Rhode Island Department of Environmental Management
Office of Water Resources
Standard Operating Procedure (SOP) Review Page

SOP No.	SOP Name	Review Date	What changes, if any?	Reviewed By	Revision/ Renewal Date
WR-W 34	SOP For measurement of DO, Temp, Sp Cond, pH, and Nitrate using a handheld YSI Pro Plus Instrument	5/28/21	NONE	Brian Zalewsky	5/28/21

APPROVALS: I certify that the SOP has been reviewed, revised (if necessary), and verify that the SOP accurately reflects the current needs of the program:

Program Quality Assurance Manager:

Jane Sawyers — Printed Name
Jane Sawyers — Signature
5/28/21 — Date

Division/Office Administrator:

Angelo S. Liberti — Printed Name
Angelo S. Liberti — Signature
Digitally signed by Angelo S. Liberti
Date: 2021.06.03 08:17:04 -04'00'
Date

OCTA Quality Assurance Staff:

Printed Name
Richard T. Enander — Signature
Digitally signed by Richard T. Enander
Date: 2021.06.07 13:36:32 -04'00'
Date

DISTRIBUTION

(x) Program QA Manager

(x) OCTA Quality Assurance Staff

Rhode Island Department of Environmental Management
Office of Water Resources
235 Promenade Street, Providence RI 02908

Standard Operating Procedure for the Measurement of Dissolved Oxygen, Temperature, Specific Conductance, pH and Nitrate Using a Handheld YSI Professional Plus Instrument

SOP No.: WR-W-34
Revision No.: 0
Originator Name: Mark Nimiroski

APPROVALS:

Deputy Chief of Water Quality & Standards:

Sue Kiernan	Sue Kiernan	10/16/12
Printed Name	Signature	Date

RIDEM Quality Assurance Manager:

Terry Gray	Terrence Gray	10/7/12
Printed Name	Signature	Date

Surface Water Monitoring and Assessment QA Manager

Connie Carey	Connie Carey	10/16/12
Printed Name	Signature	Date

DISTRIBUTION

(x) Surface Water Monitoring & Assessment (Connie Carey) By: cgc Date : 10/16/12

(x) TMDL Program (Elizabeth Scott) By: ES Date : 10/7/12

(x) Quality Assurance Manager, RIDEM (Terry Gray) By:_____ Date :_____

Rhode Island Department of Environmental Management
Office of Water Resources
235 Promenade Street, Providence RI 02908

Standard Operating Procedure for the Measurement of Dissolved Oxygen, Temperature, Specific Conductance, pH and Nitrate Using a Handheld YSI Professional Plus Instrument

SOP No.: WR-W-34
Revision No.: 0
Originator Name: Mark Nimiroski

APPROVALS:

Deputy Chief of Water Quality & Standards:

Sue Kiernan

_____	_____	_____
Printed Name	Signature	Date

RIDEM Quality Assurance Manager:

Terry Gray

_____	_____	_____
Printed Name	Signature	Date

Surface Water Monitoring and Assessment QA Manager

Connie Carey

_____	_____	_____
Printed Name	Signature	Date

DISTRIBUTION

(x) Surface Water Monitoring & Assessment (Connie Carey) By:_____Date :_____

(x) TMDL Program (Elizabeth Scott) By:_____Date :_____

(x) Quality Assurance Manager, RIDEM (Terry Gray) By:_____Date :_____

TABLE OF CONTENTS

Standard Operating Procedure for the Measurement of Dissolved Oxygen, Temperature, Specific Conductance, pH, and Nitrate Using a Handheld YSI Pro Plus Instrument

1.0 APPLICABILITY

This SOP applies to all Office of Water Resources (OWR) staff involved in routine calibration and operation of a Handheld YSI Model Professional Plus Instrument (YSI Pro Plus) to collect environmental monitoring data on behalf of the Rhode Island Department of Environmental Management (RIDEM). Any specific exemptions from the use of this SOP for project work shall be predetermined by management discretion, noted in project specific QAPPs and communicated to the analysts by the project manager.

2.0 PURPOSE

This SOP establishes a standardized method for performing water quality measurements in the field using a YSI Pro Plus. The YSI Pro Plus instrument is used to analyze water in situ for dissolved oxygen, specific conductance (temperature compensated conductivity), temperature, nitrate, pH, barometric pressure. This SOP is intended to set a consistent protocol to ensure the quality of RIDEM's data collection—resulting in improved uniformity, reproducibility, verifiability, and defensibility of the data, as well as increased program credibility. This document describes the RIDEM OWR procedure for calibrating and maintaining the YSI Pro Plus instrument, details how measurements should be taken, and how data should be recorded. This SOP is not intended to provide guidance for use of the meter in effluent discharges, brackish or saline waters, or for contaminant specific measurements such as spills. If the intended use of the meter is for the above situations, or any situations other than ambient freshwaters, a project specific QAPP or SOP should be developed.

3.0 DEFINITIONS

3.1 ANALYST: Any RIDEM employee, intern, or contractor who is collecting environmental data on behalf of the State of Rhode Island for the purposes of water quality monitoring.

3.2 ACCURACY: The degree of agreement between a measured value and the accepted reference value.

3.3 CALIBRATION: A procedure used to establish a relationship between the value measured by the YSI Pro Plus (value the device produces) and the actual value of a traceable standard. This process ensures that the YSI Pro Plus takes an accurate measurement within the specified limits.

3.4 OWR: RIDEM Office of Water Resources

3.5 PROJECT: A set amount and duration of work with explicitly stated tasks and procedures for completion of that work.

3.6 PROJECT MANAGER: The RIDEM employee or contractor who has primary and supervisory responsibility for the timely completion of an individual project according to the procedures detailed in any Quality Assurance Project Plans and Standard Operating Procedures.

3.7 QA (QUALITY ASSURANCE): Systematic processes used to ensure RIDEM OWR produces valuable, accurate, reliable, reproducible, and defensible environmental data.

3.8 QC (QUALITY CONTROL): Activities performed to produce valuable, accurate, reliable, reproducible, and defensible environmental data.

3.9 QI (QUALITY IMPROVEMENT): Any act or process performed to enhance the value, accuracy, reliability, reproducibility, or defensibility of environmental data collected by RIDEM OWR.

3.10 RIDEM: Rhode Island Department of Environmental Management

3.11 SOP: Standard Operating Procedure

3.12 VERIFICATION: A process used to document and assure the accuracy and consistency of the YSI Pro Plus instrument, by comparing a value measured by the YSI Pro Plus to a traceable standard measurement. The instrument is considered accurate and consistent if the measured value falls within a specified, acceptable range of the traceable standard.

3.13 YSI PROFESSIONAL PLUS (YSI PRO PLUS): Handheld YSI Pro Plus Instrument that measures dissolved oxygen, specific conductance (temperature compensated conductivity), temperature, nitrate, pH, barometric pressure.

4.0 RESPONSIBILITIES

4.1 TRAINING

Anyone operating the YSI Pro Plus to collect data for a RIDEM project or program should have completed RIDEM's Quality System Awareness Training Program with appropriate documentation from the Quality Assurance Manager. This training ensures the analyst recognizes the importance of proper data collection and management, and comprehends the significance of the environmental decisions that may be made with the data. It is suggested that analysts have also completed the USEPA Water Quality Standards Academy Basic Course and Supplemental Topic Modules online (or on location). To properly operate the YSI Pro Plus, the analyst must be familiar with and comply with the calibration and measurement techniques stated in this SOP. The Project Manager will ensure that any analyst not familiar with the operation of the YSI Pro Plus will be properly trained by personnel that are

familiar with the instrument. Training will take place before the start of fieldwork, and documentation of training, including date and training personnel will be kept on file. Periodic refreshers of training, if deemed necessary, should be arranged for and documented by the Project Manager. In addition field, verification of proper techniques should be done at least quarterly, or more often if necessary to achieve project goals.

4.2 RESPONSIBILITIES OF ANALYST

The analyst is responsible for verifying that the YSI Pro Plus is in proper operating condition and maintaining it in proper working order. The analyst is responsible for checking the proper function and calibrating the instrument in the Sampling Center at the beginning of the sampling event (before taking measurements in the field) and again at the end of the day (after the last measurement), in accordance with Sections 6.2-6.9 of this document. The analyst is accountable for employing proper measurement procedures and data recording in accordance with Section 6.10 of this document. When indicated in the *YSI Pro Plus Meters Maintenance Records and Log Book* located in the Sampling Center the analyst must comply with QA/QC requirements (Section 5.0) and verify the system calibration or, when applicable, change the membrane cap, probes, or batteries (Section 6.1.8).

4.3 RESPONSIBILITIES OF THE PROJECT MANAGER

The project manager is responsible for providing the materials, resources, and/or guidance necessary to perform the calibration and measurements in accordance with this SOP. The project manager is responsible for ensuring that the analyst or technician operates the YSI Pro Plus correctly in accordance with this SOP. The project or program manager is responsible for ensuring that the YSI Pro Plus is maintained in proper operating condition. This includes ensuring that the membrane cap and batteries are changed at appropriate times, the system calibration is verified, the instrument is sent out for service when necessary, and that any additional project-specific requirements are communicated to the project team. Further, the project or program manager shall ensure annual renewal and periodic revisions to this SOP to reflect current needs and standards, as well as renew this document every five years.

5.0 QUALITY CONTROL

5.1 QUALITY ASSURANCE PLANNING CONSIDERATIONS

The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. Unless specified otherwise, in a site or project-specific work plan, Quality Assurance Project (or Program) Plan (QAPP), or laboratory Quality Assurance Manual (QAM), all data collected following

the protocols set forth in this document will be done in accordance with the minimum QA/QC requirements. Further quality assurance requirements will be defined in project specific work plans and/or QAPPs, and may include duplicate or replicate measurements or confirmatory analyses.

