New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB)

Standard Operating Procedure (SOP) for

SONDE CALIBRATION AND MAINTENANCE

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Program Manager - Monitoring, Assessment and Standards Section

1.0 Purpose and Scope

The purpose of this standard operating procedure (SOP) is to describe calibration and maintenance of water quality monitoring sondes for the collection of instantaneous or unattended measurements. This procedure covers the use of the In-Situ Aqua TROLL® 600 sondes, Onset HOBO ® dissolved oxygen data loggers, and Onset HOBO ® conductivity data loggers. For procedures related to launching and deploying these loggers, refer to the SWQB SOP 6.2 Sonde Deployment. For procedures related to the upload of data from these loggers and data processing, refer to the SWQB SOP 6.4 Data logger and Upload.

2.0 Personnel Responsibilities

The Program Manager will provide input on the scope and intent of the SOP as it pertains to the program's goals and objectives. The Program Manager will ensure that sufficient resources are allocated to complete the program commitment to monitoring activities which support the protection of surface waters. The Program Manager coordinates with the Project Manager(s), Technical Staff, and the QAO as applicable to support the acquisition of data. The Program Manager, in coordination with the SME, and QAO, will determine if any revisions to this SOP are needed at a minimum of every two (2) years in accordance with SOP 1.1 Creation and Maintenance of SOPs (NMED/SWQB 2020).

Project Manager – responsible for organizing and planning data collection activities and ensuring monitoring activities adhere to applicable SOPs and Field Sampling Plans.

The QAO is involved in the development and revision of this SOP to ensure the SOP meets the requirements of the SWQB's Quality Assurance Project Plan. The QAO in coordination with the SME, and Program Manager, will determine if any revisions to this SOP are needed at a minimum of every two (2) years in accordance with SOP 1.1 Creation and Maintenance of SOPs (NMED/SWQB 2020). Pending the review and approval of the document, the QAO will ensure the SOP is accessible through the SWQB's website.

The Subject Matter Expert (SME) in coordination with the QAO, and Program Manager, will determine if any revisions to this SOP are needed at a minimum of every two (2) years in accordance with SOP 1.1 Creation and Maintenance of SOPs (NMED/SWQB 2020).

The Sonde Manager keeps a record of the disposition of each sonde or logger. A second individual designated as the "Alternate Sonde Manager" fulfills the manager's responsibilities when the manager is unavailable. For each SWQB Section the record of the disposition for the Section's sondes and loggers is located within either the "sonde tracker" spreadsheet for multiparameter sondes, or the "logger status" spreadsheet for temperature, conductivity and DO loggers. The "sonde tracker" spreadsheet records multiparameter sonde maintenance by ID and sonde probe maintenance/disposition by serial number. A separate "logger status" spreadsheet contains each logger listed by logger type (temperature, conductivity, and dissolved oxygen), serial number, current status of each logger (available for use, launched and awaiting deployment, deployed, or retrieved and awaiting offload), deployment location, person responsible for the sonde/logger, date of checkout, and any other pertinent logger disposition information. The Sonde Manager also keeps a record of the disposition of all logger-related accessories, such as optic shuttles and base stations in the "logger status" spreadsheet.

The Sonde Manager or Alternate Sonde Manager is responsible for:

- ensuring sondes are properly maintained and stored,
- maintaining the "Sonde Tracker" spreadsheet,
- maintaining the "Logger Status" spreadsheet (for conductivity and DO loggers),
- maintaining electronic deployment data files on NMED's internal server,
- maintaining hard copy deployment sheets,
- maintaining calibration sheets in binders stored in the laboratory,
- training field personnel, as needed, so they are capable of operating sondes, including calibration, post-deployment calibration verification, and data recording, and
- conducting sonde/logger quality control temperature accuracy checks.

Field Staff are responsible for:

- coordinating with the Sonde (or Alternate) Manager or Project Manager on the scope of the project and use of the equipment,
- investigating calibration and calibration verification failures and reporting equipment malfunction to the Sonde Manager or Alternate Sonde Manager,
- transferring sonde data off the instrument following long-term deployment in accordance with the SWQB's Data Logger and Upload SOP (SOP 6.4),
- ensuring equipment is cleaned and stored in accordance with this SOP,
- quality assurance (QA) of sonde data in accordance with the SWQB's Data Verification and Validation SOP (SOP 15.0),
- filing calibration sheets in binders stored in the laboratory and filing deployment/calibration/calibration verification sheets in the project binder,
- making copies of sonde calibration sheets to store with associated chemical sampling runs within the project binder,
- post-checking sondes and reporting post-deployment values on the calibration sheet, and,
- performing sonde calibration verification and data validation and verification, including flagging long-time deployment (unattended) data and grab data.

Bureau personnel who operate water quality monitoring sondes are responsible for ensuring that the sondes and loggers are properly calibrated, checked and maintained, and that the data are properly recorded in accordance with this SOP and shall acknowledge such by signing the *SOP 6.1 Sonde Calibration and Maintenance Acknowledgment Signature Form.*

3.0 Background and Precautions

3.1 Background

This Procedure is based on the capabilities of the of the In-Situ Aqua TROLL® 600, Aqua TROLL® 600 sondes and sensors, and the Onset HOBO® Dissolved Oxygen (DO) and Conductivity data loggers described in Section 5.0.

3.2 Procedural Precautions

Individuals using a sonde or data logger should have a thorough understanding of its proper use and care and be familiar with the instrument's operational manual in order to ensure data are not invalidated due to calibration or user error.

3.3 Safety Precautions

While the cleaning and calibration solutions used for maintenance of these instruments are generally non-hazardous, operators must have a signature for the Chemical Hygiene Plan (CHP) on file and be familiar with applicable Safety Data Sheets (SDS) stored in the laboratory. Operators must also have a signature for the Sampling Job Hazard Analysis on file and be aware of hazards that might be present, develop, and/or are unique to the position.

4.0 Definitions

Dissolved Oxygen (DO) logger – A water quality monitoring device that measures and records dissolved oxygen concentration, dissolved oxygen percent saturation, and temperature.

Conductivity logger – A water quality monitoring device that measures and records specific conductance and temperature.

Logger Tracking Spreadsheet – An Excel spreadsheet located within the monitoring team server folder used for documenting and tracking logger condition and status, deployment location, repairs, etc.

Monitoring, Assessment and Standards Section (MASS) – The Monitoring, Assessment and Standards Section of the Surface Water Quality Bureau consisting of three teams: The Monitoring Team, the Standards, Planning and Reporting Team and the TMDL and Assessment Team.

Program Manager – An individual within the SWQB that manages a program such as the Watershed Protection Section (WPS), the Point Source Regulation Section (PSRS) or the Monitoring, Assessment and Standards Section (MASS). The Program Manager and Project Manager are not necessarily synonymous.

Project Manager(s) – An individual responsible for a specific project identified in a field sampling plan or Sampling Analysis Plan. This individual, in most cases, holds a different title within the organization. The Program Manager and Project Manager are not synonymous. The Project Manager may be the same individual as the Subject Matter Expert.

Quality Assurance Officer (QAO) – An individual within the MASS that is responsible for overseeing the development and implementation of all quality assurance procedures and processes within the SWQB including those projects that receive support or funding from the SWQB.

Quality Assurance Project Plan (QAPP) – A formal planning document for environmental data collection activities that describes the data collection procedures and the necessary quality assurance and quality control activities that must be implemented to ensure that the results are sufficient and adequate to satisfy the stated performance criteria.

Sonde – A water quality monitoring device that is placed in the water to gather water quality data. Sondes usually have multiple sensors and are capable of recording or displaying multiple water quality parameters.

Sonde Manager – An individual within each Section (e.g., MASS, WPS) of the SWQB designated as the “Sonde Manager". The Sonde Manager is responsible for keeping a record of the disposition of each

Section's sondes or loggers. A second individual in each Section is designated as the "Alternate Sonde Manager" fulfills the sonde manager's responsibilities when the manager is unavailable.

Sonde Tracking Spreadsheet – An Excel spreadsheet located within the Monitoring Team server folder used for documenting and tracking sonde and probe condition, repairs, replacements, and other relevant information pertaining to sonde disposition.

Standard Operating Procedure (SOP) – A document that lists the steps that should be completed when doing a task.

Subject Matter Expert (SME) – A person who is familiar with the purpose and procedure for accomplishing a task. The SME may be the same individual as the Sonde Manager or the Project Manager.

Surface Water Quality Bureau (SWQB) – A Bureau under the Water Protection Division of the New Mexico Environment Department. The SWQB's mission is to preserve, protect, and improve New Mexico's surface water quality for present and future generations.

Surface Water Quality Information Database (SQUID) — The SWQB database for storing, retrieving and reporting environmental results which include laboratory results, field observations, biologic assemblage data, long-term datasets (LTD), summary data, and stream habitat/geomorphic data.

Watershed Protection Section (WPS) – The WPS (i.e. Nonpoint Source Section) contains four teams an Implementation and Restoration Team, a Wetlands Team, an NPS Effectiveness Monitoring Program and New Mexico Field Offices for NPS.

5.0 Equipment and Tools

5.1 Logger and Multiparameter Sonde Specifications

The multiparameter sondes operated by the SWQB are manufactured by In-Situ, Inc., while the dissolved oxygen and conductivity loggers are manufactured by Onset Computer Corporation.

In-Situ, Inc. 221 E. Lincoln Ave., Fort Collins, CO 80524 Phone: (800) 446-7488 Email: support@in-situ.com Internet: www.in-situ.com
Onset Computer Corporation 470 MacArthur Blvd Bourne, MA 02532 Mailing address: PO Box 3450, Pocasset, MA 02559-3450 Phone: (508) 759-9500 or (800) LOGGERS Fax: (508) 759-9100 Email: loggerhelp@onsetcomp.com Sales contact: sales@onsetcomp.com Internet: www.onsetcomp.com

The specific In-Situ model number is Aqua TROLL® 600. This instrument can be used with In-Situ's mobile app, VuSitu, for communication with Bluetooth enabled tablets and mobile devices. Sonde and sensors are described in Table 1. Instruction manuals for the sonde and sensors are available in the lab and on the SWQB file server. The following procedures are based largely on information in these manuals.

The specific Onset devices are the HOBO DO Logger model U26-001 and Conductivity Logger model U24-001, which both use the proprietary HOBOware Pro® software to communicate with a PC. Loggers and sensors are described in Table 1.

