibration Value** and enter 0.00.

1. Perform the Calibration setup (pH, ORP, ISE, conductivity, turbidity) on page 33. Rinse the sensor 2-3 times with a small amount of 0 FNU (NTU) standard.
2. Fill the calibration cup to fill line one of the calibration cup (approximately 170 mLs) with 0 FNU (NTU) standard (clear deionized or distilled water is suitable). Immerse the sensors into the water.
3. Push the (Cal) key, then select **Turbidity**.
4. Select **Calibration Value** and enter 0.00.
5. Observe the data points readings for stability with the 0 FNU (NTU) standard (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration**. "Ready for cal point 2" will be displayed in the message area.
6. Select **Finish Calibration** to complete a 1-point calibration or continue for the 2- or 3-point calibration.
7. Rinse the sensors, calibration cup, and sensor guard 2-3 times with a small amount of standard #2. Discard the standard after each rinse.
8. Fill the calibration cup to fill line 1 with standard #2. Immerse the sensors in the second calibration standard.
9. Select **Calibration Value** and enter the value of the second calibration standard.
10. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 54). "Ready for cal point 3" will be displayed in the message area.
11. Select **Finish Calibration** to complete a 2-point calibration or continue for the 3-point calibration.
12. Rinse the sensors, calibration cup, and sensor guard 2-3 times with a small amount of standard #3. Discard the standard after each rinse.
13. Fill the calibration cup to fill line 1 with standard #3. Immerse the sensors in the third calibration standard.
14. Select **Calibration Value** and enter the value of the third calibration standard.
15. Observe the data points readings for stability, then select **Finish Calibration**. "Calibration successful!" will be displayed in the message area.
16. Rinse the sensors in clean water then dry.

ISEs: Ammonium, Nitrate, & Chloride

Before performing the calibration, review Calibration setup (pH, ORP, ISE, conductivity, turbidity) on page 33.

The ISE sensors can be calibrated to one, two or three points. A 2-point calibration without chilling a third calibration solution is extremely accurate and is the preferred method. However, if there is a large temperature variation during sampling, a chilled third calibration point is recommended.

Higher calibration accuracy can be obtained if the standards used have a least one order of magnitude difference between them. For example, 1 mg/L and 10 mg/L or 10 mg/L and 100 mg/L.

mV information for the ISE calibration

Ammonium mV values

- NH_4 1 mg/L = 0 mV +/- 20 mV (new sensor only)
- NH_4 100 mg/L = 90 to 130 mV > 1 mg/L mV value
- The mV span between 1 mg/L and 100 mg/L values should be ≈ 90 to 130 mV. The slope should be 45 to 65 mV per decade.

Nitrate mV values

- NO_3 1 mg/L = 200 mV +/- 20 mV (new sensor only)
- NO_3 100 mg/L = 90 to 130 mV < 1 mg/L mV value
- The mV span between 1 mg/L and 100 mg/L values should be ≈ 90 to 130 mV. The slope should be -45 to -65 mV per decade.

Chlroide mV values

- Cl 10 mg/L = 225 mV +/- 20 mV (new sensor only)
- Cl 1,000 mg/L = 80 to 130 mV < 10 mg/L mV value
- The mV span between 10 mg/L and 1000 mg/L values should be ≈ 80 to 130 mV. The slope should be -40 to -65 mV per decade.

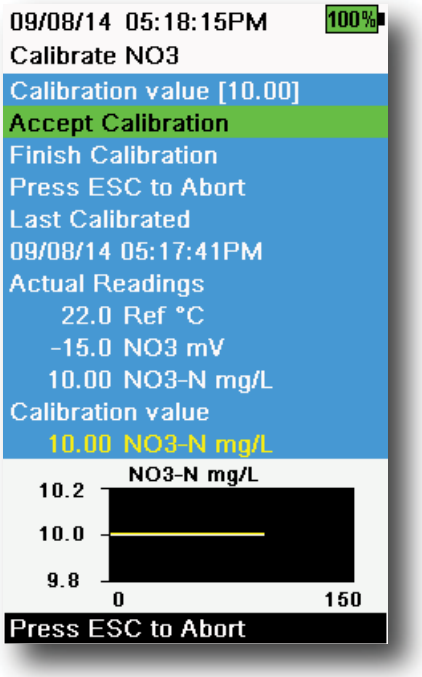

Figure 55 Calibrate ISE

ISE calibration 3-point

1. Perform the Calibration setup (pH, ORP, ISE, conductivity, turbidity) on page 33.
2. Fill the calibration cup to fill line one with standard #1 (approximately 170 mLs).
3. Push the (Cal) key, then select the applicable ISE sensor.
4. Carefully immerse the sensors into the standard solution.
5. Allow the temperature of the standard to stabilize, then select **Calibration value**. Enter the calibration value that corresponds to standard #1.
6. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 55). "Ready for cal point 2" will be displayed in the message area.
7. Rinse the sensor 2-3 times with a small amount of standard #2.
8. Rinse, then fill the calibration cup to fill line one with standard #2 (approximately 170 mLs).
9. Carefully immerse the sensors into the solution.
10. Allow the temperature of the solution to stabilize then select **Calibration value**. Enter the calibration value that corresponds to standard #2.
11. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 55). "Ready for cal point 3" will be displayed in the message area.
12. Rinse, then fill the calibration cup to fill line 1 with standard #3 (approximately 170 mLs).

    NOTE: *To calibrate with a chilled third standard, see* Chilled third calibration point on page 46.

13. Carefully immerse the sensor into the solution. Allow the temperature of the solution to stabilize then select **Calibration value**. Enter the calibration value that corresponds to standard #3.
14. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Finish Calibration**. "Calibration successful!" will be displayed in the message area.

Chilled third calibration point

The 3-point calibration method assures maximum accuracy when the temperature of the media to be monitored cannot be anticipated. If you must perform a chilled 3-point calibration, the following procedure requires one portion of the high concentration calibration solution and two portions of the low concentration calibration solution.

The high concentration solution and one of the low concentration solutions should be at ambient temperature. The other low concentration solution should be chilled to less than 10 °C (50 °F) to prior calibration point.

See ISE calibration 3-point on page 45.

1. When "Ready for cal point 3" is displayed in the message area during ISE calibration, place the proper amount of chilled 1 mg/L standard (10 mg/L for the chloride) into a clean, dry or pre-rinsed calibration cup.
2. Carefully immerse the sensor into the solution. Allow for temperature equilibration. If necessary, select **Calibration value** to manually enter the standard #3 value.
3. Once the readings are stable, select **Accept Calibration**. "Calibration successful!" will be displayed in the message area.

Preparing chloride standards

The following recipes are provided for preparation of 10 and 1000 mg/L chloride reagents. Nitrate and Ammonium standards can be purchased from YSI or other laboratory supply companies.

⚠ **WARNING:** Some of the chemicals required for these solutions could be hazardous under some conditions. It is the responsibility of the user to obtain and study the MSDS for each chemical and to follow the required instructions with regard to handling and disposal of these chemicals.

You will need:

- Solid sodium chloride or a certified 1000 mg/L chloride solution from a supplier
- Magnesium sulfate
- High-purity water
- A good quality analytical balance
- 1000 mL volumetric flask
- An accurate 10 mL measuring devices
- And 1000 mL glass or plastic storage vessels.

1000 mg/L Standard

1. Accurately weigh 1.655 grams of anhydrous sodium chloride and transfer into a 1000 mL volumetric flask.
2. Add 0.5 grams of anhydrous magnesium sulfate to the flask.
3. Add 500 mL of water to the flask, swirl to dissolve all of the reagents, then dilute to the volumetric mark with water.
4. Mix well by repeated inversion, then transfer the 1000 mg/L standard to a storage bottle.
5. Rinse the flask extensively with water prior to its use in the preparation of the 10 mg/L standard. Alternatively, simply add 0.5 grams of magnesium sulfate to a liter of a 1000 mg/L chloride standard from a certified supplier.

10 mg/L Standard

1. Accurately measure 10 mL of the above 1000 mg/L standard solution into a 1000 mL volumetric flask.
2. Add 0.5 grams of anhydrous magnesium sulfate to the flask.
3. Add 500 mL of water, swirl to dissolve the solid reagents, then dilute to the volumetric mark with water.
4. Mix well by repeated inversion, then transfer the 10 mg/L standard to a storage bottle.

Preparing nitrate standards

We recommend using YSI calibration solutions whenever possible. However, qualified users can save cost by following these recipes for 1 and 100 mg/L nitrate standards. Other concentrations can be made by altering the amount of potassium nitrate. All other concentrations should remain unchanged.

⚠ **CAUTION:** Some of these chemicals are hazardous and therefore, the standards should only be prepared by qualified chemists in laboratories where proper safety precautions are possible. It is the responsibility of the user to obtain and study the MSDS for each chemical and to follow the required instructions with regard to handling and disposal of these materials.

You will need:

- Solid potassium nitrate or a certified 1000 mg/l NO_3-N from a supplier
- Magnesium sulfate, high purity water
- A good quality analytical balance
- 1000 mL volumetric flask
- Accurate volumetric measuring devices for 100 mL, 10 mL and 1 mL of solution
- And 1000 mL glass or plastic storage vessels.
-

100 mg/L standard

1. Accurately weigh 0.7222 g of anhydrous potassium nitrate and transfer quantitatively into a 1000 mL volumetric flask. Add 1.0 g of anhydrous magnesium sulfate to the flask.
2. Add approximately 500 mL of water to the flask. Swirl to dissolve all of the reagents, and then dilute to the volumetric mark with distilled or deionized water.
3. Mix well by repeated inversion and then transfer the 100 mg/L standard to a storage bottle.
4. Rinse the flask extensively with water prior to its use in the preparation of the 1 mg/l standard. Alternatively, 100 mL of certified 1000 mg/L NO_3-N standard can be used in place of the solid potassium nitrate.

1 mg/L standard

1. Accurately measure 10.0 mL of the above 100 mg/L standard solution into a 1000 mL volumetric flask. Add 1.0 g of anhydrous magnesium sulfate to the flask.
2. Add approximately 500 mL of distilled or deionized water. Swirl to dissolve the solid reagents, and then dilute to the volumetric mark with water.
3. Mix well by repeated inversion and then transfer the 1 mg/L standard to a storage bottle.