5.2 CALIBRATION AND VERIFICATION OF FIELD PARAMETERS

Calibrating the YSI Pro Plus establishes a relationship between the actual value of a traceable standard and value reported by the instrument (number the device produces). Calibrations set the YSI Pro Plus to take an accurate measurement within the specified limits of the instrument. Calibration of dissolved oxygen, pH, barometric pressure, specific conductance, and nitrate should be completed according to the procedures detailed in Sections 6.2-6.6. Saturation values for dissolved oxygen will be different under varying environmental conditions and (i.e. barometric pressure and temperature) requires calibration at the beginning and end of each sampling day, and that the analyst leave the meter turned on once it has been calibrated. If the end of the day calibration fails, values of dissolved oxygen collected during that day are questionable, and field sheets and database entries should be flagged. Temperature verification should be completed according to proper procedures (Section 6.8 and 6.9). Because specific conductance and dissolved oxygen are both temperature compensated, when temperature verification fails these values are questionable, and should not be used in data analysis or reporting.

5.3 DUPLICATE MEASUREMENTS

Duplicate measurements will be performed at a frequency of 10% of the environmental measurements recorded. This measurement, made once every 10 measurements, will consist of a sequential duplicate set of field parameters collected at the same site under similar conditions. The error in these duplicates is the sum of the error in the instrument, and the variability in the natural waters being measured. In the absence of project-specific criteria, duplicate measurements should have a Relative Percent Difference (RPD) of less than five percent, unless field conditions are such that the analyst would expect larger differences in the data. Examples of such conditions include, but are not limited to: storm or snowmelt events, spills or other accidental releases of contaminants, or presence of wildlife. Once per year, the meter should be checked side-by side in the field with an independent meter in as near to possible identical environmental conditions. This measurement will help quantify the variation between instruments and help to isolate the instrument variability from the environmental variability. As with the sequential duplicates, in the absence of project-specific criteria, duplicate measurements should have an RPD of

less than five percent, unless field conditions are such that the analyst would expect larger differences in the data.

5.4 PERFORMANCE PROBLEMS

If there are any performance problems with the YSI Pro Plus meter that result in an inability to achieve the acceptance criteria, the appropriate section of the meter instruction manual for self-test procedures should be consulted. If the problem persists, the manufacturer's customer service department should be contacted immediately for further information (Section 6.12).

6.0 GUIDELINES AND PROCEDURES

6.1 PROPER USE AND MAINTENANCE OF YSI PRO PLUS

6.1.1 Required Materials

The following materials are required

Field Items:

- YSI Pro Plus meter (Serial Numbers 11F100644 and 11F100645)
- YSI Pro Plus carrying case
- YSI Pro Plus manufacturer's Instruction Manual (in carrying case)
- Two C batteries (located in Sampling Center at A)
- YSI Pro Plus replacement membrane cap kit (part #YSI 5906)

Sampling Center items: (See Figure 1: Map of Sampling Center)

- Lint-free tissues (Kimwipes brand located in Sampling Center at A)
- Specific conductance standard 1000 uS/cm (YSI 3167 located in Sampling Center at A)
- pH standards 4, 7, and 10 (Wilkem Cat # 2129704, 2129717, 21209720 located in Sampling Center at A)
- NIST traceable thermometer (Control company brand model 4038 serial # 102162086, located in sampling center at A)
- NIST traceable barometer (Control Company S/N: 122006218 located in sampling center at A)
- De-ionized or distilled water from carboy in sampling center (located at J; filled at RIDOH)
- YSI Field Data Collection Sheet for Monitoring Sampling Events (Datasheet 1)

- Conductivity probe cleaning solution (foaming tile cleaner located in sampling center at E)
- 1:1 isopropyl alcohol and 10N HCl
- Nylon brush (located in the Sampling Center at A)
- *YSI Pro Plus Meters Maintenance Records and Log Book* (located in the Sampling Center at A)
- YSI 5908 dissolved oxygen probe reconditioning kit (located in the Sampling Center at A)
- Full and daily calibration log sheets for RIDEM YSI Pro Plus (Datasheets 2, 3)
- RIDEM YSI Pro Plus Thermometer Calibration Log Sheet (Datasheet 4)

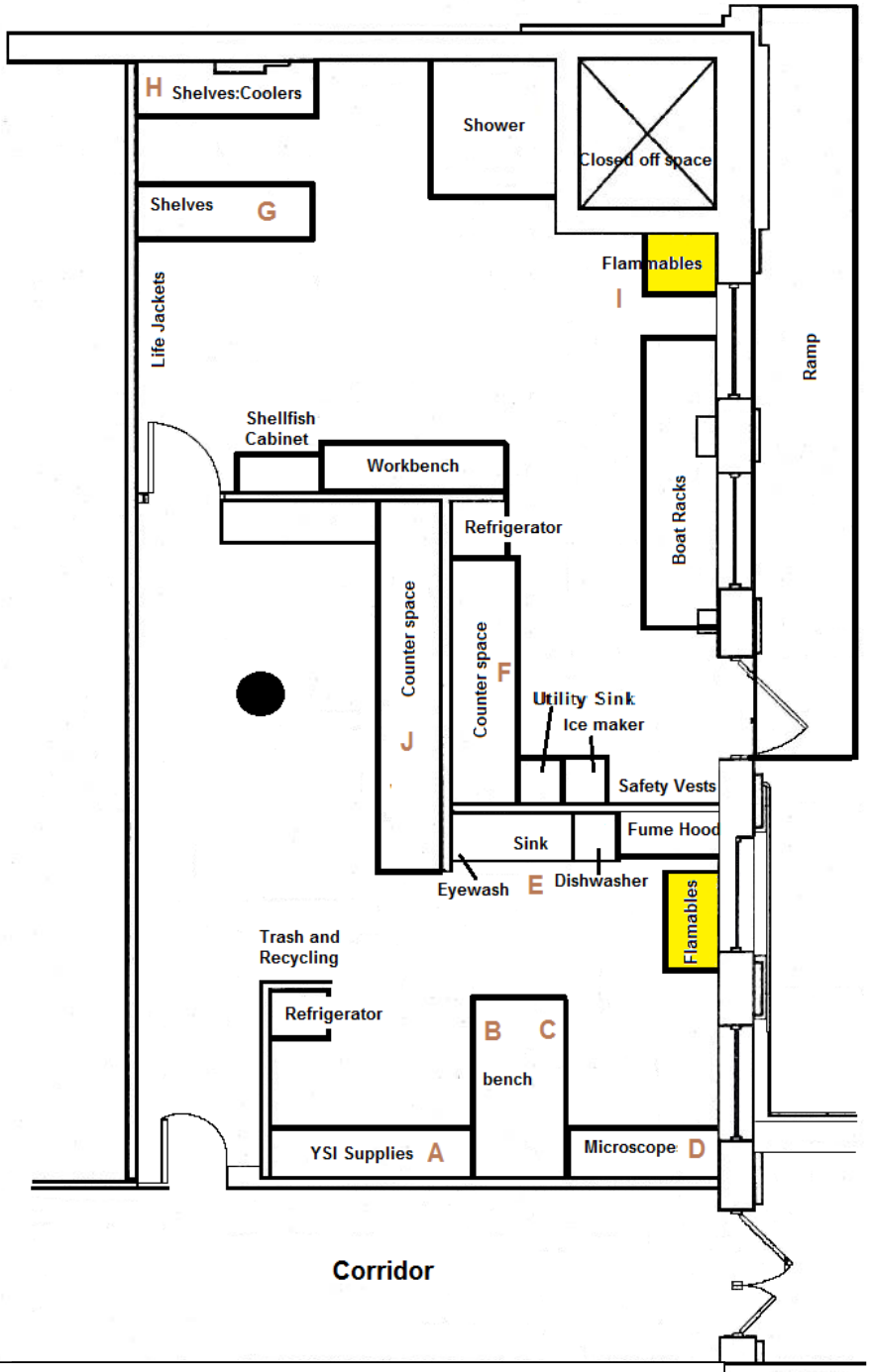


Figure 1. Map of sampling center.

6.1.2 Use of the YSI Pro Plus

For most purposes the YSI Pro Plus is used specifically for in situ water quality measurements directly taken in the field, in lotic or lentic surface waters at temperatures between -5.0°C and 65.0°C. This method does not require sample containers or preservation. The meter should be transported from the Sampling Center to vehicles and from site to site in the carrying case (Figure 2) to prevent damage to the meter. This case is waterproof and will float, so it is particularly important to utilize the case when sampling from a boat. See section 6.10 for details on use of meter in the field.

Figure 2. The carrying case for the the YSI Pro Plus.

6.1.3 Field Parameter Units

The following units should be used when recording measurements taken with the YSI Pro Plus:

Dissolved Oxygen %……..	% saturation
Dissolved Oxygen……..	mg/L
Specific Conductance…….	uS/cm
pH …….....	Standard Units
Temperature……..……..	°C

Barometric Pressure…… mm Hg

Nitrate……..……. mg/L

Instrument, probe, battery and dissolved oxygen membrane maintenance should be performed according to the procedures and frequencies required by the manufacturer at a minimum.

6.1.4 Cleaning and Storage of the Dissolved Oxygen Probe

Cleaning of the probe will typically take place when the membrane is replaced (Section 6.1.8). The probe should be stored in the calibration chamber with a small volume of water to keep the electrolyte from drying out. Should the electrolytic cell (located inside the membrane cap) begin to tarnish or turn black, lightly buff the surface with wet sandpaper from the YSI 5238 Probe Reconditioning Kit, or 400 grit wet/dry sandpaper. This procedure should remove any oxidation.

6.1.5 Cleaning and Storage of the Specific Conductance Probe

The conductivity cell should be rinsed with clean water after each use. If the conductivity cell becomes fouled and rinsing is not sufficient, the cell should be dipped in cleaning solution and agitated for two to three minutes. Any standard foaming acid tile cleaner and a soft bristled brush will clean the cell adequately. If a stronger solution is required, a solution of 1:1 isopropyl alcohol and 10N HCL can be used. Use a nylon brush to dislodge contaminants from the inside of the electrode chamber and rinse thoroughly. The probe should be stored in the calibration chamber.