Table 1

Sonde/Logger and Sensor Characteristics

Logger Type/Sensor	Parameter	Units	Range	Accuracy
In-Situ Aqua TROLL® 600 Sonde				
63460	Temperature	°C	-5 to 50	± 0.10 °C
63460	Conductivity	µS/cm	0 – 350,000	± 0.5% of reading; ± 1 µS/cm for 0-100,000, ± 1% of reading for 100,000 to 200,000, ±2% of reading from 200,000 to 350,000 µS/cm
63450	Dissolved Oxygen	mg/L	0 – 60	± 0.1 mg/L for 0–20 mg/L; ± 0.2 mg/L for greater than 20 mg/L
63470	pH	SU	0 – 14	± 0.1 SU
63480	Turbidity	NTU	0 – 4,000	± 2% of reading; ± 0.5 NTU
AT600	Barometric Pressure	mbar	300 - 1,100	±1.0 mbar
AT600	Pressure (Depth)	m	0-9 0-30 0-76 0-200	±0.01% Full Scale Range
Onset DO Logger				
U26-001	Dissolved Oxygen	mg/L	0-30	0.2mg/L up to 8mg/L; 0.5 mg/L from 8 to 20mg/L
Thermistor	Temperature	°C	-5 to 40	± 0.2°C
Onset Conductivity Logger				
U24-001	Conductivity	µS/cm	0 – 10,000	± 3% of reading; ± 5 µS/cm
Thermistor	Temperature	°C	5 – 35	± 0.1 °C

5.2 List of Equipment Required for Sonde Calibration and Maintenance

Multiparameter Sondes:

- In-Situ Aqua TROLL® 600 sonde, complete with probe guard and the following sensors installed: pH, conductivity/temperature, dissolved oxygen, and turbidity, and a wiper or wiper port plug
- Smartphone or other Bluetooth enabled device with VuSitu software installed
- RDO Calibration Sponge
- **Sonde Calibration Worksheet or Sonde Deployment/Retrieval Field Sheet**
- Calibration solutions:
    - Deionized (DI) water
    - pH buffer solutions (e.g., pH 4.0, pH 7.0, pH 10.0) sufficient to bracket samples
    - Turbidity standards (e.g., 100 NTU, 1000 NTU) sufficient to bracket samples
    - Specific conductance standard (e.g., 1413 µS/cm) sufficient to bracket samples
- Barometer (integrated on Aqua TROLL® 600 sonde)
- Abrasion-free cleaning cloth (e.g., Kim wipe)
- Compressed air
- Standard solution rinsate containers
- Solution disposal containers
- Sonde maintenance kit (includes silicon grease, o-rings, hex key set for unlocking sonde sensors, pH junctions, junction fluid, etc.)
- Small flathead screwdriver

Dissolved Oxygen and Conductivity Loggers:

- Deionized (DI) water
- Alconox® or similar detergent (phosphate-free cleaner)
- White vinegar
- Cotton swabs
- Abrasion-free cleaning cloth (Kim wipe)
- Compressed air

- Onset HOBO DO Data logger
    - Communication coupler
    - Onset HOBO Base Station or Shuttle
    - Sponge
    - Replacement DO sensor cap kit (including O-rings, silicone grease, and alcohol wipe)
    - Calibration boot

- Onset HOBO Conductivity Data logger
    - Communication coupler
    - Onset HOBO Base Station or Shuttle

6.0 Step-by-step Calibration, Post-check, Maintenance, and Storage Procedures

6.1 General Sonde Calibration Information

6.1.1 Sonde Calibration Records

Sonde calibration should be conducted in the lab prior to each "sampling run" to ensure sensors and devices are working properly. Between unattended long-term sonde deployments and prior to redeployment, clean sonde sensors and recalibrate following the procedures below. Record calibration data on the **Sonde Calibration Worksheet**, which is available as part of this SOP and is available on the webpage under "related SOP forms." Sonde Deployment field sheets can also be used for recording calibrations if the sonde is being used for a long-term deployment; a copy of the sonde calibration worksheet is on the back side of the **Sonde Deployment/Retrieval Field Sheet**. Calibration records must not be discarded. Completed calibration worksheets should be filed in the sonde calibrations binder stored in the lab, and a copy of the calibration and completed post-check must be stored in project binders along with the data sheets for the stations at which the sonde was used. The sonde manager should annually remove from the lab calibration binder the calibration sheets older than 3 years past the date of project validation and verification.

6.1.2. Sonde and Logger Temperature Sensors

In-Situ sonde thermistors cannot be calibrated. Annually, or when a malfunction is suspected, check the temperature reading against a NIST traceable thermometer to ensure the instrument temperature readings are within an acceptable in-calibration range (±0.5 °C) (refer to section 8.1 and Table 4 for temperature accuracy check procedures).

DO and conductivity logger thermistors cannot be manually calibrated. Annually, or when a malfunction is suspected, check the temperature reading against a NIST traceable thermometer to ensure the instrument temperature readings are within an acceptable in-calibration range (±0.5 °C). Refer to section 8.1 and Table 4 for temperature accuracy check procedures and for determining whether logger thermistors fall within in-calibration range. If sensors readings do not fall within the ±0.5 °C limit when performing the temperature accuracy check, the instrument should be returned to the logger manager for evaluation and maintenance.

6.1.3. Conductivity Standards

Conductivity standards are very sensitive to contamination. Inscribe the date on the standard container when opening. Standards in bottles that are exposed to air expire one month after opening. Bulk standard in containers with a tap (does not get exposed to air) expires according to the manufacturer's expiration date inscribed on the container. Standard transferred from a bulk container to a smaller container needs the date of transfer on the smaller container and expires after one month. Expired standard can be used as a rinse before calibration with a non-expired standard.

Important: Always perform conductivity calibrations prior to calibrating pH, as pH standard is extremely conductive and contamination could skew calibration values.

6.1.4 pH Buffers

The pH buffers contain high concentrations of phosphate. Take care during calibration to avoid leaving traces of buffer on equipment or workspaces that could contaminate nutrient water

samples. Inscribe the date the container is opened and your initials on the container label. Bulk standard in containers with a tap that does not get exposed to air will be considered expired on the date indicated on the container. Standard transferred from a bulk container to a smaller container expires after six months, with the exception of pH 10.0 buffer which once opened expires within three months. Write the date of transfer on the smaller container. Expired standard can be used as a rinse before calibration with a non-expired standard.

6.1.5 Turbidity Standards

Inscribe the date the turbidity standard container is opened on the label. Standard expires 6 months from opening or by the manufacturer's expiration date listed on the container. Expired standard can be used as a rinse before calibration with a non-expired standard.

Prior to using any turbidity standard gently tilt the standard bottle upside down and then gently swirl the standard for approximately 30 seconds to re-suspend the formazin. Failure to do so will bias calibration low and future calibrations high using that standard container. When swirling turbidity standard, avoid vigorous mixing that may create any bubbles in the solution as this may affect the turbidity reading. When calibrating the turbidity sensor, take note if initial turbidity values seem too high for the sensor to be simply out of calibration. If using turbidity standard out of a mostly consumed bottle, try switching to a fresh bottle of solution before investigating the turbidity probe itself. Older yet non-expired bottles of solution can be used as rinse even if they were not mixed properly and are unusable for calibrations.

Important: Use only In-Situ brand or Hach StablCal formazin standards for calibrations rather than other polymer-suspension (e.g. AMCO) turbidity standards.

6.1.6 Two-Point versus Three-Point Calibration

For pH, a three-point calibration should be used to bracket ambient water quality if a two-point calibration is not sufficient or if the range of values is unknown or expected to vary greatly. Typically, a two-point calibration is sufficient for grab samples while a three-point calibration (if it is an option) is recommended for long-term deployments where values are expected to range outside of two-point calibration bracketing.

6.1.7 Calibration Range

In-calibration range limits are shown in Table 2. If sensors cannot be calibrated within these limits, the instrument should be returned to the sonde manager or alternate sonde manager for maintenance. Refer to section 8.1 on temperature accuracy check procedures for determining whether thermistors are within in-calibration range.

Table 2. In-Calibration and Interpolation Ranges for Sonde Calibration

Parameter	Standard	Standard Value	In-Calibration Range	Linear Interpolation Range (Max Allowable Limits)
Temperature, °C	NIST Traceable Thermometer	Ambient Temperature	± 0.5 °C	± 2 °C
Conductivity, µS/cm	Standard Solution	1413 µS/cm	± 5%	± 30%

Dissolved Oxygen, %	Saturated Air	100 %	± 5%	± 30%
pH, s.u.	Buffer Solution	4.0, 7.0, 10.0	± 0.2	± 1
Turbidity, NTU	DI Water	0 NTU	± 1 NTU	± 10 NTU
	Standard Solution	100 NTU	± 5 NTU	± 30 NTU
		1000 NTU	± 50 NTU	± 300 NTU

Parameter	Corrected Qualifier (LTD only)	Rejected Qualifier
Temperature, °C	**CT**	**RT**
Conductivity, µS/cm	**CSC**	**RSC**
Dissolved Oxygen, %	**C%**	**R%**
Dissolved Oxygen, mg/L	**CDO**	**RDO**
pH, s.u.	**CPH**	**RPH**
Turbidity, NTU	**CY**	**RY**

6.1.8 Connecting to an In-Situ Sonde using a Bluetooth-Enabled Handheld Device

Connect to Aqua TROLL® 600 series multiparameter sondes via Bluetooth using a smartphone or a tablet with the VuSitu application installed.

A. Open the VuSitu app on the handheld device.
B. Invert the sonde for 3 seconds to turn on the sonde. The digital screen on the sonde will illuminate when the sonde is turned on.
C. Establish a Bluetooth connection with the sonde by navigating to the Bluetooth menu on the handheld device and scanning for available devices. To pair the sonde with the handheld device select the sonde's serial number (which can be found inscribed on the side of the sonde) from the list of available devices.
D. Within the VuSitu app tap the VuSitu menu icon located on the top left and select **Connected Instrument** from the list. If the sonde does not appear as a connected instrument, select **Choose or Add a Device** from the options and select the sonde out of the list of available connections. Once the sonde is connected to the handheld device it is ready for calibration, software updates, or live readings. Refer to the quick start guide or the operator's manual for the manufacturer's connection instructions and field operation instructions. (In-Situ, 2017 and 2019). For live readings or deployments refer to the SWQB SOP 6.2 Sonde Deployment.

6.1.9 Preparing a Sonde for Calibration

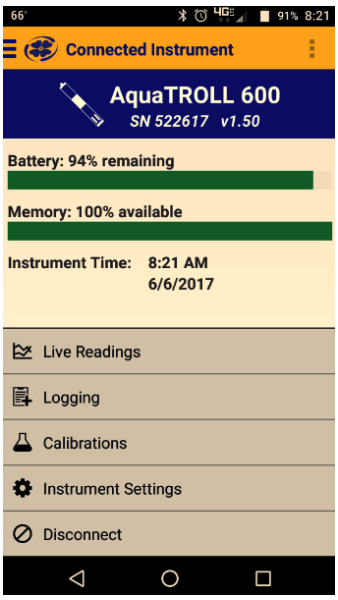
When preparing a sonde for calibration, rinse all sensors and the entire inside of the calibration cell once with DI water. This can be done by adding water to the cup while holding the sonde upright and gently swirling so that the water comes in contact with all areas of the sonde sensors and cup. Next, rinse twice with the calibration standard by adding standard into the cup and gently swirling so the standard makes contact with all areas of the sonde sensors and cup before discarding. Be certain to avoid cross-contamination of standard solutions as this may bias calibrations. Fresh standard used for the calibration may be placed in a labeled rinse container and used as rinse solution for subsequent calibrations.

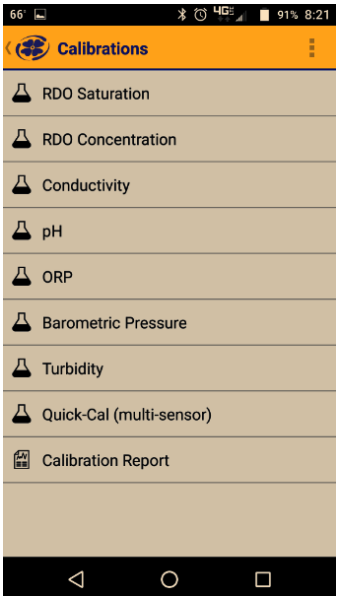
6.2 In-Situ Multiparameter Sonde Calibration Procedures

6.2.1 In-Situ Dissolved Oxygen Calibration Procedure

Upon arriving at a field sampling location, dissolved oxygen (DO) should be field calibrated to local barometric pressure to ensure accurate measurements. Record DO field calibration data on the site-specific **Field Data Form** or on the **Sonde Deployment/Retrieval Field Sheet** *or* **Calibration Worksheet**. When collecting sonde grab data, changes in elevation greater than 500 feet (152 meters) require a recalibration to local barometric pressure.

