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Technical Standard Operating Procedure (TSOP)

Office: Office of Water Quality

Branch: Watershed Assessment and Planning Branch

Section: All

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Purpose

This technical standard operating procedure (TSOP) describes the methods for calibrating YSI ProDSS and YSI EXO multiparameter data sondes used in the field by Watershed Assessment and Planning Branch (WAPB) staff to collect specific conductivity (SpC), dissolved oxygen (DO), and pH data.

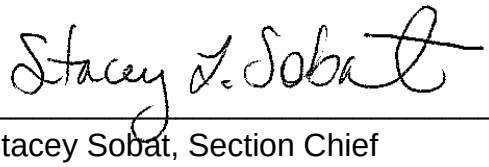
Scope

This TSOP applies to Indiana Department of Environmental Management (IDEM) Office of Water Quality (OWQ) Watershed Assessment and Planning Branch (WAPB) staff.

This document was originally authored by Charles Hostetter, Environmental Chemist, Watershed Assessment and Planning Branch, and revised by Scott Zello-Dean, Environmental Manager, Probabilistic Monitoring Section.

Authorizing Signatures

I approve and authorize this standard operating procedure:



12/12/2023

Stacey Sobat, Section Chief — Date
Probabilistic Monitoring Section, OWQ

12/13/2023

Ali Meils, Section Chief — Date
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12/12/2023

Caleb Rennaker, Section Chief — Date
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3/13/2024

Kristen Arnold, Branch Chief — Date
Watershed Assessment and Planning Branch, OWQ

This technical standard operating procedure is consistent with agency requirements.

3/20/2024

Quality Assurance Staff — Date
Office of Program Support

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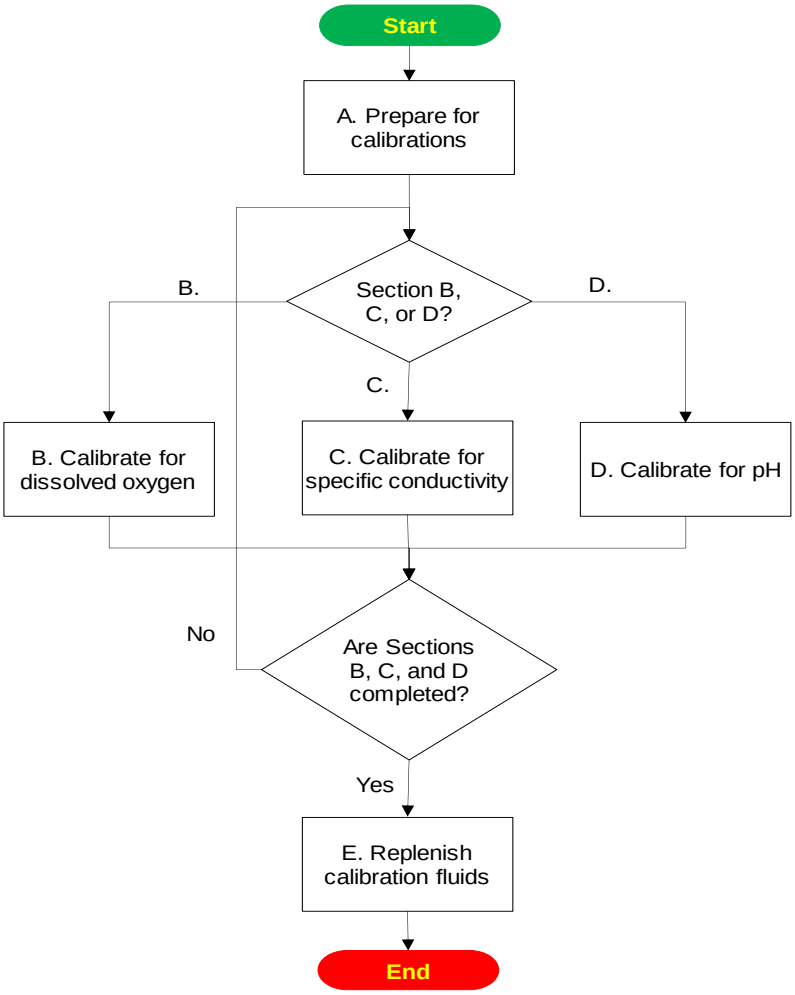
1.0. Overview Flowchart



2.0. Procedure

2.1. Procedural Flowchart

Procedural flowcharts are shown in Section 2.2, followed by a step-by-step description.