6.1.6 Cleaning and Storage of the pH Probe

The life of the pH probe is typically between twelve to twenty-four months, depending on whether it has been stored properly. The longevity of the probe relies on appropriate storage, and should be done with the utmost thoroughness. The pH probe should be rinsed with clean water and stored in the calibration cup with a small volume of water in between uses. It should be cleaned before long-term storage. The probe should be uninstalled for ease of cleaning, and a port lug placed into the probe housing. Depending on the severity and type of fouling, the probe should be gently cleaned with a cotton swab and fresh tap water, or, if more severe fouling is present, soaked in water with a few drops of detergent for ten to fifteen minutes. If the fouling is biological, the probe should be soaked for one hour in a 1:1 bleach/tap water solution. Immediately afterwards, the probe should be soaked for an additional hour in fresh tap water, with occasional

stirring to remove bleach residue. There will be periods where the meter is not regularly used and it will need to be stored for the long-term (Section 6.11).

6.1.7 Changing the Batteries of the YSI Pro Plus

The YSI Pro Plus batteries should not be changed in the field. After 100 hours of operation (approximately fourteen field days; or when the LCD screen indicates low battery) the batteries should be changed in the Sampling Center before departing for a sampling event (Figure 3).

Figure 3. The battery compartment of the YSI Pro Plus, accessed using Philips head screwdriver.

The date batteries were last changed should be written on a piece of labeled tape affixed to the YSI Pro Plus, and noted in the RIDEM *YSI Pro Plus Meters Maintenance Records and Log Book* located in the Sampling Center at A (figure 1). After the batteries have been changed, the instrument must be calibrated (Sections 6.2-6.8).

6.1.8 Changing the Dissolved Oxygen Membrane

Dissolved oxygen membranes should be changed approximately every two weeks during the field season. Evidence of damage, such as a loose, wrinkled, or fouled membrane, or large bubbles in the reservoir, are also sufficient reasons to replace the membrane. This procedure requires YSI Pro Plus replacement membrane cap kit (part #YSI 5908).

To install a new membrane on the YSI Pro Plus:

- The probe sensor guard should be unscrewed and removed (Figure 4a).
- The old membrane cap should be unscrewed, removed, and discarded (Figure 4b).

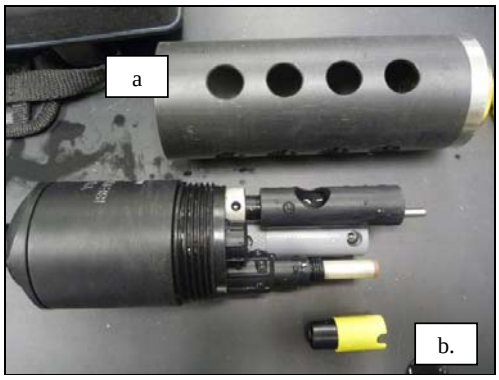


Figure 4. YSI Pro Plus probe with (a) sensor guard and (b) yellow membrane cap removed.

Formatted: Bullets and Numbering

- The sensor tip should be thoroughly rinsed with de-ionized or distilled water.
- The electrolyte solution should be prepared in accordance to the directions on the KCl solution bottle included in the kit. It is best to have the solution prepared well in advance of calibration, and the bottle should not be shaken too vigorously, because this will dissolve oxygen into the KCl solution, and affect the accuracy of the calibration.
- The new membrane cap should be filled it at least half full with KCl electrolyte solution (Figure 5).

Figure 5. New membrane cap being filled with KCl solution.

- While the probe is at a 45 degree angle, the membrane cap should be screwed onto the probe moderately tightly; a small amount of electrolyte should overflow.
- The analyst should look carefully at the membrane from several different angles to make sure that no air bubbles are caught under the membrane.

If air bubbles are observed, the membrane cap should be removed, refilled, tapped to eliminate any air bubbles, and reinstalled.

- There is no stretch period required for the membrane, once the membrane has been installed, the meter can be used to measure dissolved oxygen right away.

6.2 CALIBRATION ORDER AND ACCEPTANCE CRITERIA

6.2.1 Calibration of the YSI Pro Plus should be done in the following order, with acceptance criteria as stated.

Parameter	**Acceptance Criteria**
Barometric Pressure	3 mm Hg (within 10 degrees of calibration point)
Dissolved Oxygen	+-2% (between 0 and 200% saturated)
Specific Conductance	+-0.5% or 1 microsiemen (whichever is greater)
pH	+-0.1 Standard units (Standard values may need to be adjusted for temperature)
Nitrate	+- 10% or 2 mg/l (whichever is greater)
Temperature	+- 1.0 Degrees Celsius

Table 1. Order of calibrations and acceptance criteria for each parameter.

6.3 BAROMETRIC PRESSURE CALIBRATION PROCEDURES

The following sections describe the barometric pressure calibration procedure.

6.3.1 Required Frequency of Barometric Pressure Calibrations

The barometric pressure on the YSI Pro Plus can drift over time, and must occasionally be calibrated. At a minimum, the calibration should be done twice a year- at the beginning and end of summer field work. The barometric pressure value on the YSI Pro Plus must be calibrated using a NIST traceable barometer. Typically barometers (like the model in Figure 6), have several different units of measurement on concentric rings. The RIDEM ARM program records barometric pressure in millimeters of mercury (mm Hg). The middle ring shows these values increasing from left to right. The black needle (a), points to the current pressure which is 770.5 mm Hg. The silver indicator (b) is adjustable and allows the user to track changes in pressure. It is not generally used for RIDEM programs.

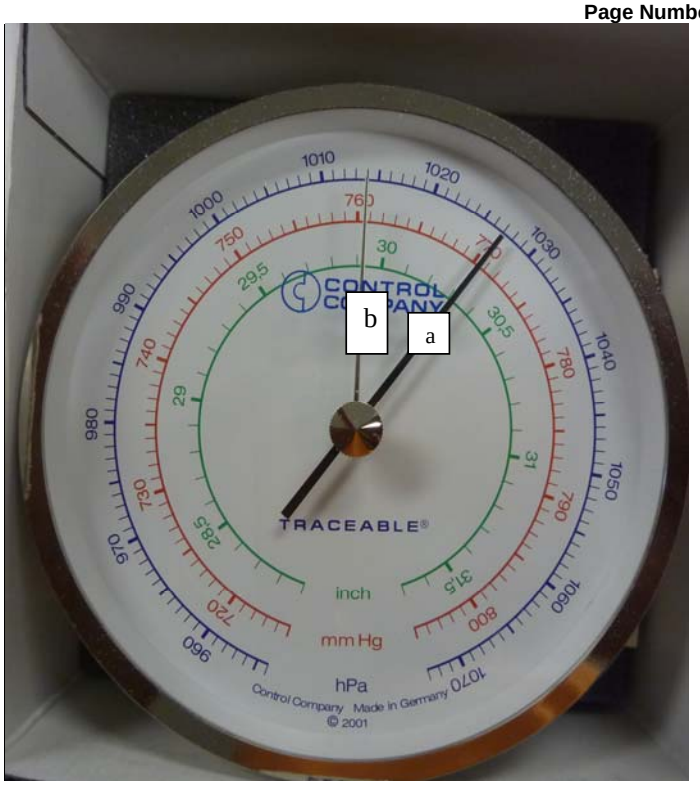


Figure 6. NIST traceable barometer The black indicator arrow is located at (a) and the adjustable silver indicator is located at (b).

6.3.2 Preparing YSI Pro Plus for Barometric Pressure Calibration

The **Cal** button (Figure 7), when pressed, will open the menu for calibrating all the parameters measured by the YSI Pro Plus. Pressing the down arrow four times will highlight "**Barometer"** in the **Calibrate** menu, which will allow the analyst to calibrate the barometric pressure (Figure 8a).

Figure 7. YSI Pro Plus instrument panel.

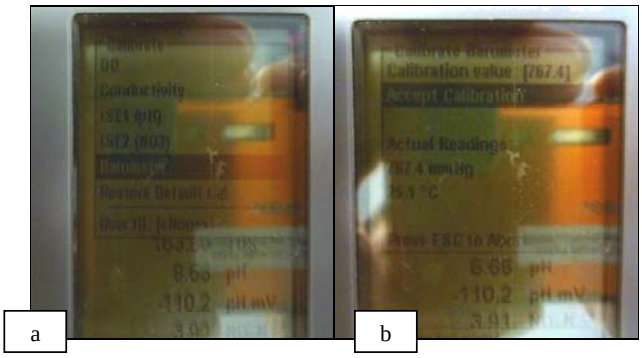


Figure 8. YSI Pro Plus Barometer calibration sequence: a) **Calibrate** menu with "**Barometer**" selected; b) **Calibrate Barometer** menu with "**Accept Calibration"** selected.

6.3.3 Calibrating Barometric Pressure

The **ENTER** button, when pressed with "**Barometer"** selected, will begin the calibration procedure (Figure 8a). It will take several minutes for the meter to stabilize. Once value is stable, the analyst should press the **ENTER** button while the "**Calibration value"** is selected to adjust the calibration value on the YSI Pro Plus to match the value on the barometer. Pressing the **ENTER** button with "**Accept Calibration"** selected will complete the calibration procedure (Figure 8b). Initial barometric pressure and instrument readings should be recorded on a Calibration Log Sheet for RIDEM YSI Pro Plus (Datasheet 3).

6.3.4 Barometric Pressure Acceptance Criteria

Barometric pressure measured with the YSI Pro Plus is accurate to within +/- three mm Hg within ten degrees Celsius of calibration point. If the reading is

within three mm Hg of the NIST barometer reading, the meter is within acceptance criteria.

6.4 DISSOLVED OXYGEN CALIBRATION PROCEDURES

The following sections describe the dissolved oxygen calibration procedure.