A. Follow the procedures outlined in section 6.1.8 to establish a connection between the Bluetooth handheld device and the sonde.
B. Within the VuSitu app tap the VuSitu menu icon and select **Connected Instrument** from the list. Select **Calibrations**. Select **RDO saturation**. Select **100% Saturation**.

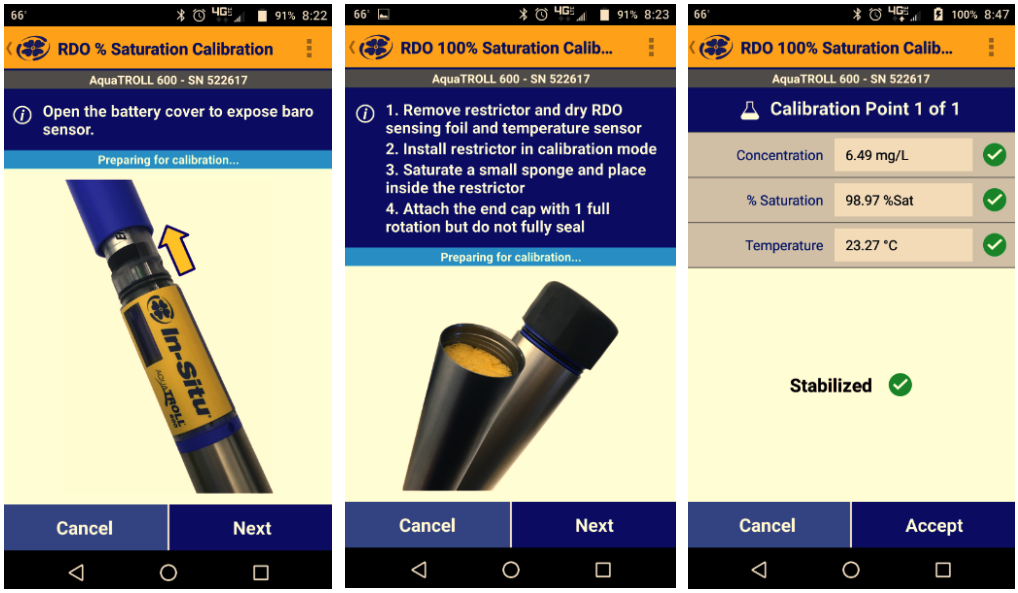




C. Follow the step by step prompts in the app. Remove the sonde restrictor and blue end cap and thoroughly dry the RDO sensing foil and thermistor. Place the sonde restrictor back on the sonde, ensuring that it is placed in calibration mode (i.e. restrictor openings are located opposite of the sensors, so the restrictor forms a calibration cup for holding liquid).
D. Follow prompts in the app to set the barometric pressure on the sonde by opening the battery cover (twist off plastic battery compartment cover opposite of the restrictor) and exposing the barometer. Barometric pressure will appear on the sonde digital screen. Wait for the pressure to stabilize, indicated by a check mark next to the pressure, before replacing and tightening the battery cover. Record the barometric pressure on the **Sonde Calibration Worksheet**.
E. Gently place a dampened RDO calibration sponge into the bottom of the restrictor, leaving ample space between the sponge and the sensors. Attach the end cap by turning it ***only*** *one full rotation*. Allow 5 to 10 minutes to reach 100% saturation of the air within the sonde calibration chamber. In VuSitu, tap **Next**.

Important: *Do NOT* fully seal the end cap on the restrictor as this may cause a build-up of pressure within the calibration cell and provide inaccurate readings. Also note that the

sensing element and thermistor should be dry. Make certain that the sponge is only damp, not dripping water onto the sensors. If there are water droplets on the sensor foil it can cause the calibration to be skewed very high.



F. Wait ample time to allow the DO and temperature readings to stabilize. Once the concentration, % saturation, and temperature have all stabilized (indicated by a green check mark next to each parameter) record the pre-calibration values on the **Sonde Calibration Worksheet** and tap **Accept** to complete calibration.

G. Record the post-calibration dissolved oxygen values from the automatically generated calibration report in VuSitu on the post-calibration section of the **Sonde Calibration Worksheet** and indicate that the calibration passed (i.e. was in-calibration range according to Table 2) on the pass/fail portion of the worksheet. If the calibrated value is out of range write “fail” and begin troubleshooting the error or retry calibration. As a last-resort, a restoration of factory calibration defaults may solve calibration problems. To restore factory calibration defaults, select **Restore Calibration Defaults** under **Instrument Settings** (*IMPORTANT NOTE:* Do not choose **Restore Factory Settings**) and follow the instructions. Return the sonde to the sonde manager for maintenance and troubleshooting if errors persist.

6.2.2 In-Situ Specific Conductance Calibration Procedure

A. Follow the procedures outlined in section 6.1.8 to establish a connection between the Bluetooth handheld device and the sonde.

B. Within the VuSitu app tap the VuSitu menu icon and select **Connected Instrument** from the list. Select **Calibrations**. Select **Conductivity**.

C. Prepare the sonde for calibration by removing the blue end cap from the restrictor and ensuring that the restrictor is placed in calibration mode. Rinse all sensors and the entire inside of the calibration cell once with DI water.

D. With the restrictor in calibration mode and the sonde inverted pour 10-20 mL (1/2” above the sensor face) of conductivity standard on top of the sensors. Holding the sonde vertically,

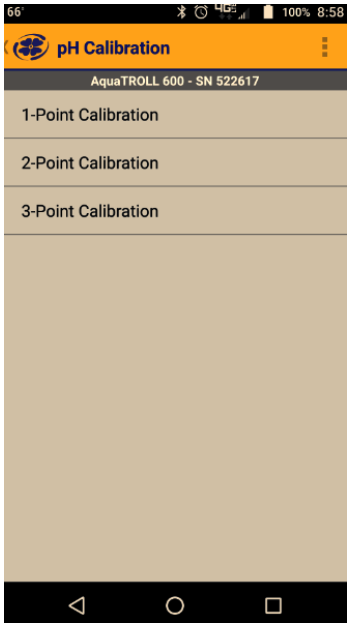
swirl the solution so that it makes contact with all areas of the sensors and the restrictor. It may be necessary to reinstall the end cap while gently swirling to ensure a good rinse. Discard the rinse standard and repeat once.

E. Pour 40-50mL of fresh standard (to the bottom of the threads) into the calibration cell. Make sure that the calibration solution is approximately 1 inch above the surface of the sensor face. Check the sensors for bubbles. Gently swirl the standard to remove any bubbles. In VuSitu, tap **Next**.
F. The VuSitu application will auto-detect the standard that is being used. If it fails to detect the correct standard, the correct value can be manually entered when prompted.
G. Once the conductivity values and temperature have stabilized (indicated by green checkmarks next to each parameter), record the pre-calibration values for specific conductivity and temperature on the **Sonde Calibration Worksheet** and tap **Accept** to complete the calibration.
H. Record the post-calibration conductivity values from the automatically generated calibration report in VuSitu on the post-calibration section of the **Sonde Calibration Worksheet** and indicate that the calibration passed on the pass/fail portion of the worksheet. If the calibrated value is out of range write “fail” and begin troubleshooting the error or retry calibration. As a last-resort, a restoration of factory calibration defaults may solve calibration problems. To restore factory calibration defaults, select **Restore Calibration Defaults** under **Instrument Settings** (*IMPORTANT NOTE:* Do not choose **Restore Factory Settings**) and follow the instructions. Return the sonde to the sonde manager for maintenance and troubleshooting if errors persist.

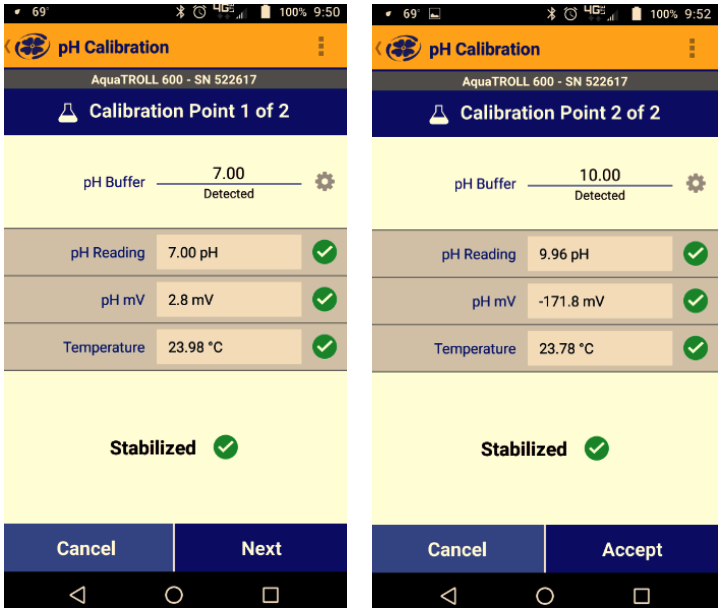
6.2.3 In-Situ pH Calibration Procedure

Calibrate the pH sensor with buffers of pH 7.0, and either pH 4.0 for acidic waters or pH 10.0 for alkaline waters. If the expected pH of the water being sampled is unknown, then a 3-Point calibration should be performed in the following order: pH 7.0, 4.0, then 10.0. For most watersheds within the state a pH 4.0 calibration is not necessary (the most well-known acidic stream in NM is Sulphur Creek in the Jemez River watershed); most waters in the state are alkaline and will only require a two-point calibration with pH 7.0 and pH 10.0. All two-point calibrations should begin with pH 7.0.

A. Follow the procedures outlined in section 6.1.8 to establish a connection between the Bluetooth handheld device and the sonde.
B. Within the VuSitu app tap the VuSitu menu icon and select **Connected Instrument** from the list. Select **Calibrations**. Select **pH**. Select either **2-point** or **3-point Calibration**.



C. Prepare the sonde for calibration by removing the blue end cap from the restrictor and ensuring that the restrictor is placed in calibration mode. Rinse all sensors and the entire inside of the calibration cell once with DI water.
D. Pour 10-20 mL (1/2” above the sensor face) of pH buffer on top of the sensors. Holding the sonde vertically, swirl the solution so that it makes contact with all areas of the sensors and the restrictor. It may be necessary to reinstall the end cap while gently swirling to ensure a good rinse. Discard the rinse standard and repeat once.
E. Pour 40-50mL of fresh standard (to the bottom of the threads) into the calibration cell. In VuSitu, tap **Next**.
F. The application will auto-detect the pH standard being used. If it does not the value can be entered manually. Wait for the sensor reading to stabilize. Once the sensor has stabilized (indicated by a green check mark next to pH, mV, and temperature) record the initial pH reading, mV, and temperature on the **Sonde Calibration Worksheet** and tap **Next** to continue the pH calibration. Discard the standard.