NOTE: *Recipes are given for 1 and 100 mg/L. Other concentrations can be made by altering the amount of potassium nitrate. All other concentrations should remain unchanged.*

Preparing ammonium standards

We recommend using YSI calibration solutions whenever possible. However, qualified users can save cost by following these recipes for 1 and 100 mg/L standards. Other concentrations can be made by altering the amount of ammonium chloride. All other ingredient concentrations should remain unchanged.

⚠ **CAUTION:** Some of these chemicals are hazardous and therefore, the standards should only be prepared by qualified chemists in laboratories where proper safety precautions are possible. It is the responsibility of the user to obtain and study the MSDS for each chemical and to follow the required instructions with regard to handling and disposal of these materials.

You will need:

- Solid ammonium chloride or a certified 100 mg/L NH_4^+-N from a supplier
- Lithium acetate dihydrate
- Concentrated hydrochloric acid
- High purity water
- A good quality analytical balance
- A 1000 mL volumetric flask
- Accurate volumetric measuring devices for 100 mL and 10 mL of solution
- And a 1000 mL glass or plastic storage vessels.

⚠ **CAUTION:** Hydrochloric acid is highly corrosive and toxic and should therefore be handled with extreme care in a well-ventilated fume hood. The user could also add the equivalent amount of a less-hazardous, more dilute sample of the acid if preferred.)

100 mg/L Standard

1. Accurately weigh 0.3817 g of ammonium chloride and transfer quantitatively into a 1000 mL volumetric flask. Add 2.6 g of lithium acetate dihydrate to the flask.
2. Add approximately 500 mL of distilled or deionized water to the flask. Swirl to dissolve all of the reagents and then dilute to the volumetric mark with distilled or deionized water.
3. Mix well by repeated inversion and then transfer the 100 mg/L standard to a storage bottle.
4. Add 3 drops of concentrated hydrochloric acid to the bottle, then seal and agitate to assure homogeneity. Alternatively, 100 mL of certified 100 mg/L NH4+-N standard can be used in place of the solid ammonium chloride.

1 mg/L Standard

1. Accurately measure 10.0 mL of the above 100 mg/L standard solution into a 1000 mL volumetric flask. Add 2.6 g of lithium acetate dihydrate to the flask.
2. Add approximately 500 mL of distilled or deionized water. Swirl to dissolve the solid reagents and then dilute to the volumetric mark with water.
3. Mix well by repeated inversion and then transfer the 1 mg/L standard to a storage bottle.
4. Add 3 drops of concentrated hydrochloric acid to the bottle, then seal and agitate to assure homogeneity.

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Maintenance and storage

Follow all maintenance and storage procedures in this section.

NOTICE: Incorrect or unapproved maintenance and/or storage can cause handheld, sensor or cable damage not covered by the warranty.

Unless otherwise specified, storage terms are defined as follows:

Short-term storage (less than 4 weeks): Storage when the ProDSS will be used at regular intervals (daily, weekly, biweekly, etc.)

Long-term storage: Storage when the ProDSS will have long periods of inactivity (over winter, end of monitoring season, etc.)

NOTICE: Perform sensor maintenance before long-term storage.

NOTICE: To prevent damage, do not store sensors in corrosive solutions.

ProDSS handheld instrument

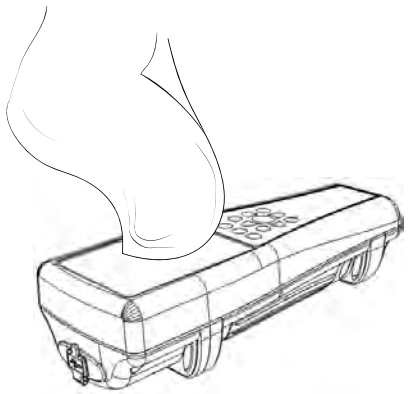

Figure 56 Handheld cleaning

Handheld instrument maintenance

Wipe the keypad, screen, and case with a cloth dampened with a mild solution of clean water and dish soap (Figure 56).

Handheld storage temperature

Optimal storage temperature of the handheld instrument:

- With battery pack installed: 0-45 °C (32-113 °F)
- Without battery pack installed: 0-60 °C (32-140 °F)

NOTICE: The battery pack permanently loses capacity at a faster rate when above 45 °C (113 °F).

Handheld short-term storage (less than 4 weeks)

Power off the handheld and store in a secure location (Startup on page 14).

Handheld long-term storage

1. Clean the handheld instrument.
2. Remove the battery pack to prevent possible battery leaks (on page 3). Reinstall the battery cover.
3. Install the protective covers on the USB and cable connectors.
4. Store the handheld and removed battery pack in a secure location. See Rechargeable Lithium-Ion battery pack safety warnings and precautions on page 79.

Cable, bulkhead, and connectors

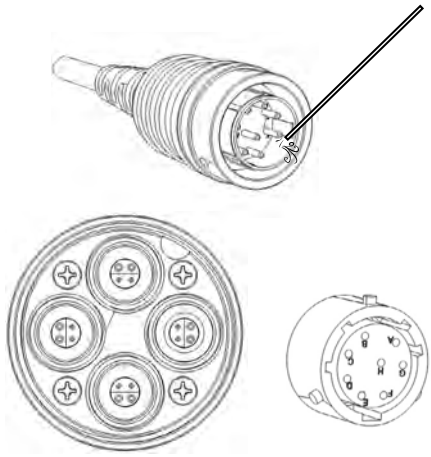

Figure 57 Cable, bulkhead, connector maintenance

Cable, bulkhead, and connector maintenance

Wipe the bulkhead cable with a cloth dampened with a mild solution of clean water and dish soap.

NOTICE: Install sensors or port plugs so that the bulkhead ports do not get wet when cleaning. Exposure to water can cause damage or corrosion to the bulkhead connectors not covered by the warranty.

Inspect the bulkhead ports and cable connectors for contamination. If dirty or wet, clean it with compressed air (Figure 57).

Cable, bulkhead, and connector storage

Clean the connectors and bulkhead cable. Install the connector covers and the bulkhead port plugs when not in use (Port plugs on page 10).

Sensor guard

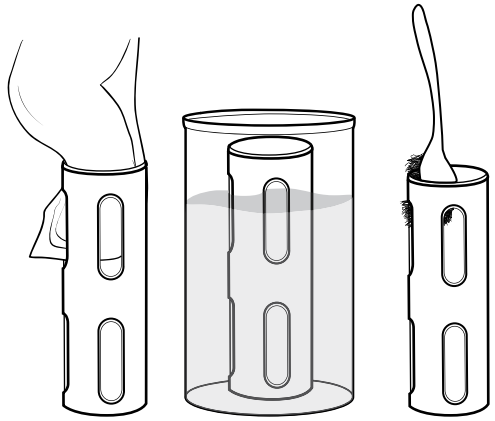

Figure 58 Sensor guard maintenance

Sensor guard maintenance

Remove minimal bio-fouling with a cloth soaked in a mild solution of clean water and dish soap (Figure 58).

Remove heavy bio-fouling by soaking the guard in a with a solution of clean water and dish soap. Soak in vinegar to remove hard growth and deposits.

Use a plastic scrub brush to remove any remaining bio-fouling. Rinse the sensor guard with clean water.

NOTICE: Do not sand or polish the guard. Removal of the guard coating can affect turbidity readings.

Depth sensor maintenance and storage

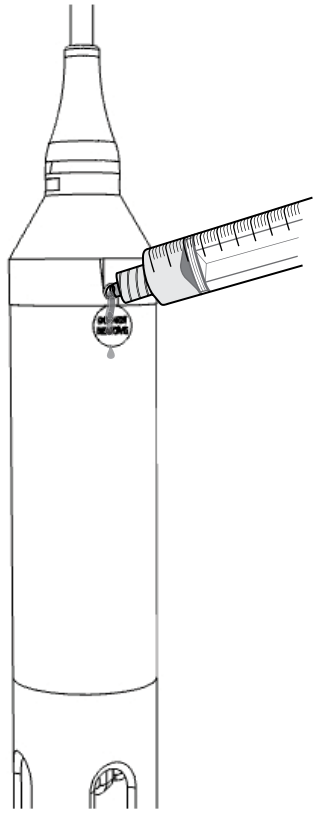

Figure 59 Depth sensor flush

Depth sensor storage

The ProDSS optional depth sensor accesses water through ports located in the bulkhead (Figure 59). Although not directly accessible, correct maintenance and storage is necessary for reliable operation.

The depth sensor can be stored dry, in water-saturated air or submerged in water.

NOTICE: To prevent damage to the sensor's strain gauge, do not store the sensor in corrosive solutions.

Depth sensor maintenance

Periodically clean the depth ports with the syringe included in the ProDSS maintenance kit (626990). Fill the syringe with clean water and gently force water into one of the ports. Flush until clean water flows from the opposite depth port.

NOTICE: Do not insert objects into the depth ports. Damage to the depth transducer from incorrect cleaning is not covered by the warranty.

Turbidity sensor

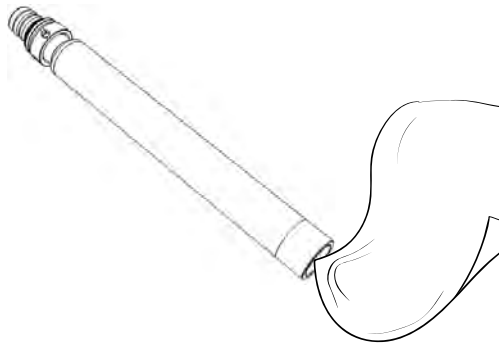

Figure 60 Turbidity sensor window

Turbidity sensor maintenance

Clean the sensing window with a non-abrasive, lint-free cloth (Figure 60).

NOTICE: Clean the window carefully to prevent scratches. If necessary, use mild soapy water.

Figure 61 Turbidity sensor storage

Turbidity sensor short-term storage (less than 4 weeks)

When in regular field use, the turbidity sensor can remain installed on the bulkhead in an environment of water-saturated air (Figure 61).

NOTE: *The turbidity sensor can be stored dry if stored separate from other sensors.*

Place approximately 0.5 in (1 cm) of any water (tap or environmental) in calibration cup.