6.4.1 Required Frequency of Dissolved Oxygen Calibrations

The YSI Pro Plus must be calibrated for dissolved oxygen measurements at the beginning of each sample day and after the last measurement of the day. During long sampling events it must be recalibrated every twelve hours, in addition to the beginning and end of the day. The end of the day calibration ensures that the instrument was operating correctly while collecting measurements. If the calibrated value of dissolved oxygen (mg/L) falls within the acceptance criteria (Section 6.4.8), the calibration will be recorded on a YSI Field Data Collection Sheets (Datasheet 1) and a Calibration Log Sheet for RIDEM YSI Pro Plus (Datasheet 2) in the *YSI Pro Plus Meters Maintenance Records and Log Book* located in the Sampling Center at A (figure 1). If the calibrated dissolved oxygen value falls outside of the acceptance criteria, the instrument should be re-calibrated. If recalibration fails, it is possible that there is a problem with the DO probe itself. Refer to sections 6.1.4 Cleaning and Storage of the Dissolved Oxygen Probe and 6.1.8 Changing the Dissolved Oxygen Membrane. If the instrument does not calibrate correctly at the end of the day, data collected that day is unreliable. Unacceptable data that do not meet the quality assurance criteria should not be used in analyses or assessments. When data do not meet acceptance criteria this should be noted on a YSI Field Data Collection Sheets (Datasheet 1) and a Calibration Log Sheet for RIDEM YSI Pro Plus (Datasheet 2) in the *YSI Pro Plus Meters Maintenance Records and Log Book* located in the Sampling Center. It is recommended that those affected sampling stations be re-sampled on a different day, after the instrument has been repaired or is properly calibrated.

6.4.2 Preparing the YSI Pro Plus Probe for Dissolved Oxygen Calibration

The probe should be inserted into the calibration cup, with water filled just below the yellow tipped dissolved oxygen probe (Figure 9). A stand makes this procedure easier. There should be no water present on the clear membrane part of the probe, if there is, it should be removed by lightly dabbing a lint-free tissue on the area. The calibration cup cap should be inversely placed on the cup, and not screwed on.

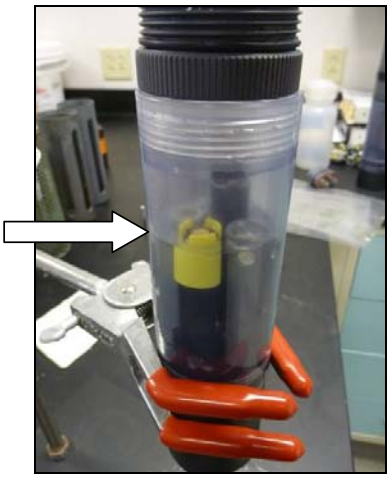


Figure 9. YSI Pro Plus with the proper set-up for calibrating dissolved oxygen; the cap unscrewed and placed inverted on top of the unit, and the water filled to the correct level (see arrow).

6.4.3 Power On and Self-Test

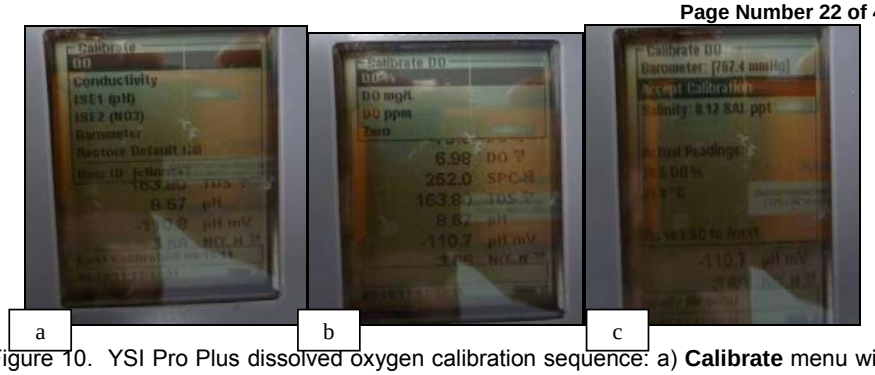
The **power** button (Figure 7) will turn the YSI Pro Plus on, and the instrument will activate all segments of the display for a few seconds. This will be followed by a self-test procedure that lasts for several more seconds. During this power on and self-test sequence, the instrument's microprocessor is verifying that the instrument is working properly.

6.4.4 Recording Initial Reading

At least fifteen minutes is required for the dissolved oxygen and temperature readings to stabilize. The analyst should record initial dissolved oxygen reading on a Calibration Log Sheet for RIDEM YSI Pro Plus (Datasheet 2).

6.4.5 Initiating Dissolved Oxygen Calibration

The analyst should press and release the **Cal** button (Figure 7), and select "**DO"** from the **Calibrate** menu, by pressing the **ENTER** button when "**DO"** is highlighted (Figure 10a). This will be the first item on the list when the **Cal** button is pushed.



a b c

Figure 10. YSI Pro Plus dissolved oxygen calibration sequence: a) **Calibrate** menu with "**DO**" selected; b) **Calibrate DO** menu with "**DO%**" selected; c) **Calibrate DO** menu with "**Accept Calibration"** selected.

6.4.6 Calibrating Dissolved Oxygen

There are several choices of how to calibrate dissolved oxygen, RIDEM uses the percent dissolved oxygen ("**DO%"**) method, by placing the probe in air saturated with water in the calibration cup (figure 9). The user places the probe in the 100% oxygen saturated environment, and the instrument adjusts the reading to this value. "**DO%**" should be selected from the **Calibrate** Menu (Figure 10b).

6.4.7 Recording calibrated Dissolved Oxygen

When the dissolved oxygen reading is no longer variable, the values for dissolved oxygen (mg/L and % saturation), temperature (degrees Celsius), and barometric pressure (mm Hg) should be recorded on a Calibration Log Sheet for RIDEM YSI Pro Plus Datasheet 2), with the date, time, and analyst performing the calibration. Sheets should be placed in the *YSI Pro Plus Meters Maintenance Records and Log Book* located in the Sampling Center at A (figure 1). To accept the calibration, the analyst should press the **ENTER** button when "**Accept Calibration"** is highlighted (Figure 10c).

6.4.8 Dissolved Oxygen Acceptance Criteria

Dissolved oxygen measured with the YSI Pro Plus is accurate to within +/- two percent of reading, or two percent of air saturation (whichever is greater), between zero and two-hundred percent saturated. If the meter is within two percent of the saturation at the given temperature and barometric pressure, then the meter is within acceptance criteria. Charts like the one in Lewis, 2006 show the saturation value for dissolved oxygen at various temperatures and pressures. When the meter has stabilized, the saturation value (in mg/l) should be recorded on the log sheet. If the calibrated value for dissolved oxygen is within two percent of the chart, then the meter is within acceptance criteria

Table 6.2–6. Solubility of oxygen in water at various temperatures and pressures—Continued

Temp	Atmospheric pressure, in millimeters of mercury																		
°C	795	790	785	780	775	770	765	760	755	750	745	740	735	730	725	720	715	710	705	700
15.0	10.5	10.5	10.4	10.3	10.3	10.2	10.1	10.1	10.0	9.9	9.9	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.3	9.3
15.5	10.4	10.4	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.4	9.4	9.3	9.2	9.2
16.0	10.3	10.2	10.2	10.1	10.0	10.0	9.9	9.8	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.1	9.1
16.5	10.2	10.1	10.1	10.0	9.9	9.9	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.4	9.3	9.2	9.2	9.1	9.0	9.0
17.0	10.1	10.0	10.0	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9	8.9
17.5	10.0	9.9	9.9	9.8	9.7	9.7	9.6	9.6	9.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.8	8.8
18.0	9.9	9.8	9.8	9.7	9.6	9.6	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.7	8.7
18.5	9.8	9.7	9.7	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.8	8.8	8.7	8.7	8.6
19.0	9.7	9.6	9.6	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.8	8.7	8.6	8.6	8.5
19.5	9.6	9.5	9.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.9	8.8	8.7	8.7	8.6	8.5	8.5	8.4
20.0	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.5	8.4	8.3
20.5	9.4	9.3	9.3	9.2	9.2	9.1	9.0	9.0	8.9	8.9	8.8	8.7	8.7	8.6	8.6	8.5	8.4	8.4	8.3	8.3
21.0	9.3	9.2	9.2	9.1	9.1	9.0	8.9	8.9	8.9	8.8	8.7	8.6	8.6	8.5	8.5	8.4	8.4	8.3	8.2	8.2
21.5	9.2	9.2	9.1	9.0	9.0	8.9	8.9	8.8	8.7	8.7	8.6	8.6	8.5	8.4	8.4	8.3	8.3	8.2	8.1	8.1
22.0	9.1	9.1	9.0	9.0	8.9	8.8	8.8	8.7	8.7	8.6	8.5	8.5	8.4	8.4	8.3	8.2	8.2	8.1	8.1	8.0
22.5	9.0	9.0	8.9	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.5	8.4	8.3	8.3	8.2	8.2	8.1	8.0	8.0	7.9
23.0	9.0	8.9	8.8	8.8	8.7	8.7	8.6	8.6	8.5	8.4	8.4	8.3	8.3	8.2	8.1	8.1	8.0	8.0	7.9	7.9
23.5	8.9	8.8	8.8	8.7	8.6	8.6	8.5	8.5	8.4	8.4	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.8	7.8
24.0	8.8	8.7	8.7	8.6	8.6	8.5	8.4	8.4	8.3	8.3	8.2	8.2	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7
24.5	8.7	8.7	8.6	8.5	8.5	8.4	8.4	8.3	8.3	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.7	7.7	7.6
25.0	8.6	8.6	8.5	8.5	8.4	8.3	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.8	7.8	7.7	7.7	7.6	7.6
25.5	8.5	8.5	8.4	8.4	8.3	8.3	8.2	8.2	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5
26.0	8.5	8.4	8.4	8.3	8.3	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.6	7.6	7.5	7.5	7.4
26.5	8.4	8.3	8.3	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4
27.0	8.3	8.3	8.2	8.2	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.3	7.3
27.5	8.2	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2
28.0	8.2	8.1	8.1	8.0	8.0	7.9	7.9	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2
28.5	8.1	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.1	7.1
29.0	8.0	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.5	7.5	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7.0
29.5	8.0	7.9	7.9	7.8	7.8	7.7	7.6	7.6	7.5	7.5	7.4	7.4	7.3	7.3	7.2	7.2	7.1	7.1	7.0	7.0

Figure 11. Chart showing solubility of oxygen in water and various temperatures and pressures (Lewis, 2006)

6.4.9 Calibration in the Field

Occasionally it may become necessary to calibrate the YSI Pro Plus in the field. Questionable readings on the meter or suspicion of damage to the probe or membrane are factors that would lead the analyst to want to confirm the accuracy of the calibration before making additional measurements or returning to the Sampling Center. Field calibration can be problematic due to lack of access to clean facilities to change the membrane, and unpredictability of temperature and barometric pressure shifts. Membrane cap kits should be carried as spares in case of damage, and field vehicles should be kept clean to act as alternative lab area for such situations. The same procedures should be followed as for a normal calibration for dissolved oxygen (Sections 6.4.2-6.4.8), and any such calibrations should be documented on field sheets and transcribed to log books upon return to the Sampling Center.