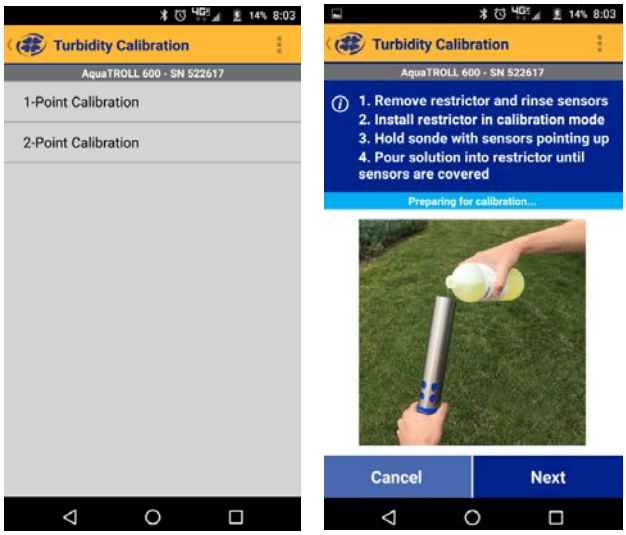
G. Repeat steps C – F with the next standard. If performing a 2-point calibration, calibrate in the following order: pH 7.0, then either pH 10.0 or pH 4.0. If performing a 3-point calibration, calibrate in the following order: pH 7.0, pH 4.0, then pH 10.0. Continue recording initial values on the **Sonde Calibration Worksheet** but note that the post-calibration values for each standard will not be available until the entire calibration is complete and the calibration report is generated. After the last calibration has been performed, select **Accept** to generate the calibration report.

H. Record all post-calibration pH values from the automatically generated calibration report in VuSitu on the **Sonde Calibration Worksheet** and indicate that the calibration passed on the pass/fail portion of the worksheet. If the calibrated value is out of range write “fail” and begin troubleshooting the error or retry calibration. As a last-resort, a restoration of factory calibration defaults may solve calibration problems. To restore factory calibration defaults, select **Restore Calibration Defaults** under **Instrument Settings** (*IMPORTANT NOTE:* Do not choose **Restore Factory Settings**) and follow the instructions. Return the sonde to the sonde manager for maintenance and troubleshooting if errors persist.
NOTE: The post calibration value may not be exactly the value of the buffer, depending on temperature.

6.2.4 In-Situ Turbidity Calibration Procedure

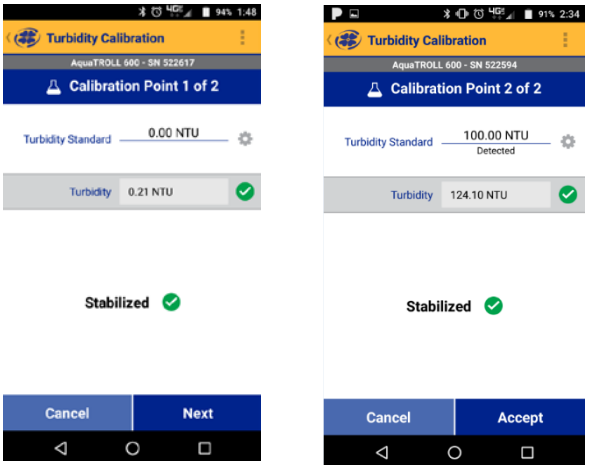
A. Follow the procedures outlined in section 6.1.8 to establish a connection between the Bluetooth handheld device and the sonde.

B. Within the VuSitu app tap the VuSitu menu icon and select **Connected Instrument** from the list. Select **Calibrations.** Select **Turbidity**. Select **2-point Calibration**.



C. Always start with the calibration of 0 NTU, using DI water. Prepare the sonde for calibration by removing the blue end cap from the restrictor and ensuring that the restrictor is placed in calibration mode (i.e. restrictor openings are located opposite of the sensors).
D. Rinse all sensors and the entire inside of the calibration cell with DI water. Add 10-20 mL of DI water to the restrictor and swirl or invert the sonde so that the water comes in contact with all areas of the sonde sensors and restrictor. It may be necessary to reinstall the blue cap while gently swirling to ensure a good rinse. Discard the DI and repeat.
E. Pour 40-50mL of DI water (to the bottom of the threads) into the restrictor. Tap **Next**.
F. The VuSitu application will auto-detect the standard being used. If it fails to detect that 0 NTU (DI water) is being used, the correct value can be manually entered when prompted (this is typically the case with DI water).
G. Once the application indicates that the sensor has stabilized (indicated by a green checkmark) record the pre-calibration turbidity value on the **Sonde Calibration Worksheet** and tap **Next** to continue the calibration. Discard the DI water.
H. Pour 10-20 mL of rinse 100 or 1,000 NTU standard (or whichever value is being used for calibration) on top of the sensors. Move the sonde around to allow the standard to make contact with all areas of the sensors and the restrictor. It may be necessary to reinstall the blue cap while gently swirling to ensure a good rinse. Discard the rinse standard and repeat. Note: the rinse standard must be the same value as the calibration standard.
I. Gently swirl and/or invert the bottle of fresh standard for approximately 30 seconds to mix the suspension. ***DO NOT* shake the bottle of standard!** This will suspend air bubbles in the solution and change the turbidity of the standard.
J. Pour 40-50mL of fresh standard (to the bottom of the threads) into the calibration cell.
K. The application will auto-detect the turbidity standard being used. If it does not the correct value can be entered manually. Wait for the sensor reading to stabilize.
L. Once the application indicates that the sensor has stabilized, record the pre-calibration turbidity value on the **Sonde Calibration Worksheet** and **Accept** the calibration. Discard the standard.
M. After the 2-point calibration is complete, VuSitu will generate an updated **calibration report**. Record the turbidity post-calibration values from this report on the **Sonde Calibration Worksheet** and indicate that the calibration passed on the pass/fail portion of the worksheet. If the calibrated value is out of range write “fail” and begin troubleshooting the

error or retry the calibration. As a last-resort, a restoration of factory calibration defaults may solve calibration problems. To restore factory calibration defaults, select **Restore Calibration Defaults** under **Instrument Settings** (*IMPORTANT NOTE:* Do not choose **Restore Factory Settings**) and follow the instructions. Return the sonde to the sonde manager for maintenance and troubleshooting if errors persist.

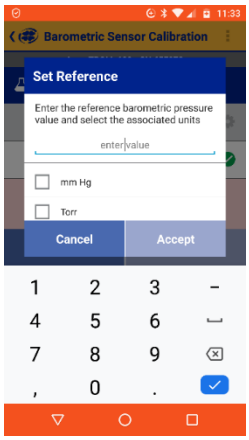


6.2.5 In-Situ Barometric Pressure Calibration Procedure

A barometric pressure calibration should be performed periodically to ensure that dissolved oxygen saturation can be properly calibrated. The SWQB will perform barometric pressure calibrations annually prior to field use and during the field season when anomalous values are observed or barometric readings in the lab deviate from expected values. Barometric pressure calibrations for each sonde used for fieldwork will be documented on the "sonde tracker" spreadsheet, indicating the date the calibration was performed, the technician, and the reference barometric pressure used. The reference barometric pressure used to calibrate sonde barometers will be obtained using an external barometer, not another sonde.

A. Follow the procedures outlined in section 6.1.8 to establish a connection between the Bluetooth handheld device and the sonde.
B. Within the VuSitu app, tap the VuSitu menu icon and select **Connected Instrument** from the list. Select **Calibrations**. Select **Barometric Pressure**.
C. Follow the on-screen prompt to open the battery cover to expose the sonde's internal barometric pressure sensor to ambient pressure. Allow the pressure on the sonde screen to update and stabilize (indicated by a check mark next to the pressure value). Leave the battery cover open during the calibration.

D. A dialog box will appear on the Vu Situ screen for **Set Reference** value. Choose the appropriate units and enter the reference barometric pressure (not normalized to sea level) provided by an external barometer. Tap **Accept**.



E. Once the sonde barometric pressure has stabilized, tap **Accept** again.

F. Close the battery cover.
Note: If the sonde sounds an audible signal and the sonde screen instructs you to close the battery cover before you have completed the calibration process, do not do so until you have accepted the calibration.

6.2.6 Depth Sensor Calibration

In-Situ sondes with depth sensing capability have an external water pressure (proxy for depth) sensor that should be calibrated to zero depth within ambient air at the barometric pressure at which the sonde is being immediately used for depth sensing capabilities (i.e. if the sonde is being used to measure a lake's depth, then calibrate for zero depth while at that specific lake). **Note:** Not all of the SWQB sondes have this capability. If the sonde has depth sensing capability it will be indicated as "vented" or "non vented" to a certain depth beneath the serial number inscribed on the sonde body. If a sonde does not have depth sensing capability this will be indicated as "no pressure" beneath the sonde serial number. Ensure that In-Situ depth readings are within one meter of the marked instrument cable or tagline. If not, use the marked cable or tagline to determine profiling and sample depths.

The Aqua TROLL® 600 sonde uses its pressure reading and specific gravity value to calculate sonde depth. The pressure sensor is located at the center of the instrument, but depth is reported at the smart sensor faces. An embedded gyroscope compensates for the distance between these sensors and allows the sonde to be deployed in any orientation (vertical, horizontal, angled).

A. Follow the procedures outlined in section 6.1.8 to establish a connection between the Bluetooth handheld device and the sonde.

B. Within the VuSitu app, tap the VuSitu menu icon and select **Connected Instrument** from the list. Select **Calibrations**. Select **Level**.

C. Follow the on-screen prompt to open the battery cover to expose the sonde's internal barometric pressure sensor to ambient pressure. Allow the pressure on the sonde screen to update and stabilize (indicated by a check mark next to the pressure value).
D. Follow the on-screen prompt to expose the external water/air pressure sensor to the atmosphere (ambient air). Tap **Next.**
E. Allow Zero-in-Air calibration to stabilize. When it is stabilized a green screen with a "stabilized" message and check mark will appear and the barometric pressure displayed will also have a green checkmark next to it. Tap **Accept**.
F. If calibration is not successful or out of range, use a tagline or marked cable for determining depths and not the depth sensor.

Note: If the barometric pressure has recently been updated the sonde will not prompt the user to remove the battery cover to reset barometric pressure. If the sonde is being used to measure level at a different location than where barometric pressure was last reset (>500 feet elevation difference), force a barometric pressure reset on the sonde by exiting out of the calibrations menu and simply opening the battery compartment and allowing the barometric pressure reading on the sonde body's screen to stabilize (indicated by a check mark next to the value) before closing the battery compartment. After this is complete, re-attempt the "Level" calibration for the new location.

6.3 Multiparameter Sonde Calibration Verification

Calibration verifications, sometimes referred to as "post checks" will be conducted following grab data collections during sampling runs and during or after long-term deployments. The purpose of a calibration verification is to check for instrument drift and ensure the accuracy of field readings. Calibration verifications are conducted by viewing the sonde's live readings in a calibration standard or buffer or in 100% saturated air for DO. Do not clean the sonde prior to conducting the calibration verification. Fill out the bottom half of the **Sonde Calibration Worksheet** under "Calibration Verification." If a sonde was taken into the field and not used, write "Not Used" on the Calibration Verification section of the **Sonde Calibration Worksheet**.

Calibration verifications can be done in the field or in the lab. Take care to not remove biofouling from the sonde prior to or during calibration verification. Gently rinse all sensors and the entire inside of calibration cup once with DI or tap water. Next, rinse twice with the calibration standard by adding standard into the calibration cell and gently swirling the sonde while holding it upright so the standard makes contact with all areas of the sonde sensors before discarding. Be certain to avoid cross-contamination of standard solution with other solutions. Fill the cup with fresh standard and allow to stabilize. Record the required sensor readings in the Calibration Verification section of the **Sonde Calibration Worksheet** and apply the correct qualifier code if it is out of range (see Table 2 and the SWQB SOP 15.0 on validation and verification procedures).