Install the calibration cup on the bulkhead and firmly tighten to prevent evaporation.

Turbidity sensor long-term storage

Store the turbidity sensor in dry air. The turbidity sensor can be left on the bulkhead or removed for storage.

If removed from the bulkhead, install the shipping cap on the sensor to prevent scratches or damage to the optical sensing window.

NOTICE: Install a port plug into the empty port on the bulkhead.

Conductivity/temperature sensor

NOTICE: Use care when handling the conductivity/temperature sensor to prevent any impact on the exposed thermistor.

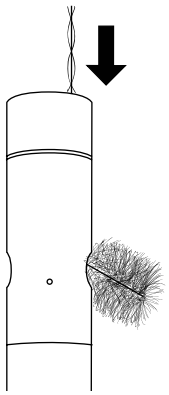

Figure 62 Channel brush

Conductivity/temperature sensor maintenance

1. Dip the sensor's cleaning brush (included with the maintenance kit) in clean water.
2. Insert the brush at the top of the channels, and sweep the channels 15 to 20 times (Figure 62).

   NOTICE: If deposits have formed on the electrodes, use a mild solution of dish soap and water to brush the channels. For heavy deposits, soak the sensor in white vinegar to assist cleaning, then scrub with the cleaning brush after soaking.

3. Rinse the channels with clean water following the sweepings or soak.

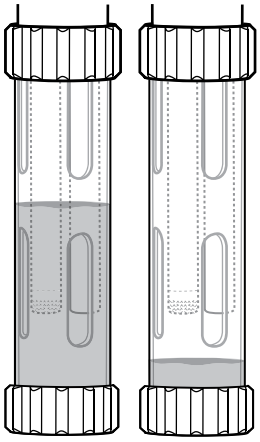

Figure 63 Conductivity/Temperature Short-term storage

Conductivity/temperature sensor short-term storage (less than 4 weeks)

When in regular field use, the conductivity/temperature sensor should remain installed on the bulkhead in a dry or water-saturated air environment.

Place approximately 0.5 in (1 cm) of any water (deionized, distilled or environmental) in calibration cup.

Install the calibration cup on the bulkhead and firmly tighten to prevent evaporation (Figure 63).

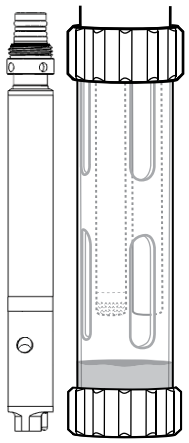

Figure 64 Conductivity/Temperature Long-term storage

Conductivity/temperature sensor long-term storage

The Conductivity/Temperature sensor can be stored dry or wet, installed on the bulkhead or detached (Figure 64).

Dissolved oxygen sensor

ODO sensor caps are warranted for 1 year but have a typical working life of 18 to 24 months. As the ODO sensor caps ages, large scratches in the paint/dye layer and changes in the dye layer can reduce measurement stability and response time.

Periodically inspect the sensor cap for damage and large scratches in the paint/dye layer. Replace the cap when readings become unstable and cleaning the cap and DO recalibration do not remedy the symptoms.

Cleaning the sensor cap

The sensor cap should be kept clean since some types of fouling may consume oxygen which could affect the dissolved oxygen measurements. To clean the sensor cap, gently wipe away any fouling with a lens cleaning tissue that has been moistened with water.

NOTICE: Do not use organic solvents to clean the sensor cap. Using an organic solvent to clean the sensor cap may cause permanent damage to the cap. For example, alcohol will dissolve the outer paint layer and other organic solvents will likely dissolve the dye in the cap.

ODO sensor cap replacement

The sensor cap should be replaced about once per year but may last longer. It should also be replaced if it is cracked or damaged. The instruction sheet shipped with the replacement ODO sensor cap includes the calibration coefficients specific to your sensor cap.

NOTE: *Make sure to save the ODO sensor cap instruction sheet in case you need to reload the calibration coefficients.*

NOTE: *The replacement ODO sensor cap is shipped in a humidified container and the package should not be opened until immediately before sensor cap replacement.*

Once the sensor cap has been installed on the ODO sensor, it is important to keep the sensor in a 100% humid environment. If the sensor dries out, refer to the rehydration procedure (ODO sensor rehydration on page 60).

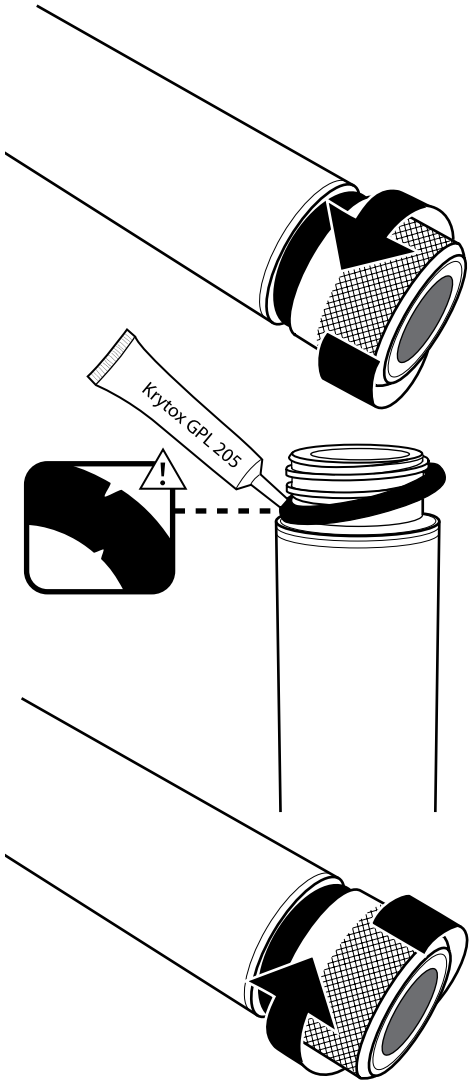

Figure 65 ODO cap replacement

ODO sensor cap replacement (continued)

1. Turn the used sensor cap counterclockwise to remove it from the sensor.

   NOTE: If possible, do not use a tool to remove the cap from the sensor. If necessary, carefully turn the cap counterclockwise with pliers until it breaks loose. Do not use the pliers on the sensor body. Make sure to not damage the sensor cap threads.

2. Without using tools, remove the used o-ring from the sensor body (pinch the o-ring out, then roll it upward over the threads), then discard it.
3. Clean the sensor threads with a clean, lint-free cloth.
4. Visually inspect the new o-ring for nicks, tears, contaminants or particles. Discard damaged o-rings.
5. Without twisting it, carefully install the new o-ring over the threads and into the o-ring groove.
6. Apply a thin coat of Krytox to the o-ring only. Wipe any excess from the threads and sensor body.
7. Clean the sensor window with a clean, lint-free cloth.
8. Make sure the new sensor cap cavity is completely dry, then carefully finger-tighten the cap clockwise onto the sensor. The o-ring should be compressed between the sensor cap and body, not pinched.

   NOTICE: Do not over-tighten the sensor cap. Do not use tools.

9. Store the ODO sensor in a moist environment.

   NOTE: If the o-ring is pinched, remove and discard it. Repeat steps 3 to 8.

Updating the ODO sensor cap coefficients

After installing a new sensor cap, connect the bulkhead cable assembly to the ProDSS instrument and turn the instrument on. Locate the Calibration Code Label on the ODO sensor cap instruction sheet and note the six numbers which are listed as K1 through K5 and KC. These six numbers contain the calibration code for this particular sensor cap.

Follow the procedures below to enter the new calibration coefficients into the instrument.

1. Push the Probe key to access the Sensor menu, then select **Setup**, then **ODO**.
2. Select **Sensor Cap Coefficients**.
3. Highlight each coefficient in turn (K1 through KC) and use the numeric entry screen to enter the corresponding new coefficient from the Calibration Code Label. Push the ENTER key after each entry and then proceed to the next K selection.
4. After all the new coefficients have been entered, select **Update Sensor Cap Coefficients**.
5. A message will appear warning that you will be overwriting the current sensor cap coefficients and you should confirm that you wish to carry out this action. Select **Yes** to confirm the new coefficients.

After updating the Coefficients, the Serial # in the Sensor Cap menu will be updated automatically based on your entries. If errors are made in entering the Sensor Cap Coefficients, the instrument will block the update and an error message will appear on the display.

If you see this error message, re-enter the coefficients and check them carefully for correct transcription from the Calibration Code Label prior to selecting Update Sensor Cap Coefficients. If you receive an error message after several entry attempts, contact YSI Technical Support for assistance.

After entering the new Sensor Cap coefficients, perform a 1-point DO calibration (ODO% and ODO% local - water saturated air calibration on page 37).

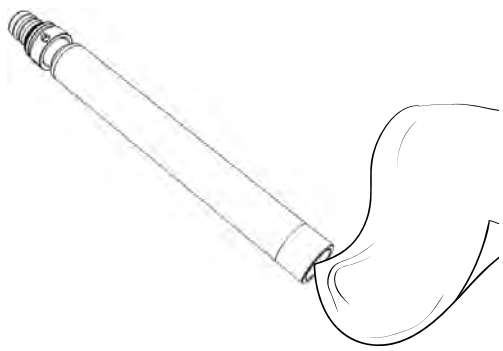

Figure 66 ODO sensor window

ODO sensor maintenance

Clean the sensing window with a non-abrasive, lint-free cloth (Figure 66).

NOTICE: Clean the window carefully to prevent scratches. Do not use organic solvents to clean the ODO sensor or sensor cap.

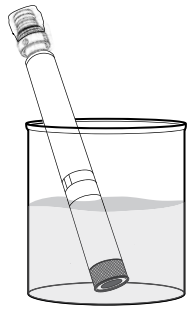

Figure 67 ODO rehydration

ODO sensor rehydration

To prevent sensor drift, always store the ODO sensor in a wet or water-saturated air environment. If the ODO sensor has accidentally been left dry for longer than 8 hours, it must be rehydrated.

If rehydration is necessary, soak the ODO sensor cap in warm (room temperature) tap water for approximately 24 hours. After the soak, calibrate the sensor (Figure 67).