2.2. Procedural Steps

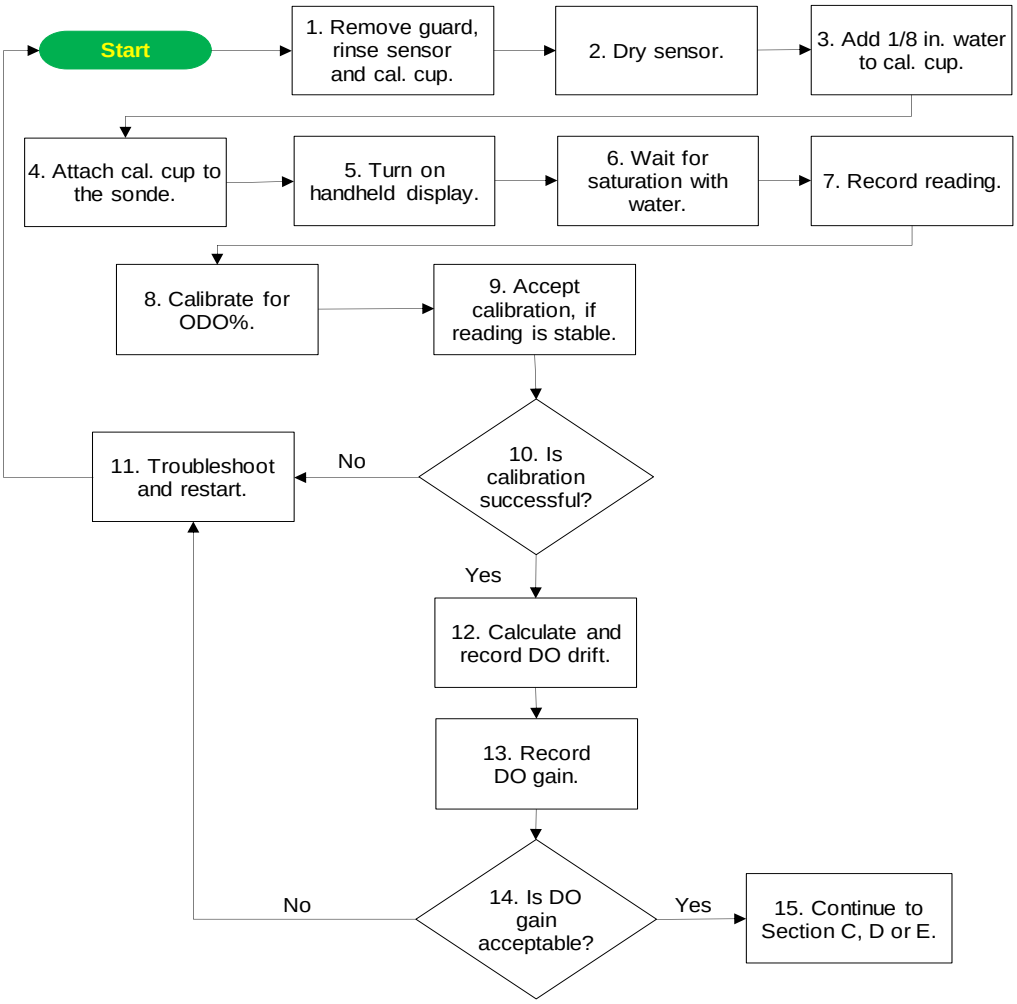
A. <u>Prepare for calibrations:</u>

Step 1. Retrieve Sonde Maintenance and Calibration Log sheet (Appendix A). Record YSI model and unit number/serial number at the top of the log sheet. Record date and analyst's initials in the calibration table.

Step 2. Prepare the necessary equipment and solutions. If solutions need to be made (i.e., pH buffers or conductivity standard), see Section E.

Note: Sections B, C, and D can be performed in any order.

B. Calibrate dissolved oxygen (DO) sensor by DO% in saturated air:



Step 1. Remove cover and protective sensor guard, then rinse the sensor and calibration cap with deionized (DI) water.

Step 2. Wipe sensor and sensor cap clean, and dry using Kimwipes®. Ensure no water droplets are left on the optical dissolved oxygen (ODO) sensor cap or temperature sensor. Make sure the cap is not scratched.

Step 3. Place a small amount (1/8 inch) of fresh DI water into a clean calibration cup.