Calibration verification results that are not within the in-calibration range will be investigated by the operating technician and reported to the Project Manager and/or Sonde Manager. Calibration verification results that fail to meet the in-calibration range after troubleshooting should be indicated as such on the **Sonde Calibration Worksheet** *or* **Sonde Deployment/Retrieval Field Sheet**. The qualifier codes in Table 2 only apply to long-term deployment calibration verifications. For sondes that were only used for grab data indicate "fail" on the calibration verification next to the parameter that failed and the out-of-range reading. Sondes that failed calibration verification and were used for grab data will be

investigated during the validation and verification process and data from the sonde may be either rejected or qualified using the validation codes from the SWQB SOP 15.0 Validation and Verification.

6.3.1 Dissolved Oxygen Calibration Verification

For Dissolved Oxygen (DO), it is recommended that calibration verifications be completed in the field at the last site of a sampling run or upon retrieval or interim download from a long-term deployment site. Ideally, DO saturation calibration verifications should be performed at the same elevation (barometric pressure) at which the sonde was field calibrated. If performing the DO saturation calibration verification off site at a different elevation, use the USGS Dissolved Oxygen Tables (located at: (https://water.usgs.gov/software/DOTABLES/ or available from the sonde manager) to calculate percent saturation using concentration, temperature, and barometric pressure.

A. When conducting a calibration verification for dissolved oxygen, make sure that the DO sensing foil is dry and install a saturated sponge into the restrictor (see DO calibration section 6.2.1). Make sure it is damp and not dripping.
B. Install the end cap with *one* full rotation. Do not tighten. Allow 5 to 10 minutes to reach 100% saturation of the air within the chamber.
C. Establish a connection with the sonde in the VuSitu App (see section 6.1.8). Select **Live Readings**. After the sonde has stabilized (i.e. values are not fluctuating) record the DO values and temperature in the post-check section of the **calibration worksheet**. If DO values are out-of-range indicate a "fail" for the calibration verification and add a qualifier code, as applicable.
    a. DO saturation calibration verifications performed in the field at the same elevation where the sonde was field calibrated should be within ± 5% of the calibrated value (Table 2).
    b. DO saturation calibration verifications performed off-site or in the lab will require the use of a Dissolved Oxygen Table to determine the correct percent concentration. When performing a DO % saturation calibration verification using this method, follow the above procedures for beginning a DO calibration verification. Once the **live reading** temperature and DO concentration (mg/L) have stabilized, record these values on the calibration verification section of the worksheet, along with the barometric pressure. Then, use the DO table to find the "expected" DO concentration (mg/L) (based on 100% solubility) at the recorded temperature, and current barometric pressure. Divide the live reading DO concentration written on the worksheet by this "expected" DO concentration and multiply by 100 to find the "true" DO percent saturation. Record this number as the DO percent saturation on the worksheet. This percent saturation is then compared to Table 2 to determine whether a qualifier should be applied, or if the calibration verification passes or fails to fall within in-calibration or interpolation ranges.

Example:

Calibration Verification		Date/Time:	6/22/20 12:30		Technician:	MZ	
Dissolved Oxygen at Retrieval		**Temperature (°C)**	**Pressure (mmHg)**	**DO Gain**	**QA Criteria**		**P/F Qua**
%	mg/L						
97.58	6.45	22.51	586.1	NA	Pass: ± 5% Interpolation: ± 30%		P

Dissolved Oxygen Table:

Temp. (deg C)	Barometric Pressure (mm Hg) 575	580	585	590
20	6.83	6.89	6.95	7.01
20.5	6.76	6.82	6.88	6.94
21	6.69	6.75	6.81	6.87
21.5	6.62	6.68	6.74	6.8
22	6.56	6.62	6.68	6.74
22.5	6.49	6.55	6.61	6.67
23	6.43	6.49	6.55	6.61

$$\frac{"observed\ concentration"}{"expected\ concentration"} = \frac{6.45\ mg/L}{6.61\ mg/L} \times 100 = 97.58\%\ \text{saturation}$$

D. If the DO calibration verification reading is within the in-calibration range, write "pass" or "P" in the pass/fail section of the calibration worksheet. If the DO calibration verification reading is not within the in-calibration range and the sonde was not used for long term deployment, write “fail” or "F" in the pass/fail section of the **Sonde Calibration Worksheet** (see Table 2 and the SWQB SOP 15.0). Grab-data cannot be interpolated, thus the sonde must be within in-calibration range. Grab-data that were collected using a sonde that failed a post-check will be examined during the data validation and verification process and the appropriate data qualifiers applied at that time using the SWQB SOP 15.0. If the sonde was used for long term deployment and the DO calibration verification reading is between the in-calibration range and the linear interpolation range, record the parameter-specific code for correction (C% and CDO) in the pass/fail section of the **Sonde Calibration Worksheet**. If the long-term deployment calibration verification is not within the linear interpolation range, record the parameter-specific code for rejection (R% and RDO) in the pass/fail section of the **Sonde Calibration Worksheet**.

6.3.2 Specific Conductance Calibration Verification

Always perform specific conductance calibration verifications prior to pH calibration verification due to the high conductance of pH buffers.

A. Gently rinse all sensors and the entire inside of calibration cup once with DI or tap water.
B. Next, rinse twice with conductivity standard by adding standard into the calibration cell and gently swirling the sonde while holding it upright so the standard makes contact with all areas of the sonde sensors before discarding.
C. Fill the cup with fresh conductivity standard. In VuSitu, select **Live Readings** and allow specific conductivity value and temperature to stabilize.
D. Record the required sensor readings in the Calibration Verification section of the **Sonde Calibration Worksheet** and apply the correct qualifier code if it is out-of-range. If the specific conductance calibration verification reading is within the in-calibration range, write "pass" or "P" in the pass/fail section of the calibration worksheet. If the calibration verification is not within the in-calibration range and was not used for long-term deployment, write “fail” in the pass/fail section of the **Sonde Calibration Worksheet** (see Table 2 and the SWQB SOP 15.0). If the sonde was used for long term deployment and the specific conductance calibration verification reading is between the in-calibration range and

the linear interpolation range, record the parameter-specific code for correction (CSC) in the pass/fail section of the **Sonde Calibration Worksheet**. If the long-term deployment calibration verification is not within the linear interpolation range, record the parameter-specific code for rejection (RSC) in the pass/fail section of the **Sonde Calibration Worksheet**.

E. Discard the standard.

6.3.3 pH Calibration Verification

Calibration verification for pH is required for both pH 7.0 and 10.0 for all grab data and deployments. If pH values of less than 7.0 were observed, then a calibration verification of pH 4.0 must also be conducted. Take care to not remove biofouling from the sonde prior to or during the calibration verification.

A. Gently rinse all sensors and the entire inside of calibration cup once with DI or tap water.
B. Next, rinse twice with pH 7.0 standard by adding standard into the calibration cell and gently swirling the sonde while holding it upright so the standard makes contact with all areas of the sonde sensors before discarding.
C. Fill the cup with fresh pH 7.0 standard. In VuSitu, select **Live Readings** and allow pH value to stabilize.
D. Record the required sensor readings in the Calibration Verification section of the **Sonde Calibration Worksheet** and apply the correct qualifier code if it is out-of-range. If the pH calibration verification reading is within the in-calibration range, write "pass" or "P" in the pass/fail section of the calibration worksheet. If the calibration verification is not within the in-calibration range and was not used for long term deployment, write “fail” in the pass/fail section of the **Sonde Calibration Worksheet** (see Table 2 and the SWQB SOP 15.0). If the sonde was used for long term deployment and the pH calibration verification reading is between the in-calibration range and the linear interpolation range, record the parameter-specific code for correction (CPH) in the pass/fail section of the **Sonde Calibration Worksheet**. If the long-term deployment calibration verification is not within the linear interpolation range, record the parameter-specific code for rejection (RPH) in the pass/fail section of the **Sonde Calibration Worksheet**.
E. Discard the pH 7.0.
F. Repeat steps A-E for the second and possibly third pH values. If required, perform a pH 4.0 post-check before performing a pH 10.0 post-check.

6.3.4 Turbidity Calibration Verification

Turbidity calibration verification for sonde grab data should be conducted for 0 NTU with DI water and a high range of at least 100 NTU using turbidity standard. Turbidity post checks for a sonde after a long-term deployment should be conducted with 0 NTU (DI water) and a high range of at least 100 NTU. It is recommended to perform calibration verifications with the same standard values used during calibration.

A. Gently rinse all sensors and the entire inside of calibration cup twice with DI water.
B. Fill the cup with fresh DI water. In VuSitu, select **Live Readings** and allow turbidity value to stabilize.

C. Record turbidity value in the Calibration Verification section of the **Sonde Calibration Worksheet** and apply the correct qualifier code if it is out-of-range. If the turbidity calibration verification reading is within the in-calibration range, write "pass" or "P" in the pass/fail section of the calibration worksheet. If the calibration verification reading is out-of-range and the instrument was not used for long term deployment, write “fail” in the pass/fail section of the **Sonde Calibration Worksheet** (see Table 2 and the SWQB SOP 15.0).). If the sonde was used for long term deployment and the turbidity calibration verification reading is between the in-calibration range and the linear interpolation range, record the parameter-specific code for correction (CY) in the pass/fail section of the **Sonde Calibration Worksheet**. If the long-term deployment calibration verification is not within the linear interpolation range, record the parameter-specific code for rejection (RY) in the pass/fail section of the **Sonde Calibration Worksheet**.
D. Discard the DI water.
E. Next, rinse twice with high range turbidity standard (at least 100 NTU) by adding standard into the calibration cell and gently swirling the sonde while holding it upright so the standard makes contact with all areas of the sonde sensors before discarding.
F. For the high range calibration verification, fill the cup with fresh turbidity standard of at least 100 NTU. The turbidity standard used should be the same value as the rinsate used in the previous step.
G. Record turbidity value in the Calibration Verification section of the **Sonde Calibration Worksheet** and apply the correct qualifier code if it is out-of-range. If the turbidity calibration verification reading is within the in-calibration range, write "pass" or "P" in the pass/fail section of the calibration worksheet. If the calibration verification is not within the in-calibration range and was not used for long term deployment, write “fail” in the pass/fail section of the **Sonde Calibration Worksheet** (see Table 2 and the SWQB SOP 15.0). If the sonde was used for long term deployment and the turbidity calibration verification reading is between the in-calibration range and the linear interpolation range, record the parameter-specific code for correction (CY) in the pass/fail section of the **Sonde Calibration Worksheet**. If the long-term deployment calibration verification is not within the linear interpolation range, record the parameter-specific code for rejection (RY) in the pass/fail section of the **Sonde Calibration Worksheet**.
H. Discard the standard and rinse sensors with DI water.

6.4 Onset HOBO DO Logger Sensor Cap and Calibration

6.4.1 Installing the DO Sensor Cap

The Onset dissolved oxygen logger uses a replaceable sensor cap that provides 6 months of continuous use. To install the sensor cap:

A. Unscrew the protective guard covering the DO sensor.
B. Remove the red dust cap that protects the sensor during shipping.
C. Take the green sensor cap out of the canister.
D. Ensure the two O-rings are in place in the grooves on the DO sensor and that they are lightly greased with silicone lubricant.
E. With the flat part of the DO sensor pointing down and the green sensor cap oriented with the arrow up, slide the sensor cap over the sensor until it snaps in place. The cap should be

snug against the logger housing without any gaps.