6.5 SPECIFIC CONDUCTANCE VERIFICATION PROCEDURES

According to the YSI Pro Plus Manual (YSI incorporated, 2009), calibrating specific conductance is rarely required because the calibration done at the factory should be adequate. In order to ensure that the data collected are of the highest quality, specific conductance verifications will be performed at fixed intervals. More frequent intervals may be necessary to meet data objectives. If

the specific conductance verification does not meet acceptance criteria (Section 6.5.7), it should be calibrated.

6.5.1 Required Frequency of Calibration and Verification

Specific conductance readings will be verified in accordance with proper procedures (Sections 6.5.2-6.5.10) at a frequency of ten percent of the dissolved oxygen calibrations. For every ten dissolved oxygen calibrations a one-point temperature verification, and a barometric pressure, specific conductance, pH, and nitrate calibration should be performed. Verifications and calibrations will be recorded on a Calibration Log Sheet for RIDEM YSI Pro Plus (Datasheet 3).

6.5.2 Preparing the YSI Pro Plus Probe for Specific Conductance Verification

Rinsing the container and the probe ensures that there is no dust or residue that would interfere with accurate measurement of readings by contaminating the solution. The receptacle and probe should be rinsed twice with de-ionized or distilled water. The receptacle should then be rinsed twice with the 1000 µS standard.

6.5.3 Verifying Specific Conductance

The calibration cup should be filled with enough 1000 µS standard solution to completely cover the cluster of probes (Figure 12). A gentle tap on the edge of the cup will ensure that there are no air bubbles present in the probe.

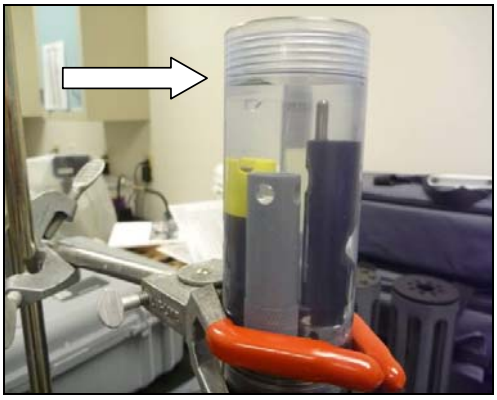


Figure 12. YSI Pro Plus with the proper set-up for calibrating specific conductance; the cap unscrewed and water filled to the correct level (see arrow).

6.5.4 Allowing Specific Conductance Value to Stabilize

The analyst should wait about one minute for the probe to adjust to the conductance of the 1000 µS standard solution.

6.5.5 Recording Specific Conductance Value on Log Sheet

Values, date, time, and name of analyst should be recorded on a Calibration Log Sheet for RIDEM YSI Pro Plus (Datasheet 3). Each meter has a section in the *YSI Pro Plus Meters Maintenance Records and Log Book* located in the Sampling Center, with the meter number at the top of the sheet.

6.5.6 Specific Conductance Acceptance Criteria

The YSI Pro Plus meter is accurate to within +/- 0.5 percent of the value of specific conductance of a liquid. If the meter is off by more than +/- 0.5 percent of the standard solution value, then it will need to be calibrated (Section 6.5.7). The analyst should record the value that the meter is reading on the part of the log sheet that requires "initial reading".

6.5.7 Calibrating Specific Conductance, if Necessary

The analyst should press the **CAL** Button (Figure 7), and select "**Conductivity"** from the **Calibrate** menu (Figure 13a). Next, "**SPC-uS/cm"** should be selected from the **Calibrate Sp. Conductance** menu (Figure 13b). When the reading on the meter has stabilized, the analyst should select "**Accept Calibration"** from the **Calibrate Sp. Conductance** menu (Figure 13c).

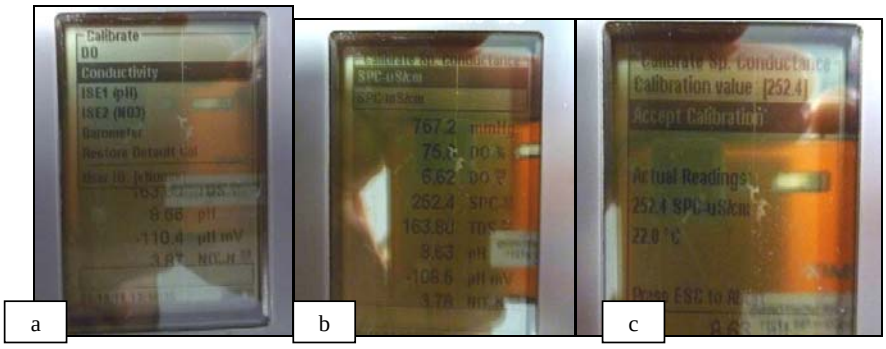


Figure 13. YSI Pro Plus Specific Conductance calibration sequence: a) **Calibrate** menu with "**Conductivity"** selected; b) **Calibrate Sp. Conductance** menu with "**SPC-uS/cm"** selected; c) **Calibrate Sp. Conductance** menu with "**Accept Calibration"** selected.

6.5.8 Additional Standards

If the meter is checked against several standard solutions, the solution with the lowest specific conductance value should be checked first, followed by standard solutions with higher values. De-ionized or distilled water should *not* be used to rinse the meter between standards. Such water is effectively a zero conductance solution and has a greater probability of contaminating the standard solution more than a solution with a specific conductance higher than zero. Rinsing the probe several times with each standard solution will reduce the probability of contaminating them and the probe during calibration.

6.5.9 Calibrating Specific Conductance with Additional Standards, if Necessary

Specific conductance should be adjusted following the proper procedure (Section 6.5.8).

6.5.10 Failure of Calibration

Contact customer service if calibration fails, see section 6.12

6.6 PH CALIBRATION AND VERIFICATION PROCEDURES

The following sections describe the calibration and verification procedures for pH. Project specific procedures may be adopted if data quality objectives require more stringent protocols. The process described below (6.6.3 through 6.6.9) is a 3-point pH calibration.

6.6.1 Required Frequency of pH Verification

Verification of pH will be done in accordance with proper procedures (Sections 6.6.3-6.6.9) at a frequency of ten percent of the dissolved oxygen calibrations. For every ten dissolved oxygen calibrations a one-point temperature verification, and a barometric pressure, specific conductance, pH, and nitrate calibration should be performed. Verifications and calibrations will be recorded on a Calibration Log Sheet for RIDEM YSI Pro Plus (Datasheet 3).

6.6.2 Uninstalling Nitrate Probe to the YSI Pro Plus

The nitrate probe is negatively affected by pH standards. Calibration for pH must be executed with the nitrate probe uninstalled (Figure 14).

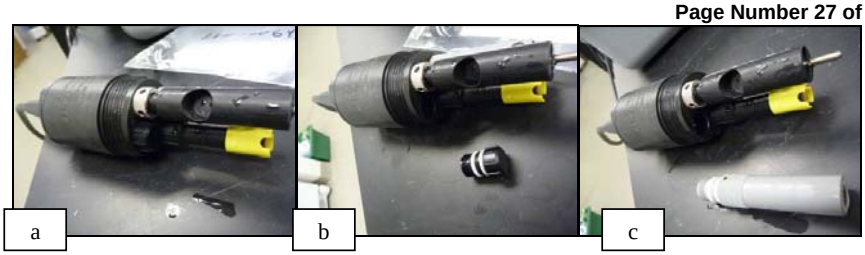


Figure 14. a) YSI Pro Plus probe housing with port plug in ISE2-receptacle for Nitrate or other ISE probes; b) ISE2 port plug removed; c) port plug removed and nitrate probe ready to install.

6.6.3 pH 7 Buffer Calibration

The probe should be placed on the stand and the calibration cup should be filled with a sufficient volume of pH 7 buffer solution to cover the pH probe and the temperature probe as well (Figure 15b). Note that the pH 7 buffer solution is typically yellow in color (Figure 15a).

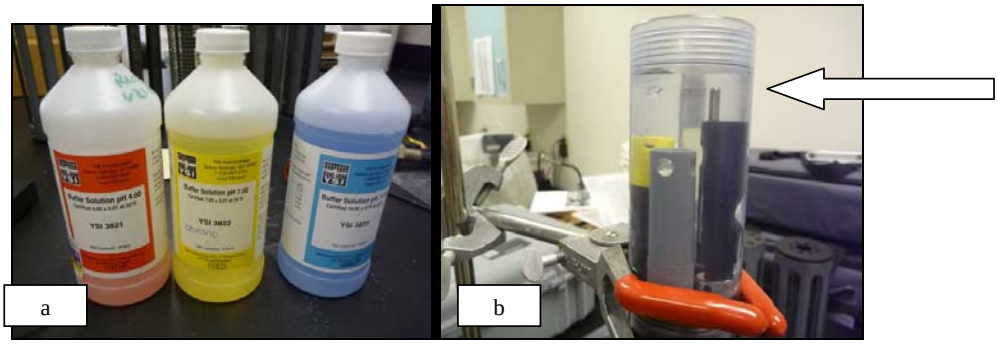


Figure 15. a) pH standards 4, 7, and 10 from left to right, respectively and b) calibration cup filled with the correct amount of pH 7 buffer so that the temperature probe (silver, indicated by arrow) is covered.