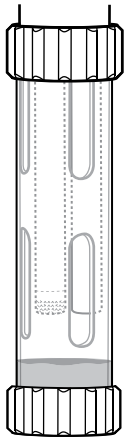

Figure 68 ODO short-term storage

ODO sensor short-term storage (less than 4 weeks)

When in regular field use, the ODO sensor should remain installed on the bulkhead. Place approximately 0.5 in (1 cm) of any water (tap or environmental) in the calibration cup (Figure 68).

Install the calibration cup onto the bulkhead and firmly tighten to prevent evaporation.

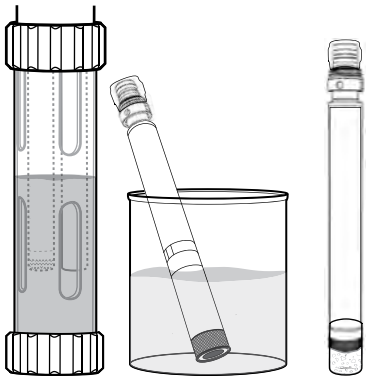

Figure 69 ODO long-term storage

ODO sensor long-term storage

The ODO sensor can be left on the bulkhead or removed for long-term storage (Figure 69).

Installed on bulkhead

Fill the calibration cup with clean water (use distilled or deionized water if a pH sensor is not installed). Submerge the sensor in the calibration cup then firmly tighten to prevent evaporation.

Removed from bulkhead

Remove the sensor from the bulkhead (Sensor removal on page 10).

Method 1 : Cover the sensor connector end with the plastic storage cap. Submerge the sensing end of the sensor in a container of clean water (use distilled or deionized water if a pH sensor is not installed). Periodically check the level of the water to make sure that it does not evaporate.

Method 2: Wet the sponge located in the cap originally included with the ODO sensor, then install on sensing end of the ODO sensor. Replace the sponge if it becomes dirty.

pH - pH/ORP sensors

NOTE: *pH and pH/ORP sensors require periodic maintenance to clear contamination from the sensing elements. These contaminants can slow sensor response time. Clean the sensors when deposits, bio-fouling or other contamination appears on the glass or when the sensor response time is noticeably slow.*

NOTICE: Do not physically scrub or swab the glass bulb. The bulbs are fragile and will break if pressed with sufficient force.

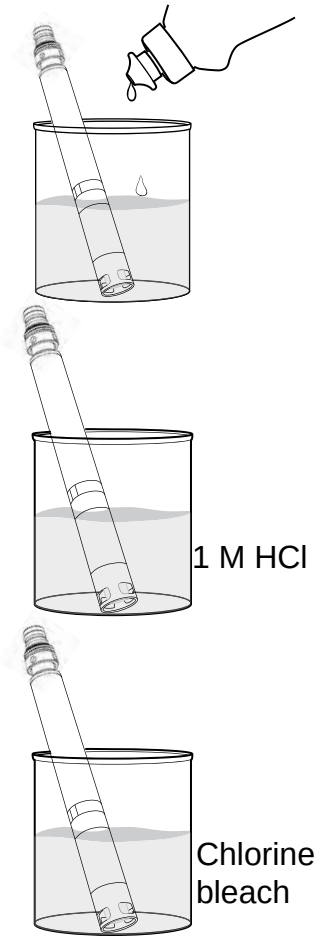

Figure 70 pH and pH/ORP sensor maintenance

pH - pH/ORP sensor maintenance

1. Remove the sensor from the bulkhead and soak for 10 to 15 minutes in a mild solution of clean water and dish soap (Figure 70).
2. Rinse the sensor with clean tap water and inspect.
3. If contaminants are removed, attach the sensor to the bulkhead and test the response time (ProDSS sensor installation/removal on page 9).

   OR

   If contaminants remain or response time does not improve, continue to the hydrochloric acid (HCl) soak in step 4.
4. Soak the sensor for 30 to 60 minutes in one molar (1 M) HCl.

   NOTE: *HCl reagent can be purchased from most chemical or laboratory distributors. If HCl is not available, soak in white vinegar.*

⚠ **CAUTION:** To prevent injury, carefully follow the HCl manufacturer's instructions.

5. Rinse the sensor in clean tap water.
6. Soak the sensor in clean tap water for 60 minutes, stirring occasionally. Repeat the clean tap water rinse.
7. Attach the sensor to the bulkhead and test the response time. If response time does not improve or biological contamination of the reference junction is suspected, continue to the chlorine bleach soak in step 8.
8. Soak the sensor for approximately one hour in a 1:1 dilution of chlorine bleach and tap water.
9. Rinse the sensor with clean tap water.
10. Soak the sensor in clean tap water for one hour or longer. Repeat the clean tap water rinse.

pH - pH/ORP sensor storage

The pH - pH/ORP sensors are shipped with their tips in a storage bottle containing KCl. Store the pH - pH/ORP sensors in the shipping container when not in use.

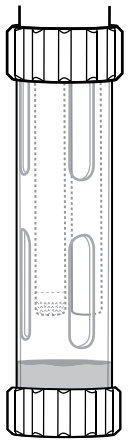

Figure 71 pH - pH/ORP short-term storage

pH - pH/ORP sensor short-term storage (less than 4 weeks)

When in regular field use, the pH-pH/ORP sensors should remain installed on the bulkhead. Place approximately 0.5 in (1 cm) of any water (tap or environmental) in the calibration cup (Figure 71).

Install the calibration cup onto the bulkhead and firmly tighten to prevent evaporation.

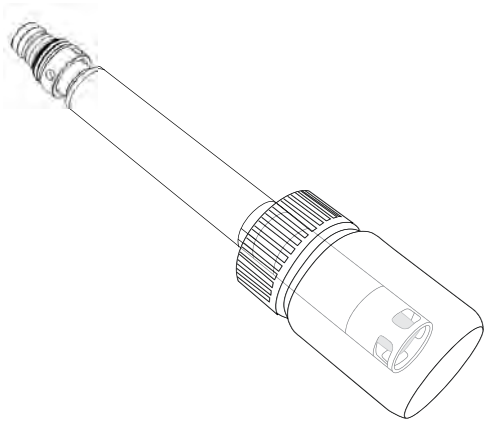

Figure 72 pH - pH/ORP long-term storage

pH - pH/ORP sensor long-term storage

Remove the sensor from the bulkhead and insert the sensing end into the shipping bottle. Install the bottle o-ring and tighten (Figure 72).

The shipping bottle contains a 2 molar solution of pH 4 buffer. If this solution is not available, store the sensor in tap water.

NOTICE: To prevent damage, do not store the pH - pH/ORP sensors in Zobell solution or DI water.

ISE sensors

Do not let the ISE sensor reference electrode junctions dry out. Clean the sensors when deposits, bio-fouling or other contamination appears on the membrane.

Ammonium and nitrate sensor maintenance

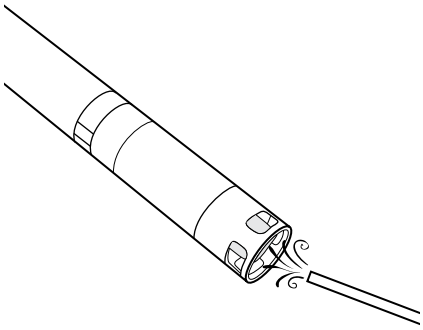

Figure 73 Ammonium and nitrate maintenance

1. Carefully clean the ammonium or nitrate sensor by using a fine jet of DI water or rinsing in alcohol followed by soaking in the high standard calibration solution (Figure 73).
2. Carefully dab the sensor dry with a clean, lint-free cloth.

NOTICE: The ion-selective membranes are very fragile. Do not use coarse material (e.g. paper towels) to clean the membranes or permanent damage to the sensor can occur. The only exception is fine emery cloth on the chloride sensor.

Chloride sensor maintenance

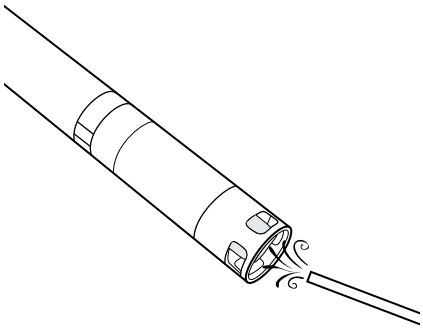

Figure 74 Chloride maintenance

Carefully clean the chloride sensor by rinsing with alcohol and/or carefully polishing with fine emery paper in a circular motion to remove deposits or discoloration (Figure 74).

Carefully rinse with DI water to remove any debris.

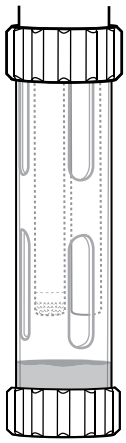

Figure 75 ISE short-term storage

ISE sensor short-term storage (less than 4 weeks)

When in regular field use, the ISE sensors should remain installed on the bulkhead in an environment of water-saturated air. Place approximately 0.5 in (1 cm) of any water (deionized, distilled or environmental) in the calibration cup (Figure 75).

Install the calibration cup onto the bulkhead and firmly tighten to prevent evaporation.

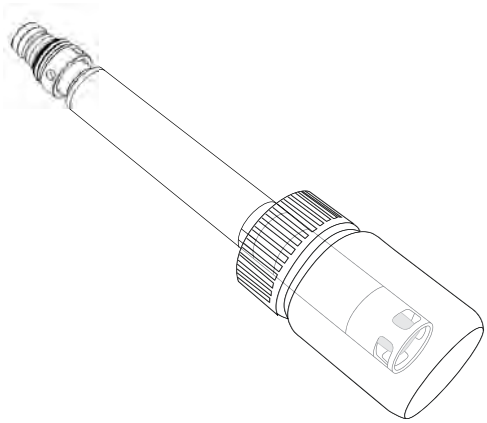

Figure 76 ISE long-term storage

ISE sensor long-term storage

NOTICE: Do not let the ISE junctions dry out. Junctions that have been allowed to dry out by improper storage may be irreparably damaged by dehydration and will require replacement.

1. Place a small amount of high-calibration solution or tap water in the storage bottle originally included with the sensor.
2. Remove the sensor from the bulkhead and insert the sensing end into the shipping bottle.
3. Install the bottle o-ring and tighten (Figure 76).

NOTICE: The sensors should not be immersed in water.