F. Screw on the protective anti-fouling guard.
G. The next time the logger is connected to HOBOware Pro, the cap will need to be initialized. The software will detect this and ask if you want to initialize now. The cap will be useable for 7 months from initialization.
H. The DO sensor cap is now ready for use.

6.4.2 Calibrating the DO Logger using HOBOware

Use the Lab Calibration tool in HOBOware when you need to calibrate the DO logger before deploying it. The tool sets the gain and offset adjustment values for the logger by calculating the values with a 100% saturation calibration procedure, which is accomplished by placing it in water-saturated air.

To calibrate the DO sensor, use the Lab Calibration tool in HOBOware following these steps:

A. Unscrew and remove the pointed communications cap from the DO logger to access the logger's optical communications window.
B. Open the HOBOware software on the computer and connect either a HOBO base station or HOBO waterproof shuttle to the computer USB port.
C. Establish a computer connection with the logger by inserting the logger into the coupler, aligning the bump/arrow on the coupler with the notches on the logger. Be sure that it is properly seated in the coupler. If the logger has never been connected to the computer before, it may take a few seconds for the new hardware to be detected by the computer. Once the logger is recognized by the computer a dialog box with the logger's serial number will appear, and the logger is connected and ready to calibrate.
D. Stop logging if the sensor is currently logging.
E. From the device menu, click "Lab Calibration." The current gain and offset adjustments are displayed in the top pane of the Lab Calibration window along with the date and time the last lab calibration was completed (if applicable). Completion of the following steps using the Lab Calibration tool will result in new gain and offset adjustment values based on the current logger conditions.

<u>Step 1: 100% Saturation</u>

1. In the Lab Calibration window enter the barometric pressure for your current location.
2. Make sure the logger either has the protective guard or the anti-fouling guard installed (whichever guard you plan to use in the deployment) so that the sensor is covered.
3. Wet the small sponge with fresh water. Squeeze out any excess water.
4. Place the sponge in the end of the calibration boot.
5. Insert the logger in the calibration boot so that there is approximately 1 cm overlap between the end of the boot and the body of the logger. This will ensure there is enough space between the end of the logger and the sponge (the logger should not be pressed up tightly against the sponge).
6. Wait approximately 15 minutes until the logger reaches temperature equilibrium and the air is saturated (and less than 30 minutes so the logger does not go to

sleep).

7. Click the "Get DO value from the logger" button to display the 100% saturation results. The results are updated each time you click this button. Click several times to confirm consistent readings of the "DO Conc from logger at 100% Saturation" value. If the value is stable, then temperature equilibrium has likely been reached.
8. When the DO value displayed in the "Step 1: 100% Saturation" tab stabilizes, click the Next button to proceed.
9. Document the calibration date and time and calibration coefficient on the **DO Logger Deployment/Upload/Retrieval Field Sheet**.

Steps 2: (Optional 0% Saturation) and Finish

1. Step 2 in the HOBOware Lab Calibration tool is 0% saturation. This step requires the use of sodium sulfite which is not currently kept in stock by the SWQB due to its poor shelf life. As long as the logger will be deployed in water with DO levels greater than 4 mg/L, it is not necessary to calibrate the logger to 0% saturation. If a 0% saturation calibration is required and sodium sulfite is available, refer to the Onset DO logger user manual for instructions. Otherwise, click the "Skip this Step" button to continue the DO calibration without a 0% saturation coefficient.
2. The results from the 100% saturation calibration will be displayed along with the overall calibration results and the new gain and offset adjustment values.
3. Click "Send Calibration to Logger" button. The logger is now calibrated based on the new values.
4. The Calibration will take effect when the logger is launched. Refer to the SWQB's Sonde Deployment SOP (SOP 6.2) for DO logger launching and field deployments.
5. After logger communications are complete, remove the logger from the coupler. Make sure the O-ring is still in the groove inside the cap and then reinstall the communications cap.

6.4.3 Onset HOBO DO Logger Post Deployment Check

A post-deployment field calibration verification is required to check logger deployment data for drift. Refer to the SWQB SOP 6.2 Sonde Deployment for DO Logger retrieval field calibration verification procedures.

6.5 Sonde and Logger Maintenance

After extended storage periods or upon retrieval from deployment (following calibration verification), clean the sonde calibration cell, sonde body and the sensors. Follow the maintenance schedule listed in the Operator's Manual, replacement kits, and/or sensor instruction sheets. Follow the unit-specific procedures for sensor maintenance and cleaning procedures. Refer to the instrument manual or manufacturer for detailed maintenance requirements specific to In-Situ sondes. Electronic .pdf copies of all manuals are kept on the SWQB file server. The sonde manager keeps additional copies on file.

Any staff member who performs maintenance activities (e.g., sensor replacement, junction fluid refills, probe winterization etc.) is responsible for tracking completed maintenance in the sonde tracker spreadsheet. The sonde tracker spreadsheet is located on the SWQB file server.

6.5.1 General Sonde Post-Deployment Maintenance

After deployment and after the calibration verification has been completed clean the sonde and the restrictor with cold water. If further cleaning is required refer to the more detailed cleaning procedures for each sensor outlined in the sections below.

6.5.2 Sonde Replacement Parts

See the Sonde Manager or for replacement parts. Do not discard any malfunctioning parts, as these may be under warranty.

6.5.3 O-rings (In-Situ sondes)

In-Situ multiparameter sondes have several O-rings that can be maintained by applying silicone grease to new and old O-rings. Check O-rings for cracks or other damage and replace as needed. If the O-rings and sealing surfaces on the sondes are not maintained properly, water can enter the battery compartment and/or sensor or cable connector ports of the sonde. Water can severely damage the battery terminals or sensor ports causing loss of battery power during a deployment, inaccurate readings and corrosion to the contacts. Therefore, when the battery compartment lid is removed from In-Situ sondes, the O-rings that provide the seal should be carefully inspected for contamination (e.g. hair, grit, etc.) and cleaned if necessary, using the instructions provided below. The same inspection should be made of the O-rings associated with sensors, port plugs and field cable connectors when they are removed. If no dirt or damage to the O-rings is evident, they should be lightly greased (see below) without removal from their groove. If there is any indication at all of damage, the O-ring can be replaced with an identical item from the Maintenance Kit supplied with the sonde. At the time of O-ring replacement, the entire O-ring assembly should be cleaned as described below. See the manufacturer's instrument manual for details regarding O-ring removal and installation.

Important: Do not use alcohol on O-rings as this may cause a loss of elasticity and promote cracking. Do not use a sharp object to remove the O-rings. Damage to the O-ring or the groove itself may result. Before re-installing the O-rings, make sure that you are using a clean workspace, clean hands, and are avoiding contact with anything that may leave fibers on the O-ring or grooves, potentially causing a leak. Do not over-grease the O-rings. The excess grease may collect grit particles that can compromise the seal. Excess grease can also cause the waterproofing capabilities of the O-ring to diminish, potentially causing leaks into the compartment. If excess grease is present, remove it using lens cloth or lint-free cloth.
NOTE: Silicon grease is NOT a sealant. It is a lubricant only and must be used sparingly.

6.5.4 Sonde Cable Connector Port

The cable connector port at the top of the sonde should be covered at all times. When a communications cable is not connected to the cable connector port, the protective cap supplied with the instrument must be securely tightened in place. If moisture has entered the connector port, dry it completely using 95% ethanol and compressed air.

6.5.5 Sonde Sensors

Whenever installing, removing, or replacing a sensor or port plug, it is extremely important that the entire sonde and all sensors and plugs be thoroughly dried prior to removal of the sensor or sensor port plug. This will prevent water from entering the port. Following removal of sensor or plug, examine the connector inside the sonde sensor port. If any moisture is present, rinse both the port and the sensor with DI water and dry thoroughly with compressed air. When reinstalling a sensor or port plug, lightly grease the O-ring with lubricant supplied in the Maintenance Kit.

- **Sonde pH Sensor**

If the ORP platinum electrode is dull or dirty, it can be cleaned with a swab and methanol or isopropyl alcohol. Rub the electrode gently until it is shiny. The pH sensor must be kept moist for the life of the sensor.

The sensor reference junction filling solution has a shelf life of 2 years. Replace the reference junction filling solution every 5 to 6 months or when:

- The sensor fails to calibrate within the acceptable slope and offset range (refer to **Sonde Calibration Worksheet**).
- Sensor readings vary.
- Readings during calibration at pH 7.0 are greater than +30 mV or less than -30 mV.
- Sensor is slow to respond.
- Sensor error notice appears during live readings or calibrations.

If the sensor fails to calibrate after you replace the pH reference junction filling solution, replace the reference junction.

Replacing the pH Reference Junction Filling Solution:

A. Remove the pH sensor from the port. The hex wrench provided with the sonde is necessary to unscrew the sensor before it can be removed.
B. Install the dust cap on the connector end of the sensor or wrap the connector end in a paper towel to prevent solution from entering the connector.
C. Unscrew the reference junction on the head of the sensor using a small flathead screwdriver.
D. Hold the sensor at an angle and shake out the old filling solution into a paper towel and discard.
E. Using the elongated dispenser cap on the filling solution bottle, insert the tube into the bottom of the empty reference junction reservoir. Squeeze a steady stream of filling solution into the reservoir until it overflows, and no bubbles are observed. Continue to add solution while pulling the tube out of the reservoir. This ensures the reservoir is completely full and bubble-free.
F. Screw the reference junction back on to the sensor and hand-tighten until firmly attached. *Do not overtighten.* Some filling solution will overflow. Wipe the excess off the sensor body.

G. Soak the sensor in room-temperature tap water for at least 15 minutes. Make sure the sensor face is immersed but be careful not to immerse or accidentally wet the port end of the sensor.
H. Calibrate the pH sensor (refer to section 6.2.3).
I. If necessary, thoroughly clean the sensor connector to remove filling solution: Using a disposable pipette, fill the connector with isopropyl alcohol (70% to 100%), and shake to dry. Repeat 3 times. Dry overnight. When thoroughly dry, replace and calibrate the sensor.

Replacing the pH Junction

Replace the pH junction when the pH sensor fails to calibrate with a reasonable slope and offset, even after you have replaced the filling solution.

A. Unscrew the pH reference junction and discard.
B. Replace the filling solution according to the procedures above and screw in a new pH reference junction.
C. Soak the sensor face in room-temperature tap water for 15 minutes, then replace and calibrate the sensor.

Cleaning – Routine Maintenance (pH Sensor)

A. Leave the sensor cap on.
B. Rinse the sensor with clean water.
C. Gently wipe with a soft cloth or brush if biofouling is present.
D. If extensive fouling or mineral buildup is present, soak the sensor in vinegar for 15 minutes, then soak in deionized water for 15 minutes.

Do not use organic solvents—they will damage the sensor cap. Do not remove the sensor cap when rinsing or brushing.

Cleaning the Optical Window (pH Sensor)

Clean the optical window only when changing the sensor cap.

A. Remove the cap.
B. Gently wipe the sensing window with the supplied lens cloth.

Do not wet the lens with any liquid.

- **Sonde Conductivity Sensor**

Cleaning

Begin with the gentlest cleaning method and continue to the other methods only if necessary. To clean the conductivity sensor face, gently rinse with clean, cold water.