Step 4. Reattach the sensor guard, then carefully place the sensor into the calibration cup. Loosely thread the calibration cup onto the

bulkhead. The calibration cup should be secure enough to not fall off, but not so tight that no air can enter.
Note: The sensor should not touch the water.

Step 5. Turn on the handheld display by pushing the green power button.

Step 6. Wait at least 10 minutes for the air in the calibration cup to become completely saturated with water.

Step 7. After the DO reading has stabilized, record the pre-calibration value on the Sonde Maintenance and Calibration Log sheet.

Step 8. If using the ProDSS handheld display, push the “Cal” key, then select “ODO” in the calibration menu. If using the EXO handheld display, select “DO% or ODO%” → “Calibrate” → “DO%” in the calibration menu. This will calibrate the instrument’s DO% measurement.
Note: YSI data sondes have internal factory calibrated barometers, as barometric pressure is used to calculate the DO% measurement. For each sonde used monthly, check the barometric pressure displayed on the handheld with an external barometer. Recalibrate if the pressure is off by more than 2 mmHg. To recalibrate the barometer, reference the appropriate owner’s manual.

Step 9. Observe the actual measurement readings for stability. The reading is considered stable when the white line on the graph shows no significant change for 40 seconds (Figure 1). If stable, then select “Accept Calibration.”

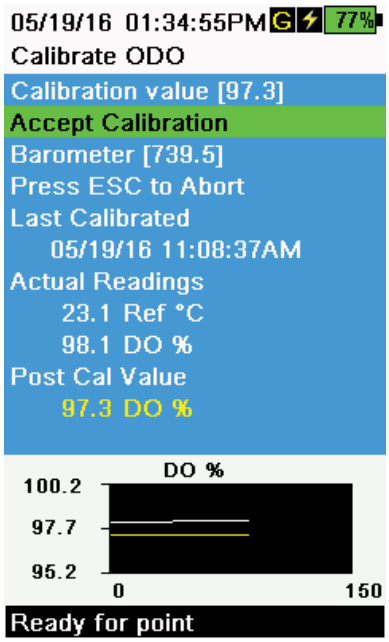


Figure 1. ProDSS handheld display of the dissolved oxygen calibration menu.

Step 10. If “Calibration successful!” is displayed in the message area at the bottom of the screen, continue to Step 12.
If “Calibration is questionable” is displayed, go to Step 11.

Step 11. Investigate the cause of the questionable results and restart the process.

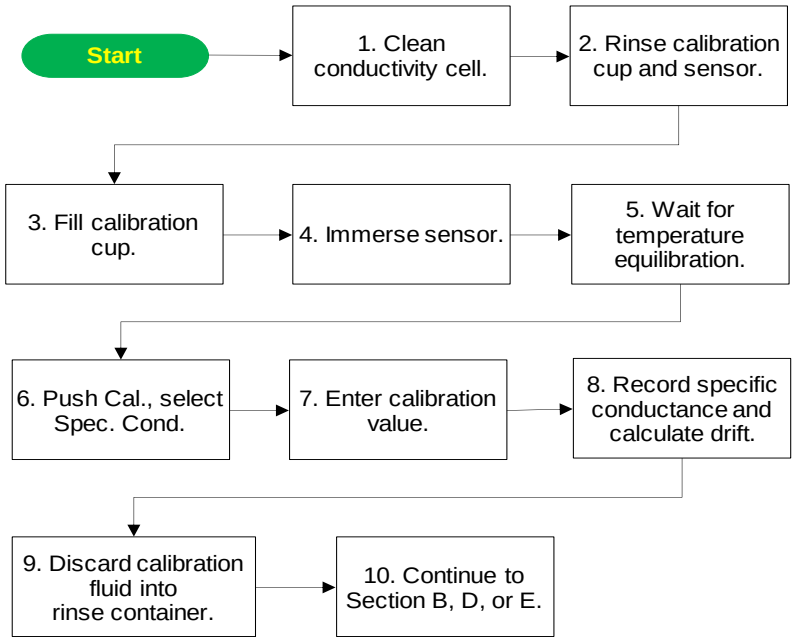
Step 12. Calculate DO drift by subtracting the “Post Cal Value” from the “Actual Reading” for DO%. Record DO drift on the Sonde Maintenance and Calibration Log.