NOTICE: Do not store the ISE sensors in conductivity standard, pH buffer or salt water.

Rehydrating the reference junction

If an ISE sensor has been allowed to dry, soak the sensor for several hours (preferably overnight) in the sensor's high-calibration solution. If the sensor is irreparably damaged, the sensor module must be replaced.

ProDSS sensor module replacement

ProDSS pH, pH/ORP, ammonium, chloride and nitrate sensors feature replaceable sensor modules. These modules can be replaced by the user as needed. Typical working life of a pH or pH/ORP sensor module is 18 to 24 months. Typical working life of ammonium, chloride and nitrate sensor modules is 4 to 8 months.

Perform the pH - pH/ORP and ISE sensor module replacement in a clean, dry laboratory environment.

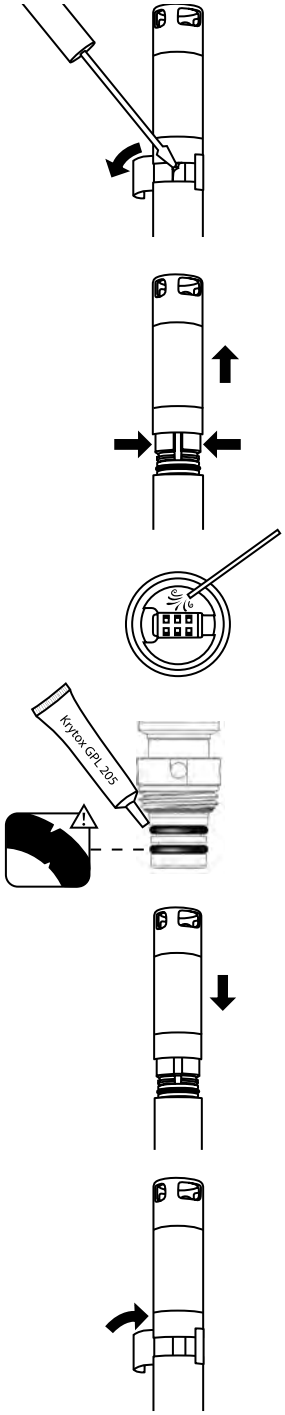

Figure 77 pH - pH/ORP sensor module replacement

Module replacement

1. Peel off and discard the sticker that covers the junction of the sensor body and the module (Figure 77).
2. With a small, flat-blade screwdriver, carefully remove the small rubber plug from the gap in the hard plastic ring at the base of the sensor module.
3. Using two fingers, squeeze the sensor module's hard plastic ring so that it compresses the gap left by the rubber plug.
4. Steadily pull the sensor module straight from the sensor body, rocking slightly if necessary.

   NOTICE: The o-ring is unusable after removal from the sensor body. Do not reinstall the removed sensor module or o-ring after removal. Dispose of the module according to you organization's guidelines or return it to YSI for recycling (Service information on page 81).

5. Inspect the sensor connector port for debris or moisture. If detected, remove it with lint-free cloth or a light blast of compressed air.
6. Visually inspect the two new o-rings for nicks, tears, contaminants or particles. Discard damaged o-rings.
7. Without twisting, carefully install the new o-rings over the threads and into the o-ring grooves.
8. Apply a thin coat of Krytox to the o-rings only. Wipe any excess from the threads and sensor module.

   NOTICE: If a sensor module is removed for any reason, the o-rings must be replaced.

9. Align the prongs on the base of the sensor module with the slots in the sensor body. The sensor module is keyed to insert in only one orientation.
10. Push the sensor module firmly into position until it clicks. Wipe any excess Krytox from the assembled components.
11. Wrap the junction of the sensor module and sensor body with the new sticker included in the sensor module kit. The sticker helps keep the sensor module junction clean and retain the rubber plug throughout deployment.
12. Write the replacement date on the sticker.
13. Calibrate the sensor (pH/ORP on page 39 or ISE calibration 3-point on page 45).

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KorDSS software installation

NOTE: YSI recommends that you have administrative privileges on the PC in which KorDSS will be installed.

Follow these steps to complete the KorDSS installation process:

1. Install the KorDSS software from the USB flash drive included with the instrument.
2. Install the ProDSS instrument driver.
3. Start KorDSS for the first time and complete the KorDSS Startup Wizard.

System requirements

Supported 32 bit (x86) Microsoft Operating Systems:

- Microsoft Windows XP Home SP3
- Microsoft Windows XP Professional SP3
- Microsoft Windows 7 Home Basic SP1
- Microsoft Windows 7 Home Premium SP1
- Microsoft Windows 7 Professional SP1
- Microsoft Windows 7 Enterprise SP1
- Microsoft Windows 7 Ultimate SP1
- Microsoft Windows 8/8.1
- Microsoft Windows 8/8.1 Professional
- Microsoft Windows 8/8.1 Enterprise

Supported 64 bit (x64) Microsoft Operating Systems:

- Microsoft Windows 7 Home Basic SP1
- Microsoft Windows 7 Home Premium SP1
- Microsoft Windows 7 Professional SP1
- Microsoft Windows 7 Enterprise SP1
- Microsoft Windows 7 Ultimate SP1
- Microsoft Windows 8/8.1
- Microsoft Windows 8/8.1 Professional
- Microsoft Windows 8/8.1 Enterprise

Ram Memory Requirement:

- Minimum of 2 GB of RAM installed

Hard Disk Free Space:

- Minimum of 500 MB of free hard drive space

Internet Access Required to Support:

- Software and device updates, software licensing, and maps

Install the KorDSS software

1. Insert the supplied USB flash drive into a USB port on your computer.
2. Depending on the PC operating system and system settings, the KorDSS Installer Guide may appear. If it does not appear, double-click **Start.exe** to start the installer guide (Figure 78).

NOTE: *If desired, view the ProDSS User Manual or the end-user license agreement.*

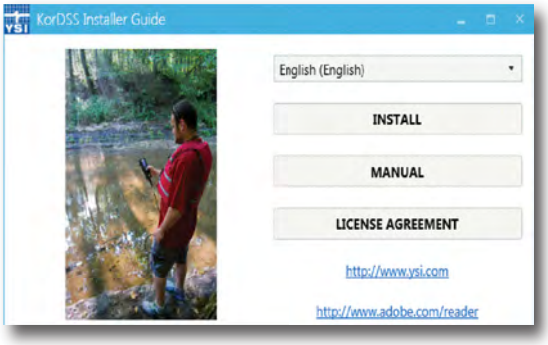

Figure 78 KorDSS Installer Guide

3. Click **Install** on the KorDSS Installer Guide.
4. Check the license agreement box. Click **Install** (Figure 79).

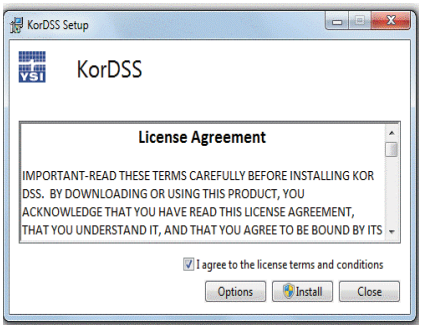

Figure 79 KorDSS license agreement

5. You may be asked if you want to allow a program from an unknown publisher to make changes on the computer. If so, select **Yes**.

KorDSS is now installed. Before using KorDSS to manage data, you must install the driver for the ProDSS instrument on your PC.

ProDSS driver installation

NOTE: *The ProDSS driver installation procedure allows the KorDSS software to recognize the instrument. To connect more than one ProDSS instrument to KorDSS, perform the driver installation procedure for each additional instrument.*

The driver installation procedure is different for each operating system. Follow the applicable installation procedure carefully.

Windows XP ProDSS driver on page 70
Windows 8 and 8.1 ProDSS driver on page 71

Windows 7 ProDSS driver

1. Turn the instrument on and connect it to the PC with the included USB cable.

If a message appears indicating successful download of the driver, proceed to the KorDSS Startup Wizard (page 72).

If you do not see a message indicating the successful download of the driver or if you see a message indicating unsuccessful download of the driver, continue this driver installation procedure.

2. Open the Device Manager. To access: Click the **Start** button, click **Control Panel**, click **System and Security**, and then, under **System**, click **Device Manager**.
3. Under **Other devices**, right click on **smxUSBD Serial Emulator** and select **Update Driver Software** (Figure 80).

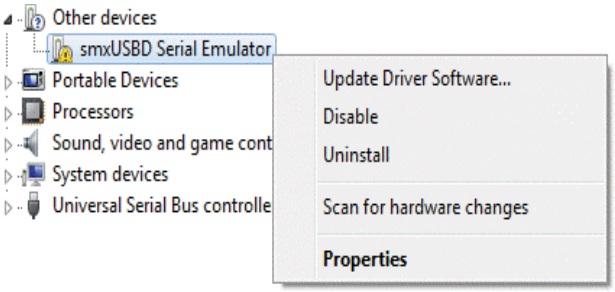

Figure 80 Device Manager Windows 7

4. Click **Browse my computer for driver software**.
5. Click **Browse**, then navigate to the file location: **C:\Program Files (x86)\YSI\KorDSS** for 64 bit systems or **C:\Program Files\YSI\KorDSS** for 32 bit systems. Click **Next**.
6. A warning will appear indicating that Windows can't verify the publisher of the driver software. Select **Install this driver software anyway**.
7. After driver installation, proceed to the KorDSS Startup Wizard (page 72).

Windows XP ProDSS driver

1. Turn the instrument on and connect it to the PC with the included USB cable.
2. On the **Found New Hardware Wizard** window, select **No, not at this time** when asked if Windows can connect to Windows Update. Click **Next**.
3. Select **Install from a list or specific location**, then click **Next**.
4. Select **Search for the best driver in these locations**, then **Include this location in the search:**. Click **Browse**, then navigate to the file location: **C:\Program Files (x86)\YSI\KorDSS** for 64 bit systems or **C:\Program Files\YSI\KorDSS** for 32 bit systems (Figure 81). Click **Next**.