To remove crystalline deposits:

A. Clean the sensor face with warm water and mild soap.
B. Use a soft brush to gently clean the sensor pins and temperature button. Ensure removal of all debris around the base of the pins and button.
C. If crystalline deposits persist, soak in 5% HCl for 10 to 30 minutes followed by warm soapy water and soft brushing.
D. If deposits persist, alternate soaking in 5% HCl and 5% NaOH solutions followed by warm soapy water and soft brushing.

To remove oily or greasy residue:

A. Clean the sensor face with warm water and mild soap.
B. Using a soft brush, gently clean the sensor pins and temperature button. Ensure removal of all residue around the base of the pins and temperature button.
C. Isopropyl alcohol may be used for short soaking periods, up to one hour.
D. Do not soak in strong solvents such as chlorinated solvents, ethers or ketones (such as acetone).

To remove protein-like material, or slimy film:

A. Clean the sensor face with warm water and mild soap.
B. Using a soft brush, gently clean the sensor pins and temperature button. Ensure removal of all material/film around the base of the pins and temperature button.
C. Soak the sensor in 0.10% HCl for 10 minutes and then rinse thoroughly with distilled water.

- **Sonde Turbidity Sensor**

Cleaning

The optical windows should be clear of foreign material. To clear material gently rub the sensing windows using clean water and a soft cloth or swab. Do not use solvents on the sensor.

Replacing Wiper Bristles

Wiper bristles need to be replaced based on site conditions. In-Situ recommends replacing bristles at least every 12 months or when visibly bent, damaged, or fouled.

Table 3. Troubleshooting

Symptoms	Possible Cause	Action
DO reading unstable or inaccurate	Sensor not properly calibrated	Follow DO calibration procedures
	End cap on sonde is too tight	Loosen the end cap, ensuring it is turned only one rotation

Symptoms	Possible Cause	Action
	Water droplets on the DO sensing foil or thermistor	Gently dry sensing foil or thermistor with a Kimwipe. Ensure sponge is not dripping water – only moistened
	Water in sensor port	Dry port; reinstall sensor
	Algae or other contaminant clinging to DO sensor	Rinse DO sensor with clean water and wipe gently with a Kimwipe
	Calibrated using improper barometric pressure	Repeat DO calibration procedure using proper barometric pressure
	Calibrated at extreme temperature	Recalibrate at (or near) sample temperature
pH readings are unstable or inaccurate. Error messages appear during calibration.	Sensor requires cleaning	Follow sensor cleaning procedure
	Sensor requires calibration	Follow calibration procedures
	pH sensor has dried out from improper storage.	Re-hydrate pH sensor by storing pH 4.0 fluid in the calibration cup overnight. Change the pH reference junction fluid. If necessary, replace reference junction.
	Water in sensor connector	Dry connector; reinstall sensor
	Sensor has been damaged or has expired	Replace sensor
	Calibration solutions out of spec or contaminated with other solution	Use new calibration solutions
	pH value out of range	If all of the above solutions do not fix the problem, replace the pH probe
Specific conductivity unstable or inaccurate. Error messages appear during calibration.	Conductivity improperly calibrated.	Follow calibration procedure
	Conductivity sensor requires cleaning	Follow cleaning procedure
	Conductivity sensor damaged or has expired	Replace sensor
	Calibration solution out of spec or contaminated	Rinse with DI water and use new calibration solution
	Internal failure	Return sonde for service
	Calibration solution or sample does not cover entire sensor.	Immerse sensor fully
Temperature, unstable or inaccurate	Water in connector	Dry connector; reinstall sensor
	Sensor has been damaged	Replace the sensor
Turbidity sensor: general	Sensor requires cleaning	Follow sensor cleaning procedure
	Sensor requires calibration	Follow calibration procedures
	Sensor has been damaged or has expired	Replace sensor
	Water in sensor connector	Dry connector; reinstall sensor
	Calibration solutions out of spec	Use new calibration solutions
	Wiper is fouled or damaged	Clean or replace wiper
	Internal failure	Return sensor for service
	Sensor has been disabled	Enable sensor

Symptoms	Possible Cause	Action
Installed sensor has no reading	Water in sensor port	Dry port; reinstall sensor
	Sensor has been damaged	Replace the sensor
	Report output improperly set up	Set up report output
	Internal failure	Return sonde for service

6.5.6 General Dissolved Oxygen and Conductivity Logger Maintenance

Between unattended logger deployments and prior to redeployment, clean the logger if necessary and perform any other required maintenance. Refer to the instrument manual or manufacturer for detailed maintenance requirements specific to Onset HOBO instruments. Electronic .pdf copies of all manuals are kept on the SWQB file server. The logger manager keeps additional copies on file.

Any staff member who performs maintenance activities is responsible for tracking completed maintenance in the logger status tracker spreadsheet located on the SWQB file server. Maintenance activities and the date performed can be recorded in the "notes" section next to the logger's serial number. Some maintenance activities such as DO cap replacement are also recorded and displayed in HOBOware Pro when launching the logger.

6.5.7 Onset HOBO DO Logger Maintenance

The DO logger is equipped with a replaceable sensor cap that provides six months of continuous use. The sensor cap expires seven months after the cap is initialized to allow a month buffer between lab calibration and deployment. The sensor should only be cleaned with a sensor cap installed.

To clean the sensor cap:

1. Remove the protective guard or anti-fouling guard but leave the sensor cap on the sensor.
2. Rinse the logger with clean water from a squirt bottle or spray bottle.
3. Gently wipe the cap with a soft-bristled brush (such as a toothbrush) or soft cloth if biofouling is present. Use Alconox® to remove grease.
4. If extensive debris or mineral build-up is present, soak the cap end in vinegar for 15 minutes, then soak it in deionized (DI) water for another 15 minutes.
5. If the logger is being immediately redeployed with the same sensor cap, a field calibration is adequate. If a new sensor cap is being installed, a lab calibration with HOBOware is recommended (refer to sections 6.4.1 and 6.4.2 of this SOP).

WARNING: Do not use organic solvents; they will damage the sensor. Do not remove the sensor cap from the sensor prior to cleaning with a brush. Only clean the sensor when you replace the sensor cap. Refer to the instructions that ship with the replacement sensor cap. Do not wet the sensor optical lens area with water or any solution. Remove the cap and gently wipe the window with the alcohol wipe provided in the sensor cap kit.

To clean the logger body:

1. Make sure the sensor cap is installed on the logger.

2. Gently scrub the logger body with a plastic bristle brush or nylon dish scrubber.
3. Use Alconox® to remove grease.
4. Soak in vinegar to remove mineral deposits.
5. Rinse the logger with deionized (DI) water.

6.5.8 Onset HOBO Conductivity Logger Maintenance

- **Onset HOBO Conductivity Logger Post Deployment Check**

  The Conductivity Logger conductance sensor is factory-calibrated and cannot be adjusted. Calibration verification checks are performed against a calibrated sonde in ambient water at both deployment and retrieval. The conductivity calibration verification readings should include the actual conductivity without temperature compensation (i.e. not specific conductance at 25°C), and temperature in °C. These sonde readings should be taken at the same time the data logger is programmed to record (usually every 15 minutes), and should be recorded on the **Conductivity Logger Deployment/Upload/Retrieval Field Sheet**. Allow enough time after deployment for the conductivity logger temperature to stabilize (approximately 15 minutes) before taking calibration verification sonde readings.

- **Onset HOBO Conductivity Logger Maintenance and Cleaning**

  Onset conductivity loggers require little maintenance, only gentle cleaning of the sensor following deployments.

  To clean the sensor:
  Mix several drops of dish detergent or biodegradable soap in a cup of tap water with a clean cotton swab. Clean the sensor face using the cotton swab and then rinse the sensor with clean or distilled water. Be cautious about scratching the sensor face with sharp objects. Do not use solvents that are incompatible with the logger housing materials. See the manual for more information.

  Check for biofouling:
  Biofouling and excessive plant growth on the logger will compromise accuracy. Organisms that grow on the sensor can interfere with the sensor's operation and eventually make the sensor unusable. If the deployment area is prone to biofouling, check the logger periodically for biological growth.

6.6 General Sonde Storage

Following calibration verification, clean and rinse the sonde and sensors with tap water or pH 4.0. Do not use distilled or DI water for storage.

6.6.1 In-Situ Sonde Storage

Short-term (<1 Month or during the field season)

The sonde restrictor can be used as a storage cup. Tap water is safe for short periods of storage (i.e. <24 hours), however pH 4.0 solution should be used for longer periods of short-term storage (i.e. >24 hours) to prevent the pH probe from dehydrating while the sonde is not in use.

A. Remove the end cap from the restrictor.
B. Remove the restrictor from the sonde body.
C. Replace the restrictor onto the sonde body in storage mode.
D. Pour 15 mL (0.5 oz.) of clean tap water or pH 4.0 solution (not DI water) into the calibration cup.
E. Screw end cap back on to the restrictor so that the liquid is contained in the calibration cup.

Long-term (>1 Month during the off season)

Note: The pH sensor should not be removed from the sonde during the field season even if it will be in temporary storage for greater than one month. It is acceptable to store the sonde with pH 4.0 during periods of storage while the field season is ongoing. This protocol should be used to prepare sondes for off-season storage.

A. Remove the pH/ORP sensor and place a sensor port plug into the empty pH/ORP port.
B. Add a small amount of pH Storage Solution (0065370) or pH 4.0 calibration solution (0083210) to the sponge in the pH/ORP storage cap.
C. Place the storage cap firmly on the sensor. Use electrical tape to seal the cap to the sensor.
D. Place a dust cap on the sensor connector. Store the sensor in its original box in a cool location.
E. Remove the batteries from the sonde.
F. Remove the restrictor from the sonde body. Remove the blue end cap from the restrictor and replace it on the opposite end of the restrictor.
G. Screw the restrictor on to the sonde so that it is in storage mode.
H. Store the sonde and pH/ORP sensor in the box they arrived, at temperatures between -5° to 65° C.

Prior to using the pH sensor after long-term storage, rinse the sensor with DI water and then soak it in pH 4.0 buffer for 1 or 2 hours. This will saturate the glass bulb with hydrogen ions and prepare it for use. Do not store the pH sensor in DI water because it will deplete the reference solution and drastically reduce the life of the sensor.

The Aqua TROLL® 600 sonde contains a small, replaceable desiccant capsule in the battery compartment. This capsule prevents moisture from causing damage to the electronic components. It is filled with color-indicating silica that changes from purple to pink as the desiccant's effectiveness decreases. Desiccant is included in the Maintenance kit. Replace the desiccant where it has turned pink.

6.6.2 Tracking Logger Status

Record the status of each dissolved oxygen and conductivity logger in the "Logger status" spread sheet located on the SWQB file server. Operational loggers in storage are marked as "available." Once a logger has been launched and scheduled for deployment, it is marked as "launched." While collecting data in the field, it is marked as "deployed." When a logger has been retrieved

and is awaiting offload, it is marked as “retrieved.” It is also possible to mark a logger status as “malfunctioning,” “unknown,” “lost,” and “retired.” It is imperative to indicate the status of the logger on this tracking tool as soon as the logger status changes or is known. The logger status tracking tool serves to allow all team members to see at a glance which loggers are available for use and serves as a redundancy to deployment field sheets for recording when and where deployed loggers were anchored.

6.6.3 Onset HOBO DO Logger Storage and Battery

Between deployments, keep DO loggers stored in their rubber calibration boot. The DO sensor should be stored with a calibration cap installed (preferably NOT a new un-initiated sensor cap).