Step 13. Record DO gain on the Sonde Maintenance and Calibration Log. For the YSI ProDSS handheld, view the DO gain on display by pushing the “File” button, then “View GLP.” The DO gain will be displayed. On the EXO handheld display, the DO gain will be displayed in the calibration summary.

Step 14. If the DO gain is between 0.75 and 1.50, DO calibration is complete. If the DO gain is outside of 0.75 to 1.50, go back to Step 11.

Step 15. Continue to Section C or D. If Sections C and D are complete, continue to Section E.

C. <u>Calibrate specific conductivity sensor:</u>



Step 1. If necessary, clean the conductivity sensor with the supplied soft brush or Kimwipe®.

Step 2. Rinse calibration cup and sensor with DI water. Then rinse the calibration cup and sensor with conductivity standard in the

designated rinse cup. After rinsing, discard contents of cup into the sink and flush with water.

Step 3. Fill calibration cup with conductivity standard to the second marked line, ensuring the surface of the standard is above the vent holes on the conductivity sensor. Record the manufacturer, lot number, date made, and date expired of the calibration fluid on the Sonde Maintenance and Calibration Log.

Step 4. Immerse the sensor into the solution. Gently rotate the sonde and move it up and down to remove any bubbles from the conductivity cell.

Step 5. Allow at least one minute for temperature equilibration before proceeding.

Step 6. If using the ProDSS, push the Cal key, select Conductivity, then select Specific Conductance. If using the EXO handheld, enter the Calibrate menu, select Conductivity, and in the second menu select Specific Conductivity.

Step 7. If using the ProDSS, select Calibration Value and enter the calibration value of the standard used (i.e., 718). If using the EXO, select Specific Conductance and enter the calibration value of the standard used (i.e., 718). Click Start Calibration.

Step 8. Observe the actual reading for stability, then select Accept Calibration (Figure 2). Calibration successful will be displayed in the message area at the bottom of the screen. Record specific conductance drift by subtracting the post-calibration value from the pre-calibration value. Click Esc to return to the sensor calibration menu, and then the back arrows to return to main calibration menu.

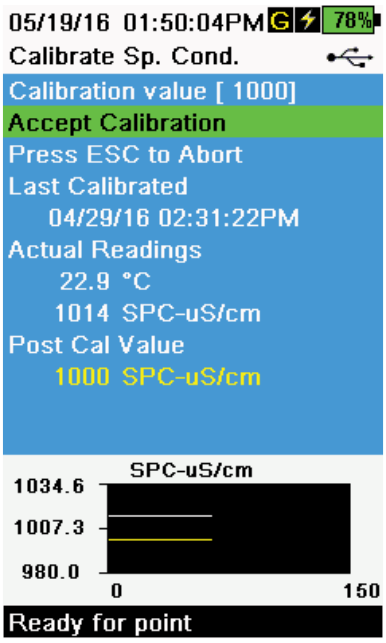
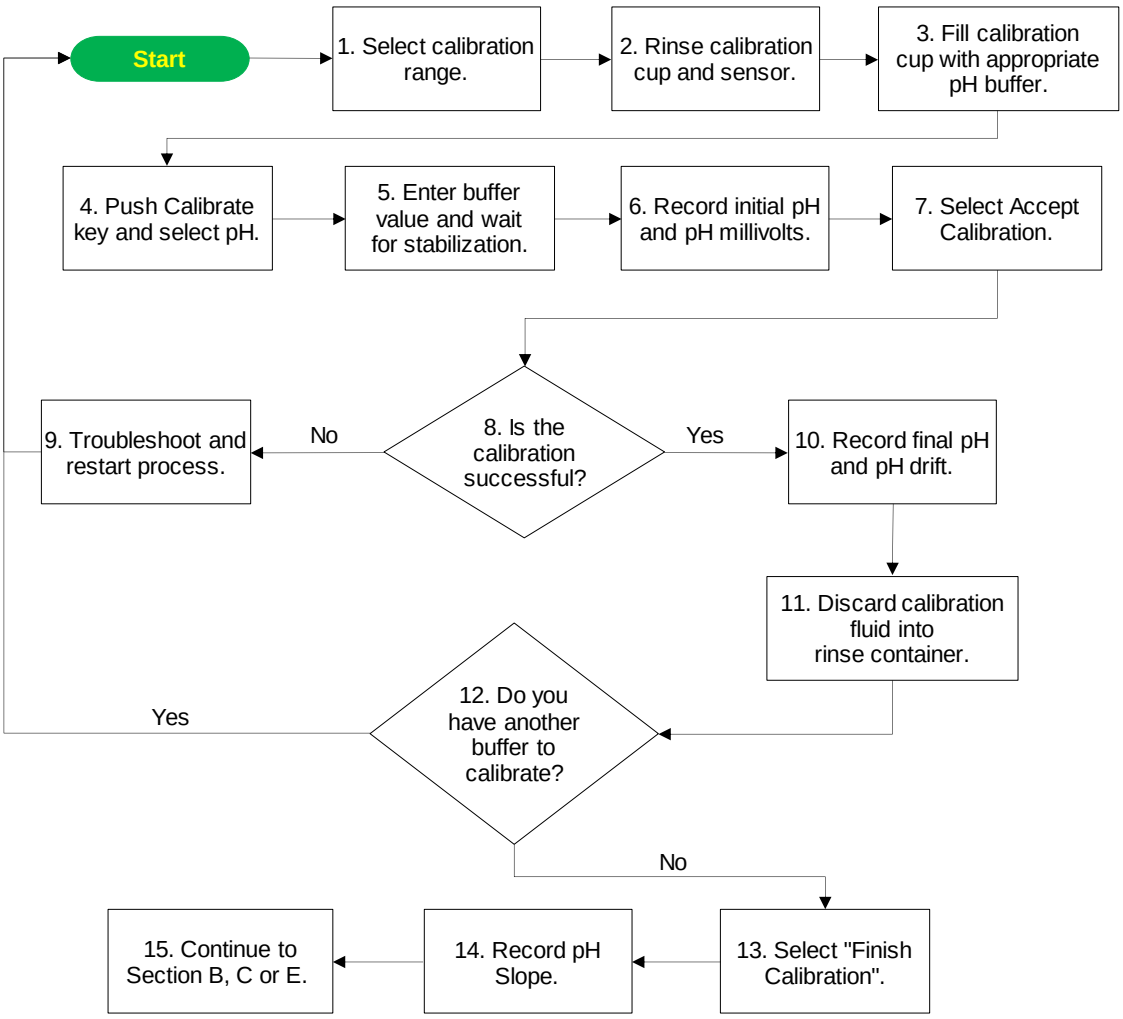