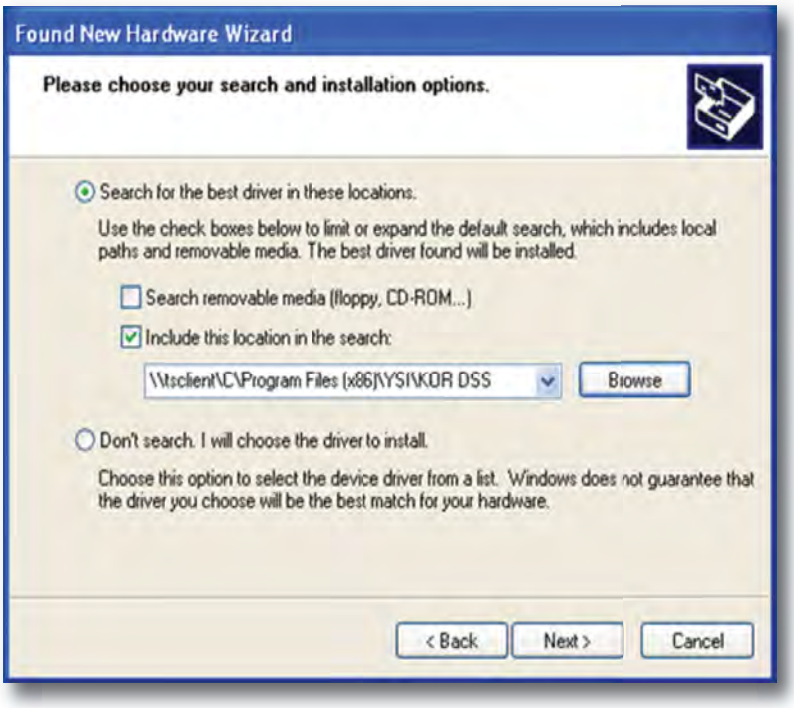

Figure 81 Found New Hardware Wizard file location

5. Select **Continue Anyway** when warned that the software has not passed Windows Logo testing.
6. Click **Finish** to close the New Hardware Wizard.
7. After driver installation, proceed to the KorDSS Startup Wizard (page 72).

Windows 8 and 8.1 ProDSS driver

1. Save any open files and close all programs. Your computer will restart during this process.
2. Open **Settings** by moving the computer mouse to the bottom right corner of the computer screen. If using a touch screen, swipe the screen from the right to reveal the Settings charm. Alternately, settings can be opened by pressing the Windows key + I.
3. Complete the following navigation steps under Settings:

- For Windows 8.1: **Change PC Settings** → **Update and Recovery** → **Advanced Setup** → **Restart now**
- For Windows 8: **Change PC Settings** → **General** → **Advanced Setup** → **Restart now**

4. When the **Choose an option** appears, select **Troubleshoot**, then **Advanced Options**.
5. Select **Startup Settings**, then **Restart**.
6. After the computer reboots, the **Startup Settings** screen will be shown. Use the **F7** or **7** key to select **Disable driver signature enforcement**.
7. Connect the ProDSS to the PC with the included USB cable. After connection, turn the instrument on.
8. Open Device Manager by pressing the Windows Key + X to open the Start Menu, then selecting **Device Manager**. Alternately, search for **devmgmt**, then select **Device Manager**.
9. Under **Other devices**, right click on **smxUSBD Serial Emulator** and select **Update Driver Software** (Figure 82).

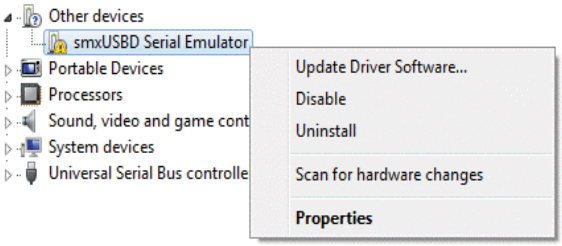

Figure 82 Device Manager Windows 8/8.1

10. Click **Browse my computer for driver software**.
11. Click **Browse**, then navigate to the file location: **C:\Program Files (x86)\YSI\KorDSS** for 64 bit systems or **C:\Program Files\YSI\KorDSS** for 32 bit systems (Figure 83). Click **Next**.

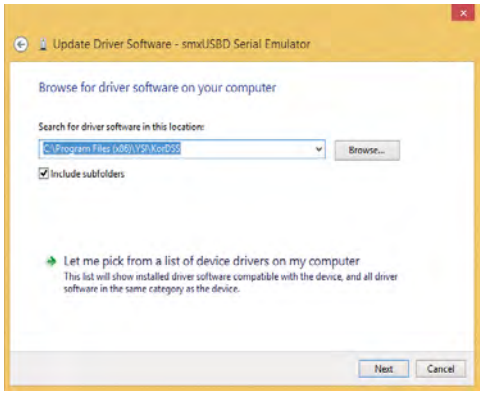

Figure 83 Driver location Windows 8/8.1

12. A warning will appear indicating that Windows can't verify the publisher of the driver software. Select **Install this driver software anyway**.
13. After driver installation, reboot the computer, then proceed to the KorDSS Startup Wizard (page 72).

KorDSS startup wizard

1. After Windows has successfully updated the driver software, start KorDSS and set the language preference (Figure 84). Click **Next**.

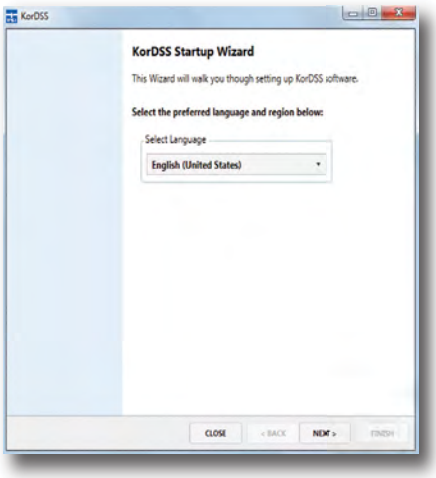

Figure 84 KorDSS language preference

2. On the Software Licensing Mode screen, select **Premium Mode** if you would like to view sampling locations on a map (internet connection required) (Figure 85). To upgrade to Premium Mode for free, follow the link, register your ProDSS, then use the code sent to you via email to upgrade to the Premium Mode. You can upgrade to Premium Mode at any time by going to the File tab in KorDSS.

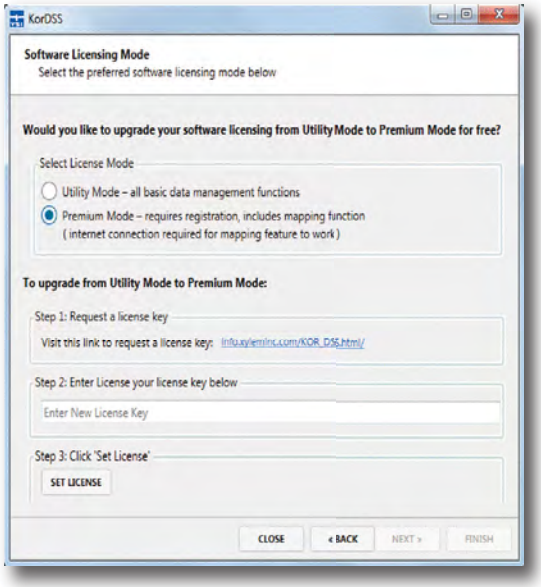

Figure 85 Software licensing mode screen

3. Select your ProDSS and KorDSS update preference to finish the installation process. Consult the HTML help file, found under the File tab of the KorDSS software, for a complete description of all KorDSS features.

Accessories

Ordering

Telephone: 800 897 4151 (USA)
+1 937 767 7241 (Globally) Monday through Friday, 8:00 AM to 5:00 ET
Fax: +1 937 767 9353 (orders)
Email: info@ysi.com
Mail: YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA
Internet: ysi.com

When placing an order please have the following available:

1. YSI account number (if available)
2. Name and phone number
3. Purchase Order or Credit Card number
4. Model Number or brief description
5. Billing and shipping addresses
6. Quantity

ProDSS handhelds

YSI Item #	Description
626870-1	ProDSS handheld, no GPS
626870-2	ProDSS handheld with GPS

ProDSS cable assemblies (No sensors included)

YSI Item #	Description
626909-1	DSS-1 meter 4 port cable assembly, no depth
626909-4	DSS-4 meter 4 port cable assembly, no depth
626909-10	DSS-10 meter 4 port cable assembly, no depth
626909-20	DSS-20 meter 4 port cable assembly, no depth
626909-30	DSS-30 meter 4 port cable assembly, no depth
626909-40	DSS-40 meter 4 port cable assembly, no depth
626909-50	DSS-50 meter 4 port cable assembly, no depth
626909-60	DSS-60 meter 4 port cable assembly, no depth
626909-70	DSS-70 meter 4 port cable assembly, no depth
626909-80	DSS-80 meter 4 port cable assembly, no depth
626909-90	DSS-90 meter 4 port cable assembly, no depth
626909-100	DSS-100 meter 4 port cable assembly, no depth
626910-1	DSS-1 meter 4 port cable assembly, with depth
626910-4	DSS-4 meter 4 port cable assembly, with depth
626910-10	DSS-10 meter 4 port cable assembly, with depth
626911-20	DSS-20 meter 4 port cable assembly, with depth
626911-30	DSS-30 meter 4 port cable assembly, with depth
626911-40	DSS-40 meter 4 port cable assembly, with depth
626911-50	DSS-50 meter 4 port cable assembly, with depth
626911-60	DSS-60 meter 4 port cable assembly, with depth
626911-70	DSS-70 meter 4 port cable assembly, with depth
626911-80	DSS-80 meter 4 port cable assembly, with depth
626911-90	DSS-90 meter 4 port cable assembly, with depth
626911-100	DSS-100 meter 4 port cable assembly, with depth

ODO/OBOD sensor and cable assemblies - DO/Temp only

NOTE: *ODO/OBOD cable assemblies feature non-replaceable temperature and optical DO sensors* with replaceable DO sensor caps (626320 for ODO cable assemblies; 626482 for OBOD cable assemblies). There is no depth option with ODO/OBOD cables.