6.6.4 Calibrating the pH with pH 7 Buffer

The analyst should press the **Cal** button, and select "**ISE1 (pH**)" from the **Calibrate** Menu by pressing the **ENTER** button when it is highlighted on the screen (Figure 16a).

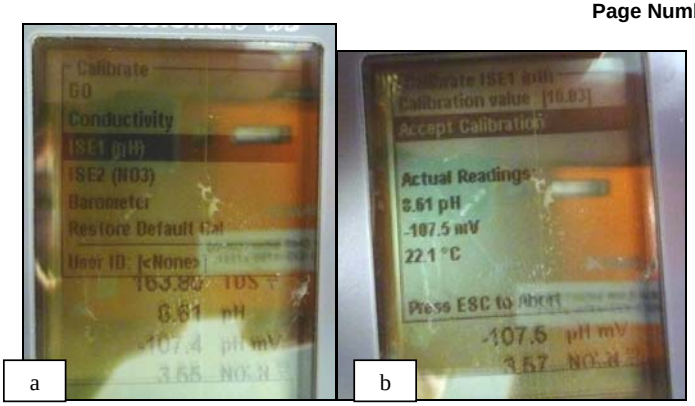


Figure 16. YSI Pro Plus pH calibration sequence: a) **Calibrate** menu with "**ISE1 (pH)"** selected; b) **Calibrate ISE1 (pH)** menu with "**Accept Calibration"** selected.

6.6.5 Allowing Value to Stabilize and Accepting Calibration

The meter will automatically recognize the buffer value, and will display it on the **Calibrate** screen as "**Calibration Value [7.00]**". "**Actual Readings**" will need a few minutes to stabilize. When the "**Actual Readings**" value has stabilized, the analyst should press the **ENTER** button with "**Accept Calibration**" selected (Figure 16b). The meter is now ready for a second calibration point.

6.6.6 pH 4 Buffer Calibration

The calibration cup should be rinsed twice with pH 4 buffer solution and filled with a sufficient volume of solution to cover the pH probe (Figure 15b). Note that the pH 4 buffer solution is typically red in color (Figure 15a).

6.6.7 Allowing Value to Stabilize and Accepting Calibration

The meter will automatically recognize the buffer value, and will display it on the **Calibrate** screen as "**Calibration Value [4.00]**". "**Actual Readings**" will need a few minutes to stabilize. When the "**Actual Readings**" value has stabilized, the analyst should press the **ENTER** button with "**Accept Calibration**" selected (Figure 16b). The meter is now ready for a third calibration point.

6.6.8 pH 10 Buffer Calibration

The calibration cup should be rinsed twice with pH 10 buffer solution and filled with a sufficient volume of solution to cover the pH probe (Figure 16b). Note that pH 10 buffer solution is typically blue in color (Figure 16a).

6.6.9 Allowing Value to Stabilize and Completing Calibration Sequence

The meter will automatically recognize the buffer value, and will display it on the **Calibrate** screen as "**Calibration Value [10.00]**". "**Actual Readings**" will need a minute to stabilize. When the "**Actual Readings**" value has stabilized, the analyst should press the **ENTER** button with "**Accept Calibration**" selected (Figure 16b). Press the **Cal** button to complete the calibration.

6.6.10 pH Acceptance Criteria

The YSI Pro Plus meter is accurate to within +/- 0.1 units of the value of pH. If the reading on the meter is within +/- 0.1 units from the value of the standard (corrected for temperature), the meter is within acceptance criteria.

6.7 NITRATE PROBE CALIBRATION PROCEDURES

6.7.1 Required Frequency of Nitrate Probe Calibration

Nitrate will be verified in accordance with proper procedures (Sections 6.7.2-6.7.10) at a frequency of ten percent of the dissolved oxygen calibrations. For every ten dissolved oxygen calibrations, a one-point temperature verification, and a barometric pressure, specific conductance, pH, and nitrate calibration should be performed. Verifications and calibrations will be recorded on a Calibration Log Sheet for RIDEM YSI Pro Plus (Datasheet 3).

6.7.2 Installing Nitrate Probe to the YSI Pro Plus

The nitrate probe is negatively affected by pH standards and should be removed before pH is calibrated (6.6.2). Once pH has been calibrated, the nitrate probe can be reinstalled for the nitrate calibration (Figure 14).

6.7.3 Accepting Nitrate Probe Values

The meter needs to be set up to accept and interpret the values that it receives from the nitrate probe. The **Probe** button should be pressed to begin this process (Figure 7).

6.7.4 Preparing the YSI Pro Plus Nitrate Probe

The user should go to the **Sensors** menu and press the **ENTER** button when "**Setup**" is highlighted (Figure 17a). Next, the user should select "**ISE2 [NO3]"** when it is highlighted in the **Sensors** menu (Figure 17b) to ensure that the correct nitrate probe feature is being calibrated.

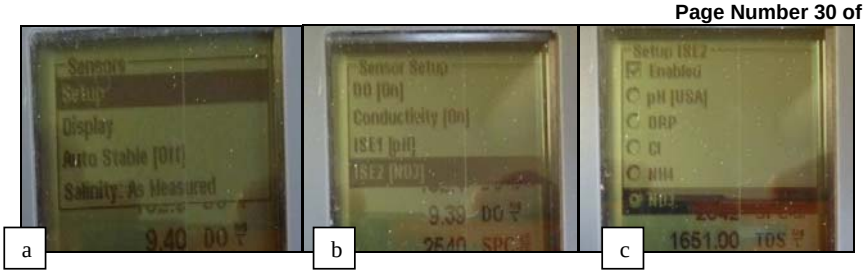


Figure 17. YSI Pro Plus nitrate calibration sequence: a) **Sensors** menu with "**Setup"** selected; b) **Sensors** menu with "**ISE2 [NO3]**" selected; c) **Setup ISE2** menu with "**Enabled**" checked off and "**NO3**" selected.

6.7.5 Enabling the Nitrate Probe

The user should select "**Enabled**" from the **Setup ISE2** menu and press the **ENTER** button to enable the ISE2 port (Figure 17c). Next the user should select "**NO3**" and press the **ENTER** button to set the port to recognize the probe as a Nitrate probe (Figure 17c). The same procedure can be followed to enable other probes utilized by this instrument.

6.7.6 Preparing the YSI Pro Plus for the 1.0 MG/L Nitrate Standard Calibration

Typically a two-point calibration should be done for the nitrate probe as described in the YSI Pro Plus manual (YSI incorporated, 2009). The first standard to be used is a 1.0 mg/L standard solution. The calibration cup and probe should be rinsed two times with this standard, and then filled with a sufficient volume of solution to cover the nitrate probe (Figure 18).

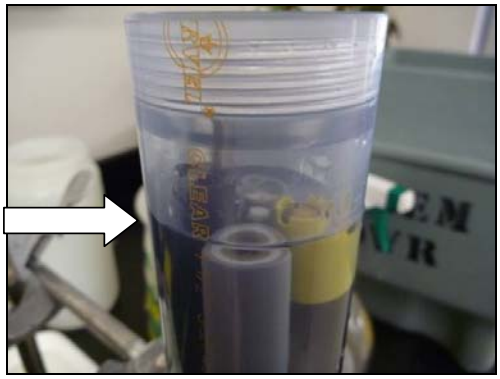


Figure 18. YSI Pro Plus probe submerged with the proper amount of Nitrate standard solution (see arrow).

6.7.7 Calibrating Nitrate

The **CAL** button should be pressed and "**Nitrate"** selected from the **Calibrate** menu. The meter will automatically recognize the standard.

6.7.8 Allowing the Meter to Stabilize and Accept Calibration

The analyst should wait at least five minutes for the value to stabilize, select "**Accept Calibration**", and press the **ENTER** button to accept the first calibration.

6.7.9 Preparing the YSI Pro Plus for the 100.0mg/L Nitrate Standard Calibration

The second standard to be used is a 100.0 mg/L standard solution. The calibration cup and probe should be rinsed two times with this standard, and then filled with a sufficient volume of solution to cover the nitrate probe (Figure 18). Once the cup is filled, the **Cal** button should be pressed.

6.7.10 Completing the Calibration

The analyst should wait at least five minutes for the value to stabilize, before selecting "**Accept Calibration**" and pressing the **ENTER** button to accept the second calibration. Once accepted, the **Cal** button should be pressed to accept the nitrate calibration sequence.

6.7.11 Nitrate Acceptance Criteria

The Nitrate probe with the YSI Pro Plus meter is accurate to within +/- ten percent or two mg/L, whichever is greater. If the reading on the meter is within +/- ten percent or two mg/L, then the meter is within acceptance criteria.

6.8 ONE-POINT TEMPERATURE VERIFICATION PROCEDURES

This verification is intended to assure that the meter is accurately measuring temperature. The meter should be returned to YSI for service if verification fails.

6.8.1 Required Frequency of One-Point Temperature Verification

Temperature readings will be verified using an NIST traceable thermometer. This thermometer is a Control Company brand model 4038 and is located in the sampling center (Figure 1, at A). Verifications will be done in accordance with proper procedures (Sections 6.8.2-6.8.5) at a frequency of ten percent of the dissolved oxygen calibrations (every ten dissolved oxygen calibrations) temperature should be verified.

6.8.2 Preparing YSI Pro Plus Probe and NIST Traceable Thermometer

The probe and thermometer should be lowered into a rinsed container with a sufficient volume of room temperature water to cover them. Cold tap water will slowly warm, making it difficult to get a stable temperature reading on both the probe and the thermometer, so it is best to use room temperature water.