Figure 2. ProDSS handheld display of specific conductivity calibration.

Step 9. Empty calibration cup into the KCl specific conductance rinse container.

Step 10. Continue to Section B or D. If Sections B and D are complete, continue to Section E.

D. Calibrate pH sensor:



Step 1. Typically, a two-point calibration with pH 7 and 10 buffers is sufficient. However, if taking pH readings of acidic water (e.g., in acid mine drainage areas), it is necessary to include the pH 4 buffer as well. **Always start the calibration with the pH 7 buffer.** Follow Steps 2 – 11 for each buffer solution to be used.

Step 2. Rinse the calibration cup and sensor with DI water. Then rinse with the appropriate pH standard in the rinse cup.

Step 3. Fill the calibration cup to line 1 with the pH buffer. With the sensor guard installed, carefully immerse the sensors into the buffer solution. Both the pH sensor and temperature sensor should be submerged. Record the manufacturer, lot number, date made, and date expired of the calibration fluid on the Sonde Maintenance and Calibration Log.

Step 4. If using the ProDSS, push the Cal key, then select pH. If using the EXO handheld, in the calibrate menu select 2-pH or 3-pH (depending on how many buffer solutions are being used). Then select Calibrate. The display will read Ready for Cal point 1 (or 2 or 3, respectively) at the bottom of the screen.

Step 5. Wait for the temperature and pH reading to stabilize. The calibration value will automatically be adjusted based on the buffer used (4, 7, or 10) and temperature of the buffer.

Step 6. Record initial pH and pH millivolts (mV) (under Actual Readings on the handheld display) after the reading stabilizes.

Step 7. Press Enter to accept calibration (Figure 3).

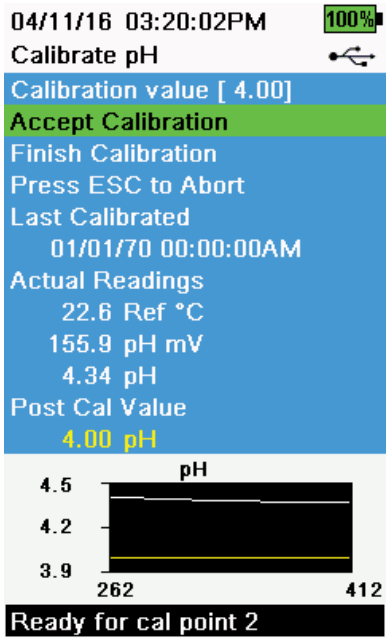


Figure 3. ProDSS handheld display of pH calibration.