YSI Item #	Description
626250-1	ODO-1 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-4	ODO-4 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-10	ODO-10 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-20	ODO-20 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-30	ODO-30 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-40	ODO-40 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-50	ODO-50 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-60	ODO-60 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626250-100	ODO-100 meter cable assembly with non-replaceable ODO/temperature sensors, no depth
626400	ProOBOD BOD probe/cable assembly, lab probe; U.S./Japanese version with power supply
626401	ProOBOD BOD probe/cable assembly, lab probe; International version with power supply

ProDSS smart sensors

YSI Item #	Description
626900	ProDSS Optical Dissolved Oxygen sensor
626902	ProDSS conductivity and temperature sensor
626901	ProDSS turbidity sensor
626903	ProDSS pH sensor with module
626904	ProDSS pH/ORP sensor with module
626906	ProDSS ammonium sensor with module
626905	ProDSS nitrate sensor with module
626907	ProDSS chloride sensor with module

Replacement sensor modules and ODO sensor caps

YSI Item #	Description
626890	Replacement ProDSS Optical Dissolved Oxygen sensor cap (for 626900 smart sensor)
626320	Replacement ODO Optical Dissolved Oxygen sensor cap (for 626250 probe/cable assemblies)
626482	Replacement OBOD Optical Dissolved Oxygen sensor cap (for 626400 or 626401 lab probes)
626963	Replacement ProDSS pH sensor module
626964	Replacement ProDSS pH/ORP sensor module
626966	Replacement ProDSS Ammonium sensor module
626965	Replacement ProDSS Nitrate sensor module
626967	Replacement ProDSS Chloride sensor module

ProDSS accessories

YSI Item #	Description
626946	Large, hard-sided carrying case
603075	Large, soft-sided carrying case
626945	Small, hard-sided carrying case (fits 1- and 4-meter cables)
599080	Flow cell
603056	Flow cell mounting spike
063507	Tripod (screws into back of meter)
063517	Ultra clamp (screws into back of meter)
603070	Shoulder strap
603069	Belt clip (screws into back of meter)
626942	USB car charger
626943	Small external Li-Ion rechargeable battery pack (Typical performance: will charge a completely discharged ProDSS battery to about 50%)
626944	Large external Li-Ion rechargeable battery pack (Typical performance: will charge a completely discharged ProDSS battery to full charge, plus have power to charge a second battery to 20%)
626940	AC charger (USA). Includes power supply and USB cable (included with ProDSS handheld)
626941	AC charger (international). Includes power supply, USB cable and outlet adapters (included with ProDSS handheld)
626846	Replacement Lithium-ion battery pack
626969	ProDSS USB flash drive (included with ProDSS handheld)
626991	Cable for charging and PC connection (included as part of 626940 and 626941)
626992	Cable for connection to USB drive (included with ProDSS handheld)
626990	ProDSS maintenance kit (included with all ProDSS cables): • 3 port plugs • 1 Krytox tube • 1 brush • 1 syringe • 1 sensor installation/removal tool • O-rings (6)
626919	Sensor guard for 4 port ProDSS cable assembly (included with all ProDSS cables)
599786	Calibration/storage cup for 4 port ProDSS cable assembly (included with all ProDSS cables)
603062	Cable management kit (included with any ProDSS cable 10, 20, or 30-meters long; included with any ODO cable 4, 10, 20, or 30-meters long)
626918	1 lb weight (included with any ProDSS cable 10-meters and longer)
605978	4.9 oz weight

Calibration standards

YSI Item #	Description
065270	Conductivity standard, 1000 µmhos/cm (quart, glass); ideal for fresh water
065272	Conductivity standard, 10000 µmhos/cm (quart, glass); ideal for brackish water
065274	Conductivity standard, 100000 µmhos/cm (quart, glass); ideal for supersaturated sea water
060907	Conductivity standard, 1000 µmhos/cm (box of 8 individual pints, plastic); ideal for fresh water
060906	Conductivity standard, 1413 µmhos/cm, ±1%, 0.01 M KCl (box of 8 individual pints, plastic)
060911	Conductivity standard, 10000 µmhos/cm (box of 8 individual pints, plastic); ideal for brackish water
060660	Conductivity standard, 50000 µmhos/cm (box of 8 individual pints, plastic); ideal for sea water
061320	ORP (mV) standard, Zobell solution, powder - needs hydrated (125 mL bottle, plastic)
003821	pH 4 buffer (box of 6 individual pints, plastic); ideal for storage solution for pH sensor
003822	pH 7 buffer (box of 6 individual pints, plastic)
003823	pH 10 buffer (box of 6 individual pints, plastic)
603824	Assorted case of pH 4, 7, and 10 buffers (2 individual pints of each buffer, plastic)
005580	Confidence solution to verify conductivity, pH and ORP system (box of 6 individual 475 mL bottles, plastic). ***Note:*** *Not for calibration*
003841	Ammonium standard, 1 mg/L (500 mL, plastic)
003842	Ammonium standard, 10 mg/L (500 mL, plastic)
003843	Ammonium standard, 100 mg/L (500 mL, plastic)
003885	Nitrate standard, 1 mg/L (500 mL, plastic)
003886	Nitrate standard, 10 mg/L (500 mL, plastic)
003887	Nitrate standard, 100 mg/L (500 mL, plastic)
608000	Turbidity standard, 0 FNU (1 gallon, plastic)
607200	Turbidity standard, 12.4 FNU (1 gallon, plastic)
607300	Turbidity standard, 124 FNU (1 gallon, plastic)
607400	Turbidity standard, 1010 FNU (1 gallon, plastic)

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Safety and support

Rechargeable Lithium-Ion battery pack safety warnings and precautions

⚠ **CAUTION:** Failure to follow the safety warnings and precautions can result in fire, personal injury and/or equipment damage not covered under warranty.

⚠ **CAUTION:** If the internal battery fluid comes into contact with skin, wash the affected area(s) with soap and water immediately. If it comes into contact with your eye(s), flush them with generous amounts of water for 15 minutes and seek immediate medical attention.

⚠ **CAUTION:** Always keep batteries away from children.

⚠ **WARNING:** In the unlikely event a lithium-ion battery catches fire, **DO NOT** attempt to put the fire out with water, use a Class A, B or C fire extinguisher.

Do:

- Store the battery pack in a cool, dry, ventilated area.
- Store the battery pack in a non-conductive and fireproof container.
- Store the battery pack at approximately 50% of the capacity.
- Disconnect the battery pack when not in use and for long-term storage.
- Follow applicable laws and regulations for transporting and shipping of batteries.
- *Immediately discontinue* use of the battery pack if, while using, charging or storing the battery pack:
  - Emits an unusual smell
  - Feel hot
  - Changes color
  - Changes shape
  - Appears abnormal in any other way.

Battery pack general precautions:

- **DO NOT** put the battery in fire or heat the battery.
- **DO NOT** connect the positive and the negative terminal of the battery to each other with any metal object (e.g. wire).
- **DO NOT** carry or store the battery pack with neckaces, hairpins or other metal objects.
- **DO NOT** carry or store the battery pack with hazardous or combustible materials.
- **DO NOT** pierce the battery pack with nails, strike with a hammer, step on or otherwise subject the battery pack to strong impacts or shocks.
- **DO NOT** solder directly onto the battery pack.
- **DO NOT** expose the battery pack to water or salt water or allow it to get wet.
- **DO NOT** disassemble or modify the battery pack. The battery contains safety and protection devices that, if damaged, can cause the battery to generate heat, rupture or ignite.
- **DO NOT** place the battery pack on or near fires, stoves or other high-temperature locations.
- **DO NOT** place the battery pack in direct sunlight or extreme temperatures for extended periods of time or store the battery pack inside cars in hot weather. Doing so may cause the battery pack to generate heat, rupture or ignite. Using the battery pack in this manner may also result in a loss of performance and a shortened life expectancy.
- **DO NOT** place the battery pack in microwave ovens, high-pressure containers or on induction cookware.
- **DO NOT** ship damaged or potentially defective batteries to YSI or any of our authorized service centers unless instructed otherwise. All federal and international shipping laws should be consulted prior to shipping lithium-ion batteries.

Charging/discharging/handling the battery pack

⚠ **WARNING:** Failure to follow the battery pack charging/discharging instructions can cause the battery to become hot, rupture or ignite and cause serious injury and/or equipment damage.

⚠ **WARNING:** Only charge the battery using charging devices designed specifically for the ProDSS by YSI. Use of unapproved chargers can result in battery failure and potentially serious injury to the user.

If at any time the battery pack becomes damaged, hot or begins to balloon or swell, discontinue charging (or discharging) immediately. Quickly and safely disconnect the charger. Then place the battery pack and/or charger in a safe, open area way from flammable materials. After one hour of observation, remove the battery pack from service. **DO NOT** continue to handle, attempt to use or ship the battery.

Damaged or swollen batteries can be unstable and very hot. **DO NOT** touch batteries until they have cooled. In the event of a fire use a Class A, B, or C fire extinguisher. **DO NOT** use water.

- **DO NOT** attach the battery pack to a power supply plug or directly to a car's cigarette lighter.
- **DO NOT** place the battery pack in or near fire or into direct extended exposure to sunlight. When the battery pack becomes hot, the built-in safety equipment is activated, preventing the battery pack from charging further. Heating the battery pack can destroy the safety equipment and cause additional heating, breaking or ignition.
- **DO NOT** leave the battery pack unattended while charging.

  NOTICE: The ambient temperature range over which the battery pack can be discharged is -20°C to 60°C (-4°F to 140°F). Use of the battery pack outside of this temperature range may damage the performance of the battery pack or may reduce its life expectancy.

- **DO NOT** discharge the battery pack using any device except for the ProDSS handheld. When the battery pack is used in other devices it may damage the performance of the battery or reduce its life expectancy. Use of a non-approved device to discharge the battery pack can cause an abnormal current to flow, resulting in the battery pack to become hot, rupture or ignite and cause serious injury.
- **DO NOT** leave the battery pack unattended while discharging.

Battery Disposal

When the battery pack is worn out, insulate the terminals with adhesive tape or similar materials before disposal. Dispose of the battery pack in the manner required by your city, county, state or country. For details on recycling lithium-ion batteries, please contact a government recycling agency, your waste-disposal service or visit reputable online recycling sources such as www.batteryrecycling.com.

This product must not be disposed of with other waste. Instead, it is the user's responsibility to dispose of their waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment.

For more information about where you can drop off your waste equipment for recycling, please contact your local city office, or your local waste disposal service. **DO NOT** ship batteries to YSI unless instructed to do otherwise.