6.8.3 Allowing Temperature to Stabilize

The analyst should wait about five minutes for the YSI Pro Plus probe and NIST traceable thermometer to adjust to the temperature of the water. The thermometers should not rest on the bottom or sides of the container.

6.8.4 Recording Temperature of YSI Pro Plus and NIST Traceable Thermometer

Values, date, time, and name of analyst should be recorded on a YSI Calibration Log Sheet for RIDEM YSI Pro Plus (Datasheet 3). Each meter has a log book located in the Sampling Center at A (figure 1), with the meter number on the cover of the book.

6.8.5 Temperature Acceptance Criteria

The YSI Pro Plus meter is accurate to within +/-0.35 degrees Celsius. The NIST traceable thermometer is accurate to within +/-1.0 degrees Celsius. If the reading on the meter is different from the reading on the thermometer by more than +/-1.0 degrees Celsius, then the meter is not within acceptance criteria. The thermometer and probe should be removed from the water and inspected to verify that the thermometer probe and the YSI Pro Plus probe are clean and not in disrepair. The probes should be placed back in the water for a second test. Once again, the analyst should wait five minutes for the temperatures to stabilize and monitor that the temperature of the water stays constant If the meter is still different from the thermometer by more than +/-1.0 degrees Celsius, the meter will need to be sent in for service, and the temperature probe will likely have to be replaced. See Section 6.12 for contact information.

6.9 THREE-POINT TEMPERATURE VERIFICATION PROCEDURE

This methodology is adapted from Radtke et. al 1998.

6.9.1 Required Frequency of Three-Point Temperature Verification

Temperature readings will be verified using the NIST traceable thermometer in accordance with proper procedures (Sections 6.9.2-6.9.14) at a frequency of three times per year, or every four months.

6.9.2 Documentation for Three-Point Temperature Verification

RIDEM YSI Pro Plus Three-Point Temperature Verification Log Sheets (Datasheet 4) should be used for this procedure. These forms are kept in the *YSI Pro Plus Meters Maintenance Records and Log Book* located in the Sampling Center at A (figure 1).

6.9.3 Preparing for Temperature Verification I

A container large enough to fit the YSI Pro Plus probe and the NIST traceable thermometer should be filled with a mixture of tap water and ice. Ice from the machine located in the Sampling Center is sufficient for this procedure (near F figure 1).

6.9.4 Temperature Verification I: Ice Water

Both the YSI Pro Plus probe and the NIST traceable thermometer should be immersed into the ice water (Figure 19). It will take at least two minutes to stabilize. The ice-water mixture should be stirred periodically to ensure that the temperature is uniform. Both the YSI Pro Plus probe and the NIST traceable thermometer need to be completely covered for a proper temperature reading.

Figure 19. YSI Pro Plus meter in ice/water bath with NIST traceable thermometer.

6.9.5 Recording Temperatures

The display for both meters should be easily readable. After a five minute stabilization period, three temperatures for both the YSI Pro Plus and the NIST traceable thermometer should be recorded on a RIDEM YSI Pro Plus Three-Point Temperature Verification Log Sheets (Datasheet 4).

6.9.6 Calculating and Comparing the Mean Temperatures

The mean temperature values of the three values read from the YSI Pro Plus and the NIST traceable thermometer should be calculated for each device and compared. The mean values should be within +/-1.0 degrees Celsius of each other.

6.9.7 Preparing for Temperature Verification II

The water should be set aside for at least one half hour to equilibrate to the temperature in the Sampling Center. The temperature should be near 25 degrees Celsius.

6.9.8 Temperature Verification II: Room Temperature Water

Both the YSI Pro Plus probe and NIST traceable thermometer should be immersed into the water. It will take at least two minutes to stabilize. The water should be stirred periodically to ensure that the temperature is uniform. Both the YSI Pro Plus probe and the NIST traceable thermometer need to be completely covered for a proper temperature reading.

6.9.9 Recording Temperatures

The display for both meters should be easily readable. After a five minute stabilization period, three temperatures for both the YSI Pro Plus and the NIST traceable thermometer should be recorded on the RIDEM YSI Pro Plus Three-Point Temperature Verification Log Sheets (Datasheet 4).

6.9.10 Calculating and Comparing the Mean Temperatures

The mean temperature values of the three values read from the YSI Pro Plus and the NIST traceable thermometer should be calculated for each device and compared. The mean values should be within +/- 1.0 degrees Celsius of each other.

6.9.11 Preparing for Temperature Verification III

Hot tap water should be used for this verification, with an aim for a temperature near 40 degrees Celsius. The water will slowly equilibrate to the temperature in the Sampling Center. To mitigate this effect, thermal protection, such as putting the water container into a cooler partially filled with packing material is helpful (figure 19).

6.9.12 Temperature Verification III: Hot Water

Both the YSI Pro Plus probe and NIST traceable thermometer should be immersed into the water. It will take at least two minutes to stabilize. The water should be stirred periodically to ensure that the temperature is uniform. Both the YSI Pro Plus probe and the NIST traceable thermometer need to be completely covered for a proper temperature reading.

6.9.13 Recording Temperatures

The display for both meters should be easily readable. After a five minute stabilization period, three temperatures for both the YSI Pro Plus and the NIST traceable thermometer should be recorded on a RIDEM YSI Pro Plus Three-Point Temperature Verification Log Sheets (Datasheet 4).

6.9.14 Calculating and Comparing the Mean Temperatures

The mean temperature values of the three values read from the YSI Pro Plus and the NIST traceable thermometer should be calculated for each device and compared. The mean values should be within +/- 1.0 degrees Celsius of each other.

6.10 FIELD MEASUREMENT PROCEDURES

The following sections describe the use of the YSI Pro Plus in the field to make measurements of field parameters. The procedures below should be followed unless project specific requirements require different methods.

6.10.1 Preparing YSI Pro Plus Probe for the Field

The meter should be transported using the carrying case (Figure 2). The sensor guard should always be used when taking field measurements because probes are easily damaged. The guard is screwed on to threaded area (Figure 20).

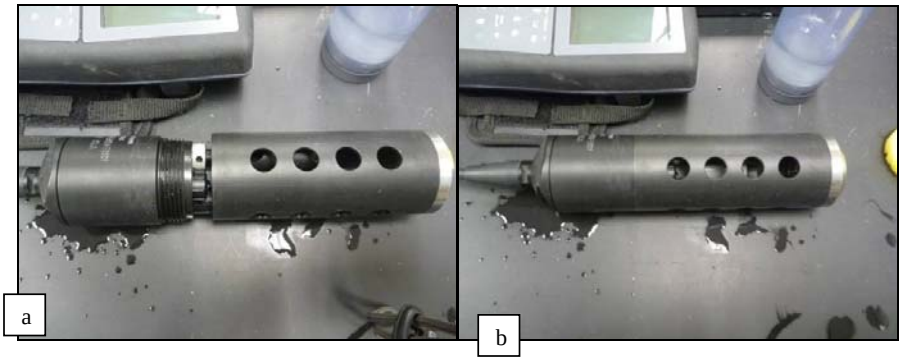


Figure 20. YSI Pro Plus sensor guard a) off and b) on.

6.10.2 Taking a Measurement in the Field

The YSI Pro Plus probe, with sensor guard on, should be lowered to a desired depth (surface, middle, or bottom of the water column). When recording the bottom measurement, the analyst should keep the electrode at least 0.5 feet above the bottom, unless shallow depths do not allow. The bottom substrate should not be disturbed prior to or during measurement. Because the electrolytic cell (for dissolved oxygen) consumes oxygen in the water during measurement, it may be necessary to agitate the probe up and down in the water column to ensure that water is actively passing across the membrane. This is particularly important when the probe is immersed in stagnant water. It is evident when this occurs because the dissolved oxygen value will slowly decrease. Once the probe is agitated, the value of dissolved oxygen will slowly increase to a steady maximum; this value should be recorded.

6.10.3 Recording Field Measurements

The YSI Pro Plus can be set to display a number of parameters on the screen at one time. Depending on project needs, it may be desirable to only display necessary parameters and hide others. The screen has the capacity to display no more than nine parameters, so the down arrow must be pressed to see additional values. The YSI Pro Plus has an “Auto-Range” function that automatically calculates the average of the values being measured by the probe and only displays that value. The YSI Pro Plus manual should be consulted on how to change the units that the meter displays.

6.10.4 Storing Values on the Internal Memory of the YSI Pro Plus

In certain circumstances it will be valuable to store values electronically on the internal memory of the YSI Pro Plus. This should not be a replacement for good field notes. The YSI Pro Plus can be programmed to store site names using the YSI Data Manager software. Instructions for the software package for this unit should be consulted, if the user wishes to store site names. In addition, cross-sectional data can be stored on the unit internally, and median values reported for field parameters in the database.

6.10.5 Storing YSI Pro Plus between Sites

The probe should be retracted from the water and shaken to remove excess sample water. Distilled or de-ionized water should be poured over the probe to rinse it, and excess water can be blotted away with a clean lint-free tissue. To minimize contamination of the storage water in the calibration cup and prevent

damage to the probes, the whole sensor end with sensor guard attached can slide into the grey rubber storage sleeve (Figure 21). This sleeve has a small round piece of sponge that should be damp to keep the probes from desiccating. The sponge should be changed periodically.

Figure 21. YSI Pro Plus with sensor guard and storage sleeve.

6.11 LONG-TERM OR WINTER STORAGE OF YSI PRO PLUS METER

RIDEM OWR ambient monitoring program measures water quality parameters using the YSI Pro Plus typically from April to October. Long term storage of the YSI Pro Plus during extended periods of disuse is vital to the operational life of the unit.

6.11.1 Uninstalling the Nitrate Probe

When uninstalling the Nitrate probe, the analyst should unscrew the probe from the sensor housing and place it in its original shipping container. In this shipping container there will be a bottle in KCl with a sponge, and a rubber cap that should be placed over the threaded end of the probe. (Figure 22).