Step 8. Calibration successful or Calibration is questionable will be displayed. The display will prompt readiness for the next calibration point, at the bottom of the screen.

Step 9. If calibration is questionable, troubleshoot and restart the process.

Step 10. Record the final pH displayed under the Post Cal Value heading. Then, calculate drift by subtracting the final pH value from the initial pH value (recorded in Step 6).

Step 11. Empty the buffer from the calibration cup into the rinse container.

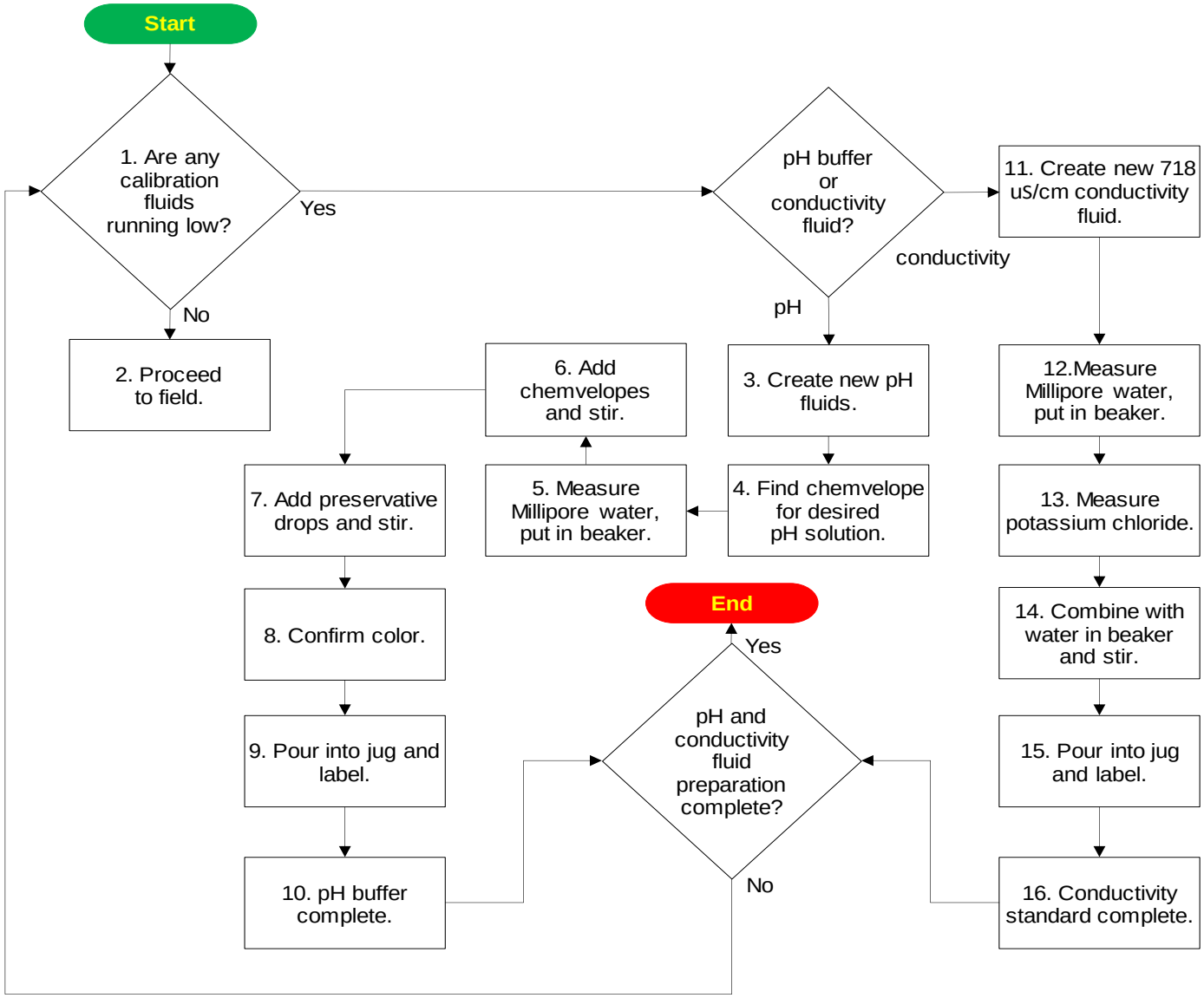
Step 12. Repeat Steps 2 – 11 until calibration is successful for each buffer in the selected range.