Contact YSI Technical Support at (937) 767-7241 if you have additional questions.

Service information

YSI has authorized service centers throughout the United States and Internationally. For the nearest service center information, please visit ysi.com and click 'Support' or contact YSI Technical Support directly at 800-897-4151 (+1 937-767-7241).
When returning a product for service, include the Product Return form with cleaning certification. The form must be completely filled out for a YSI Service Center to accept the instrument for service. The form may be downloaded from ysi.com.

Technical support

Telephone: 800 897 4151 (USA)

+1 937 767 7241 (Globally) Monday through Friday, 8:00 AM to 5:00 ET

Fax: +1 937 767 9353 (orders)

Email: info@ysi.com

Mail: YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA

Internet: ysi.com

Declaration of Conformity

The undersigned hereby declares on behalf of the named manufacturer under our sole responsibility that the listed product conforms to the requirements for the listed European Council Directive(s) and carries the CE mark accordingly.

Manufacturer:	YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA
Product Name:	ProDSS
Conforms to the following:	
Directives:	EMC 2004/108/EC RoHS 2011/65/EU WEEE 2012/19/EU
Harmonized Standards:	EN61326-1:2013 (IEC 61326-1:2012) IEC 61000-3-2:2005 +A1:2008+A2:2009 IEC 61000-3-3:2008
Supplementary Information:	All performance met the operation criteria as follows: 1. ESD, IEC 61000-4-2:2008 2. Radiated Immunity, IEC 61000-4-3:2006 +A1:2007+A2:2010 3. Electrical Fast Transient (EFT), IEC 61000-4-4:2004 +A1:2010 4. Immunity to Surge, IEC 61000-4-5:2005 5. Radio Frequency, Continuous Conducted Immunity, IEC61000-4-6:2008 6. IEC 61000-4-8:2009 7. IEC 61000-4-11:2004
Authorized EU Representative	Xylem Analytics UK Ltd Unit 2 Focal Point, Lacerta Court, Works Road Letchworth, Hertfordshire, SG6 1FJ UK

Signed: Lisa M. Abel
Title: Director of Quality

Date: September 24 2014

The undersigned hereby declares on behalf of the named manufacturer under our sole responsibility that the listed product conforms to the requirements for electrical equipment under US FCC Part 15 and ICES-003 for unintentional radiators.

Manufacturer:	YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA
Product Name:	Professional Digital Sampling System Instrument
Model Numbers	
Instrument/Accessory:	ProDSS non-GPS (626870-1) / ProDSS GPS (626870-2)
Probe/Cable Assemblies:	626909-1, 626909-4, 626909-10, 626909-20, 626909-30, 626909-40, 626909-50, 626909-60, 626909-70, 626909-80, 626909-90, 626909-100, 626910-1, 626910-4, 626910-10, 626911-20, 626911-30, 626911-40, 626911-50, 626911-60, 626911-70, 626911-80, 626911-90, 626911-100
Sensors:	626900, 626902, 626901, 626903, 626904, 626906, 626905, 626907
Conforms to the following:	
Standards:	• FCC 47 CFR Part 15-2008, Subpart B, Class B, Radio Frequency Devices • ICES-003:2004, Digital Apparatus
Supplementary Information:	Tested using ANSI C63.4-2003 (excluding sections 4.1, 5.2, 5.7, 9, and 14)

Signed: Lisa M. Abel Date: September 24 2014
Title: Director of Quality

Warranty

The YSI Professional Digital Sampling System (ProDSS) is warranted for three (3) years from date of purchase by the end user against defects in materials and workmanship. The ProDSS bulkhead, sensors and cable assemblies are warranted for two (2) years from date of purchase by the end user against defects in material and workmanship. ProDSS pH and pH/ORP sensor modules, optical ODO sensor caps, and Li-Ion battery pack are warranted for one (1) year from date of purchase by the end user against defects in material and workmanship (6 months for ammonium, nitrate, chloride sensor modules). ProDSS systems (instrument, cables & sensors) are warranted for 1 year (excluding sensor modules) from date of purchase by the end user against defects in material and workmanship when purchased by rental agencies for rental purposes. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio at +1 937 767-7241, 800-897-4151 or visit www.YSI.com (Support tab) for a Product Return Form. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

LIMITATION OF WARRANTY

This Warranty does not apply to any YSI product damage or failure caused by:

1. Failure to install, operate or use the product in accordance with YSI's written instructions;
2. Abuse or misuse of the product;
3. Failure to maintain the product in accordance with YSI's written instructions or standard industry procedure;
4. Any improper repairs to the product;
5. Use by you of defective or improper components or parts in servicing or repairing the product;
6. Modification of the product in any way not expressly authorized by YSI.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI's LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.

Appendix A - DO% calibration values

Calibration Value	Pressure			
D.O. %	**in Hg**	**mmHg**	**kPa**	**mbar**
101%	30.22	767.6	102.34	1023.38
100%	29.92	760.0	101.33	1013.25
99%	29.62	752.4	100.31	1003.12
98%	29.32	744.8	99.30	992.99
97%	29.02	737.2	98.29	982.85
96%	28.72	729.6	97.27	972.72
95%	28.43	722.0	96.26	962.59
94%	28.13	714.4	95.25	952.46
93%	27.83	706.8	94.23	942.32
92%	27.53	699.2	93.22	932.19
91%	27.23	691.6	92.21	922.06
90%	26.93	684.0	91.19	911.93
89%	26.63	676.4	90.18	901.79
88%	26.33	668.8	89.17	891.66
87%	26.03	661.2	88.15	881.53
86%	25.73	653.6	87.14	871.40
85%	25.43	646.0	86.13	861.26
84%	25.13	638.4	85.11	851.13
83%	24.83	630.8	84.10	841.00
82%	24.54	623.2	83.09	830.87
81%	24.24	615.6	82.07	820.73
80%	23.94	608.0	81.06	810.60
79%	23.64	600.4	80.05	800.47
78%	23.34	592.8	79.03	790.34
77%	23.04	585.2	78.02	780.20
76%	22.74	577.6	77.01	770.07
75%	22.44	570.0	75.99	759.94
74%	22.14	562.4	74.98	749.81
73%	21.84	554.8	73.97	739.67
72%	21.54	547.2	72.95	729.54

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Appendix B - oxygen solubility table

Solubility of oxygen in mg/L in water exposed to water-xaturated air at 760 mm Hg pressure.

Salinity = Measure of quantity of dissolved salts in water.

Chlorinity = Measure of chloride content, by mass, of water.

S(0/00) = 1.80655 x Chlorinity (0/00)

Temp °C	Chlorinity : 0 Salinity: 0	5.0 ppt 9.0 ppt	10.0 ppt 18.1 ppt	15.0 ppt 27.1 ppt	20.0 ppt 36.1 ppt	25.0 ppt 45.2 ppt
0.0	14.62	13.73	12.89	12.10	11.36	10.66
1.0	14.22	13.36	12.55	11.78	11.07	10.39
2.0	13.83	13.00	12.22	11.48	10.79	10.14
3.0	13.46	12.66	11.91	11.20	10.53	9.90
4.0	13.11	12.34	11.61	10.92	10.27	9.66
5.0	12.77	12.02	11.32	10.66	10.03	9.44
6.0	12.45	11.73	11.05	10.40	9.80	9.23
7.0	12.14	11.44	10.78	10.16	9.58	9.02
8.0	11.84	11.17	10.53	9.93	9.36	8.83
9.0	11.56	10.91	10.29	9.71	9.16	8.64
10.0	11.29	10.66	10.06	9.49	8.96	8.45
11.0	11.03	10.42	9.84	9.29	8.77	8.28
12.0	10.78	10.18	9.62	9.09	8.59	8.11
13.0	10.54	9.96	9.42	8.90	8.41	7.95
14.0	10.31	9.75	9.22	8.72	8.24	7.79
15.0	10.08	9.54	9.03	8.54	8.08	7.64
16.0	9.87	9.34	8.84	8.37	7.92	7.50
17.0	9.67	9.15	8.67	8.21	7.77	7.36
18.0	9.47	8.97	8.50	8.05	7.62	7.22
19.0	9.28	8.79	8.33	7.90	7.48	7.09
20.0	9.09	8.62	8.17	7.75	7.35	6.96
21.0	8.92	8.46	8.02	7.61	7.21	6.84
22.0	8.74	8.30	7.87	7.47	7.09	6.72
23.0	8.58	8.14	7.73	7.34	6.96	6.61
24.0	8.42	7.99	7.59	7.21	6.84	6.50
25.0	8.26	7.85	7.46	7.08	6.72	6.39
26.0	8.11	7.71	7.33	6.96	6.62	6.28
27.0	7.97	7.58	7.20	6.85	6.51	6.18
28.0	7.83	7.44	7.08	6.73	6.40	6.09
29.0	7.69	7.32	6.93	6.62	6.30	5.99
30.0	7.56	7.19	6.85	6.51	6.20	5.90
31.0	7.43	7.07	6.73	6.41	6.10	5.81
32.0	7.31	6.96	6.62	6.31	6.01	5.72

Temp °C	Chlorinity : 0 Salinity: 0	5.0 ppt 9.0 ppt	10.0 ppt 18.1 ppt	15.0 ppt 27.1 ppt	20.0 ppt 36.1 ppt	25.0 ppt 45.2 ppt
33.0	7.18	6.84	6.52	6.21	5.91	5.63
34.0	7.07	6.73	6.42	6.11	5.82	5.55
35.0	6.95	6.62	6.31	6.02	5.73	5.46
36.0	6.84	6.52	6.22	5.93	5.65	5.38
37.0	6.73	6.42	6.12	5.84	5.56	5.31
38.0	6.62	6.32	6.03	5.75	5.48	5.23
39.0	6.52	6.22	5.98	5.66	5.40	5.15
40.0	6.41	6.12	5.84	5.58	5.32	5.08
41.0	6.31	6.03	5.75	5.49	5.24	5.01
42.0	6.21	5.93	5.67	5.41	5.17	4.93
43.0	6.12	5.84	5.58	5.33	5.09	4.86
44.0	6.02	5.75	5.50	5.25	5.02	4.79
45.0	5.93	5.67	5.41	5.17	4.94	4.72