The battery life of the logger should be three years or more. Actual battery life is a function of the number of deployments, logging interval, and operation/storage temperature of the logger. Frequent deployments with fast logging intervals, continuous storage/operation at temperatures above 35°C (95°), and keeping the logger connected to the coupler will result in significantly lower battery life. To obtain a three-year battery life, a logging interval of five minutes or greater should be used and the logger should be operated and stored at temperatures between 0° and 25°C (32° and 77°F).

The logger can report and log its battery voltage. If the battery falls below 3.2 V, the logger will record a “bad battery” event in the datafile. The logger will record a second “bad battery” event and stop logging when the battery falls below 3.1 V. If the datafile contains “bad battery” events, the logger should be returned to Onset for battery replacement. Do not attempt to replace the battery yourself; severe damage to the logger will result if the case is opened without special tools, and the warranty will be voided. Record “bad battery” occurrences on the SWQB MASS “logger status” tracking spreadsheet and document if/when battery replacement occurred.

Although battery voltage is indicated in the status mode dialog box, the most reliable indicator of battery voltage is to log one data point and then view the file.

6.6.4 Onset HOBO Conductivity Logger Storage and Battery

In between deployments and for long-term storage, place the protective cap over the sensor face. Care should be taken that the unit is stored with the cap on to prevent damage or abrasion to the unit.

The battery life of the logger should be three years or more. Actual battery life is a function of the number of deployments, logging interval, and operation/storage temperature of the logger. Frequent deployments with logging intervals of less than one-minute, continuous storage/operation at temperatures above 35°C (95°), and keeping the logger connected to the coupler will result in significantly lower battery life. To obtain a three-year battery life, a logging interval of one minute or greater should be used and the logger should be operated and stored at temperatures between 0° and 25°C (32° and 77°F).

The logger can report and log its battery voltage. If the battery falls below 3.1 V, the logger will record a "bad battery" event in the datafile. If the datafile contains "bad battery" events, or if logged battery voltage repeatedly falls below 3.3 V, the battery is failing and the logger should be returned to Onset for battery replacement. To have a logger battery and sensor replaced, contact Onset. Do not attempt to replace the battery yourself! Severe damage to the logger will result if the case is opened without special tools, and the warranty will be voided.

7.0 Data and Records Management

The following files are generated following the procedures outlined above:

- Sonde Calibration Worksheet
- Sonde Deployment/Retrieval Field Sheet (calibration and calibration verification)
- VuSitu data file
- VuSitu calibration report
- QC check spreadsheet
- DO Logger Deployment/Upload/Retrieval Field Sheet (see SOP 6.2)
- Conductivity Logger Deployment/Upload/Retrieval Field Sheet (see SOP 6.2)
- Logger status tracking spreadsheet
- HOBOware® data file
- Temperature QC check spreadsheet

All sonde calibration logs must be retained for a minimum of 3 years from the date of project verification and validation in the sonde calibration binder located in the lab. A copy of sonde calibration logs will also be placed in project binders for permanent record retention.

For each SWQB Section the record of the disposition for the Section's sondes or loggers is located within a "sonde tracker" spreadsheet for multiparameter sondes, or a "logger status" spreadsheet for conductivity and DO loggers. The "sonde tracker" spreadsheet records sonde maintenance by ID and sonde probe maintenance/disposition by serial number, while the "logger status" spreadsheet contains each logger serial number, current status of each logger (available for use, launched and awaiting deployment, deployed, or retrieved and awaiting offload), deployment location, person responsible for the sonde/logger, date of checkout, and any other pertinent logger disposition information. The Sonde Manager keeps a record of the disposition of all logger-related accessories, such as optic shuttles and base stations.

8.0 Quality Control and Quality Assurance

The SWQB controls the quality of sonde and logger data by using standardized methods that are documented in this SOP. All personnel who deploy sondes or loggers must be familiar with these protocols, sign the acknowledgment form associated with this specific SOP and calibrate and maintain sondes and loggers in accordance with the procedures as they are defined in this SOP. In addition to standardized methods, proper training of personnel represents a critical aspect of meeting the data quality objectives in order to fulfill the goals of the SWQB's QAPP (NMED/SWQB. 2018). If, at any time, the QAO determines this process is not being adhered to, the QAO has the authority to cease activities specific to this SOP with prior support and approval by the SWQB Bureau Chief and MASS Program Manager, until such a time that the issue can be resolved.

Between each field season, the Sonde Manager verifies that each sonde and logger is reading temperature within ±0.5°C of a NIST-traceable and calibrated thermometer (Table 4) at a minimum of two temperatures (approximately 10 degrees and 35 degrees Celsius) bracketing the range of water quality standards. See Accuracy Procedure below. New sondes and loggers with a Compliance Certificate or equivalent do not require accuracy verification prior to first use. The SWQB uses the State Laboratory Division of the New Mexico Department of Health (SLD) and private vendors to inspect and certify thermometers for accuracy traceable to NIST standards. The certified thermometer should be certified annually at two temperatures.

8.1 Temperature Accuracy Check Procedure

The Sonde Manager verifies the accuracy of the temperature sensor on the multiparameter sondes, DO loggers, and conductivity loggers according to the following procedure:

A. Program DO or conductivity loggers to record simultaneously at five-minute intervals. Refer to SOP 6.2 (Sonde Deployment) for instructions on preparing and launching logging on the HOBO Dissolved Oxygen and Conductivity loggers. If verifying the accuracy of multiparameter sondes skip this step and proceed to step B.
B. Set up a cold-water bath in an insulated cooler that is allowed to equilibrate for low range temperature verification. The cold-water bath should be allowed to equilibrate overnight so that thorough mixing occurs, and the water is not stratified. An optimal way to do this is to place the water bath in the walk-in cooler overnight. Low range water temperature should be 4-10 °C.
C. Place the DO logger(s), conductivity logger(s), or multiparameter sonde(s) in the water bath and allow the temperature probe to stabilize for at least 20 minutes. Ensure that temperature sensors on the sondes and/or loggers are all at an equal depth. This can be accomplished by placing multiparameter sondes in the water bath vertically so the end cap rests on the bottom of the cooler or by zip-tying a group of loggers together and placing them in the water bath vertically. Ensuring the temperature sensors are all at an equal depth is critical, as water of different temperatures becomes stratified and even an inch or two can make a difference in the temperature output.
D. Refer to SOP 6.2 (Sonde Deployment) for instructions on logging data using the In-Situ multiparameter sonde. Program the sondes to begin logging every 5 minutes.
E. Record the temperature of the water with a certified NIST traceable thermometer at the same time that the multiparameter sonde is logging or the DO or conductivity loggers are set to record, taking care to ensure that the bath is well mixed and has not stratified during the equilibration period. Allow the multiparameter sondes or DO/conductivity loggers to record several data points (at least 3), each 5 minutes apart and record the temperature of the water using the NIST certified thermometer at the same time sondes/loggers are set to log a data point. Record the temperatures and the exact time temperatures were taken. If the NIST certified thermometer has an associated temperature reporting error from when it was last checked, add the error to the reported temperature. For example, if the thermometer reads 5.8°C but the lab that checked the thermometer noted an error of -0.2°C, then the reported temperature should be 6.0°C, not 5.8°C.
F. Repeat the steps above in a warm water bath for the high range (35-40 °C) temperature verification. Hot tap water is usually sufficient for the high temperature accuracy check. Temperature needs to be high enough to bracket the highest temperature standard, which is 34 °C. Allow sondes to equilibrate to the water temperature in the warm water bath for no less than 20 minutes. Warm water quickly becomes stratified. Again, ensure that the temperature sensors are all at an equal

depth in the water bath, and that the NIST certified thermometer is reading the temperature at the same depth as the temperature sensors.

G. Offload the data logs from multiparameter sondes (refer to SOP 6.2) and store each log in the appropriate QC Check folder for the current year. Offload data from the DO/conductivity loggers and store each logger file in the appropriate QC temperature check folder for the current year. Refer to SOP 6.4 Data Logger and Upload for procedures on offloading the viewing logger data.
H. Verify that the multiparameter sondes or DO/conductivity loggers recorded temperatures within ±0.5°C of the NIST traceable certified thermometer at the time of at least one logging interval following the stabilization period. Record in the temperature logger accuracy check electronic log each unit's serial # or unit number, test date, low/high reference temperature, recorded low/high temperature, battery voltage, low/high temperature discrepancy with the reference temperature, and the reference thermometer used.

Return to the manufacturer any temperature sensors or DO/conductivity loggers that fall outside the acceptable accuracy range. For grab data, if sondes/loggers fall outside the in-calibration range (Table 4), reject all temperature data collected by the instrument and qualify all temperature dependent measurements as suspect. For long term datasets, if sondes were used to collect data during the current year and the temperature check falls outside the in-calibration range but within the linear interpolation range, all temperature data collected using the sonde/logger in question should be flagged "CT" on the Long Term Data Management Spreadsheet for all deployments (SOP 6.4). If the temperature check falls outside of the linear interpolation range, all temperature data collected using the sonde/logger in questions should be flagged as rejected and all temperature-dependent measurements qualified as suspect.

Table 4. Accuracy Verification Criteria and Maximum Allowable Limits for Data Adjustment

Measurement	Standard	Standard Value	In-calibration Range	Linear Interpolation Range (Max Allowable Limits)
Temperature, °C	NIST Certified Thermometer	Ambient Temperature	± 0.5	± 2

9.0 Related Forms

- Sonde Calibration Worksheet
- Sonde Deployment/Retrieval Field Sheet
- Stream/River Field Data Form (see SOP 8.0)
- DO Logger Deployment/Upload/Retrieval Field Sheet (see SOP 6.2)
- Conductivity Logger Deployment/Upload/Retrieval Field Sheet (see SOP 6.2)
- HOBO® Dissolved Oxygen Logger (U26-001) Manual
- HOBO® U24 Conductivity Logger (U24-00x) Manual
- HOBO® Waterproof Shuttle Instruction Manual
- HOBO® Optic USB Base Station Instruction Manual
- Long Term Data Management Spreadsheet (see SOP 6.4)

10.0 Revision History

Original modified from SOP 2007.

Revision 1. February 2012. updated to incorporate Hydrolab sondes

Revision 2. February 2013. updated to incorporate Onset HOBO DO Loggers, updated Table 2 to current Calibration Range values. Directed "Sonde Data Manager" duties to the survey Project Coordinators
Jodey Kougioulis, QAO; Scott Murray, SME; Jeff Scarano, Program Manager MASS

Revision 3. February 2016. updated to include instructions for YSI V2 sondes, requirements for calibration verification bracketing, and maintenance documentation, formatted to SOP 1.1.
Jodey Kougioulis, QAO; Scott Murray, SME; James Hogan, Acting Program Manager MASS

Revision 4. January 2017. Updated to incorporate In-Situ sondes and HOBO Conductivity Loggers, added post check procedures and in-calibration range table, formatted to SOP 1.1 (2017).
Jennifer Fullam, Acting QAO; Chuck Dentino, SME; Kristopher Barrios, Program Manager MASS

Revision 5. October 2020. Removed references to YSI and Hydrolab sondes. Revised sonde calibration information and organization. Added barometric pressure and depth sensor calibration.
Miguel Montoya, QAO; Meredith Ziegler, SME; Kristopher Barrios, Program Manager

Revision 6. February 2021. Revised content in letter E of the Temperature Accuracy Check Procedure due to a quality control issue in the example provided. The value +.02°C was changed to -0.2°C to make example true.
Miguel Montoya, QAO; Meredith Ziegler, SME; Kristopher Barrios, Program Manager

11.0 References

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