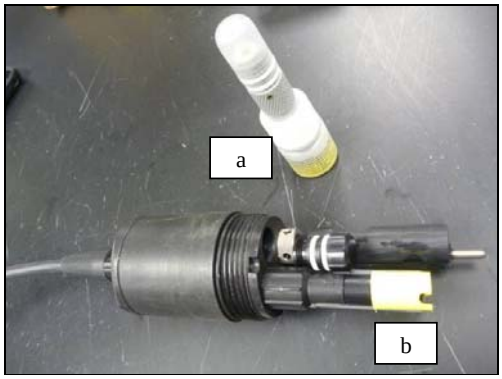


Figure 22. Sensor housing with a) Nitrate probe removed, and b) port plug ready to be uninstalled.

6.11.2 Uninstalling the pH Probe

When uninstalling the pH probe, the analyst should unscrew the probe from the sensor housing. O-rings should be coated with a small amount of grease, and the probe should be stored in pH 4 buffer in the container it was shipped in. (Figure 23).

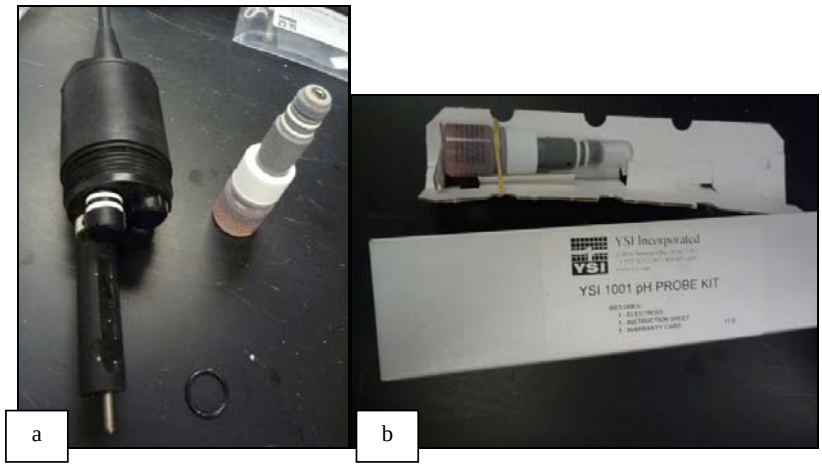


Figure 23. a) pH probe uninstalled from sensor housing and port plug partly installed, and b) pH probe attached to cardboard and ready to be stored in box.

6.11.3 Uninstalling the Dissolved Oxygen Probe

When uninstalling the dissolved oxygen probe, the analyst should unscrew the membrane cap from the dissolved oxygen probe, drain the probe's electrolyte, rinse it with de-ionized or distilled water, and allow it to dry (Figure 24). This procedure can be done with the probe installed or uninstalled from the sensor housing.

Figure 24. Dissolved oxygen probe uninstalled emptied, rinsed, and drying on a Kimwipe.

6.11.4 Storing the Calibration Cup

The calibration cup should be cleaned, dried, and screwed back on to the sensor housing (Figure 25).

Figure 25. Sensor housing with Nitrate and pH probes uninstalled and stored for the winter. Dissolved oxygen and temperature/conductance probe are installed and stored dry in the calibration cup.

6.12 ISSUES THAT CANNOT BE FIXED BY ANALYST

Occasionally issues will arise that cannot be fixed locally. In the case of meter malfunction, the manufacturer's customer service department should be consulted immediately for further information. Contact: Q.C. Services, Inc. P.O. Box 68, Harrison, Maine, 04040; telephone: (207)583-2980; website: www.qcservices.com; email: qcservices@gwi.net; shipping address: Q.C. Services, Inc. 8 Smith St, Harrison, Maine, 04040.

7.0 DOCUMENTATION

7.1 FIELD MEASUREMENTS

All calibration and field measurements will be recorded on the RIDEM YSI Field Data Collection Sheet for Monitoring Sampling Events (Datasheet 1).

7.2 CALIBRATION

Calibration documentation must be maintained in a thorough and consistent manner. Documentation of all calibration and maintenance operations shall be filled out on a Calibration Log Sheet for RIDEM YSI Pro Plus (Datasheet 2) in entirety and kept in the *YSI Pro Plus Meters Maintenance Records and Log Book* located in the Sampling Center.

8.0 DOWNLOADING FIELD DATA TO PC

The following instructions assume that the YSI data manager and cradle have already been installed on the user's personal computer. The instruction manual should be consulted to properly install software.

8.1 CONNECT YSI PRO PLUS TO CRADLE

The YSI Pro Plus should be slid onto cradle (Figure 26).

Figure 26. YSI Pro Plus and cradle.

8.2 OPEN YSI DATA MANAGER

YSI data manager can be activated by double clicking the desktop icon. The manual and online support documentation should be consulted for proper use of this software package.

9.0 REFERENCES

Lewis, M.E., 2006. Dissolved Oxygen. United States Geological Survey Techniques of Water Resources Investigations. Book 9, Chapter 6.1. Accessed 09/10/2012:

http://water.usgs.gov/owq/FieldManual/Chapter6/6.2_contents.html

Radtke, J.D., Kurklin, J.K., and Wilde, F.D., 1998. Temperature. United States Geological Survey Techniques of Water Resources Investigations. Book 9, Chapter 6.1. Accessed 08/23/2011:
http://www.commtec.com/Library/technical_papers/USGS/Section6.1.pdf.

YSI incorporated. 2009. YSI Professional Plus: User Manual. Yellow Springs Ohio, USA. http://www.ysi.com/media/pdfs/605596-YSI-ProPlus-User-Manual-RevD.pdf

Field Crew:	**Weather Conditions:**
YSI Instrument (circle one): #1 #2 #3 ProPlus	

Site ID												
Location Name												
Date												
Time												
Temp (°C)												
B. Pres. (mmHg)												
Saturation (%)												
DO (mg/L)												
SPC (µS/cm)												
pH												
Nitrate (mg/L)												
Photographs												
O.G.												
Flow												
Sample Method												
Comments												

Datasheet 1. RIDEM YSI Field Data Collection Sheet for Monitoring Sampling Events.

Meter Seria

Number

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

*

Calibration Log For RIDEM YSI-85

	Date	Time	membrane changed (yes / no)	Temperature reading (oC)	INITIAL D.O. reading %	INITIAL D.O. reading mg/L	Calibrated D.O. reading %	Calibrated D.O. reading mg/L	Ideal DO value mg/L (see table)	Difference between calibration reading and ideal value (100%) %	Difference between calibration reading and ideal value (100%) mg/L	Difference is within + 0.5 mg/L ? (yes/no)	Acceptable Calibration (Y/N, intials)
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													

QAQC			Temperature reading (oC)	Distilled water reading	Difference between reading and 0	1000 µS Standard Reading	Difference between reading and 1000	Ideal value (thermometer or standard)	Difference between reading and ideal value		Differences are within + 5 % Ideal Values ? (yes/no)	Acceptable Verification (Y/N, intials)
Verify temperature												
Verify conductivity												

* batteries should be changed every 12 field days; please note when batteries have been changed.

Datasheet 2. Daily Calibration Log Sheet for RIDEM YSI Pro Plus.

ProPlus Calibration Log

Date:	Analyst:		
Meter Serial Number:	Long Cord Meter: 11F100644		Short Cord Meter: 11F100645
Barometric Pressure (S/N 122006218)		**Specific Conductance**	
Temperature (°C)		Temperature (°C)	
Initial Reading (mmHg)		Standard (µS/L)	
Barometer Reading (mmHg)		Lot Number	
Reading after Calibration (mmHg)		Initial SPC Reading (µS/L)	
Dissolved Oxygen		Reading after Calibration (µS/L)	
Temperature (°C)		**Nitrate**	
B. Pres. (mmHg)		Temperature (°C)	
100% Saturated (chart)		1.0 mg/l Standard	
Initial DO Reading (mg/L)		Lot Number	
Reading after Calibration (mg/L)		Initial Reading (mg/L)	
Temperature (verification only S/N 102162086)		Reading after Calibration (mg/L)	
Meter Reading (°C)		Temperature (°C)	
NIST Thermistor Reading (°C)		10.0 mg/l Standard	
Difference (°C)		Lot Number	
Acceptable Calibration		Initial Reading (mg/L)	
pH (Uninstall nitrate probe before calibration!)		Reading after Calibration (mg/L)	
Temperature (°C)		Temperature (°C)	
4.0 Standard (pH)		100.0 mg/l Standard	
Lot Number		Lot Number	
Initial Reading (pH)		Initial Reading (mg/L)	
Reading after Calibration (pH)		Reading after Calibration (mg/L)	
Temperature (°C)			
7.0 Standard (pH)			
Lot Number			
Initial Reading (pH)			
Reading after Calibration (pH)			
Temperature (°C)			
10.0 Standard (pH)			
Lot Number			
Initial Reading (pH)			
Reading after Calibration (pH)			

Datasheet 3. Full Calibration Log Sheet for RIDEM YSI Pro Plus.

RIDEM OWR Thermometer Calibration Log Sheet

Date/Time: NIST Serial #:

Calibrator's Initials: YSI Meter #:

Ice Bath (0°C)	YSI Field Thermometer Temperature (°C)	NIST Thermometer Temperature (°C)	Comments
Reading #1			
Reading #2			
Reading #3			
Mean			
Difference Between Means			
Within 1.0°C? (Y/N)			

Room Temp Bath (25°C)	YSI Field Thermometer Temperature (°C)	NIST Thermometer Temperature (°C)	Comments
Reading #1			
Reading #2			
Reading #3			
Mean			
Difference Between Means			
Within 1.0°C? (Y/N)			

Warm Bath (40°C)	YSI Field Thermometer Temperature (°C)	NIST Thermometer Temperature (°C)	Comments
Reading #1			
Reading #2			
Reading #3			
Mean			
Difference Between Means			
Within 1.0°C? (Y/N)			

Datasheet 4. RIDEM YSI Pro Plus Thermometer Verification Log Sheet.