Step 13. Select Finish Calibration to end calibration.

Step 14. Record pH slope on the Sonde Maintenance and Calibration Log. For the YSI ProDSS handheld, view the pH slope on the display by pushing the File button, then View GLP. The pH slope will be displayed. On the EXO handheld display, the pH slope will be displayed in the calibration summary. If the pH slope is between 55 and 60 mV, pH calibration is complete. If the pH slope is outside of 55 and 60 mV, go back to Step 9.

Step 15. Continue to either Section B or C. If Sections B and C are complete, continue to Section E.

E. Replenish calibration fluids:



Step 1. The sonde is now ready for use in the field. Rinse the sensors and calibration cup with DI water. Fill the storage cup with about 1.5 inches of fresh tap water (or stream water if calibrating in the field) and reattach to the sonde. If no solutions are needed, calibration is complete. If calibration fluids are running low, replenish them. Proceed to Step 3 for pH buffers and proceed to Step 11 for conductivity standard.
Note: Do NOT store sensors in DI water.

Step 2. Proceed to the field.

Step 3. Create new pH buffers. Follow directions on Hydrion® buffer chemvelope box (outlined below).
Note: About 1500 mL (1.5 L) fits in a half gallon jug. It is recommended to make 2 L of solution at a time, to mostly fill two half gallon jugs.

Step 4. Find the appropriate Hydrion® buffer chemvelope for the desired solution (pH 4, 7, or 10).

Step 5. Use a volumetric flask or graduated cylinder to measure desired volume of Millipore water (must be a multiple of 500 mL). Pour into the beaker.

Step 6. Add one chemvelope for desired pH per 500 mL of water. Stir until dissolved using a clean magnetic bar and stir plate.

Step 7. Add three drops of the buffer preservative per 100 mL (15 drops per 500 mL or 30 per 1 L). Stir until the color is uniform using a clean magnetic bar and stir plate.

Step 8. Confirm the color of the solution. pH 4 is orange, 7 is green, and 10 is blue. If the color doesn't match, start over.

Step 9. Pour the solution into a clean, empty half gallon jug. Label with buffer type, the manufacturer, lot number, date made, date expired, and initials.

Step 10. The pH buffer is complete, return to Step 1.

Step 11. Create new 718 uS/cm conductivity standard:
Note: About 1500 mL (1.5 L) fits in a half gallon jug. It is recommended to make 2 L of solution at a time, to mostly fill two half gallon jugs.

Step 12. Use a volumetric flask or graduated cylinder to measure the desired volume of Millipore (must be a multiple of 500 mL). Pour into the beaker.

Step 13. Use a clean weigh boat and metal scoop to measure 0.1864 g of dry potassium chloride per 500 mL of water. (i.e., If 1 L water, use 0.3728 g.)

Step 14. Add potassium chloride to the beaker of water. Stir until dissolved using a clean magnetic bar and stir plate.

Step 15. Pour solution into a clean, empty half gallon jug. Label as 718 uS/cm conductivity standard. Mark with the manufacturer, lot number, date made, date expired, and initials.

Step 16. The conductivity standard is complete, return to Step 1.
Note: Once prepared, pH buffers have a three-month shelf-life and conductivity standards have a 90-day shelf life.

2.3. Related Technical Issues

A. Health and Safety Warnings
   1. Due to possible hazards presented by the pH buffers and potassium chloride, review the safety data sheets (SDS), IDEM Hazard Communication (HazCom) Plan, OWQ Watershed Assessment and Planning Branch Laboratory Safety Plan, and wear the required PPE:
      a. Chemical resistant latex or nitrile gloves
      b. UV safety glasses

B. Cautions
   1. To ensure equipment measurements are correct, make sure conductivity standards or pH buffers used are NOT expired.
   2. To ensure accurate calibration of equipment, use enough solution to cover the sensor(s) when measuring pH and conductivity.
   3. To ensure proper calibration, make certain the correct mode is used when calibrating the equipment.

C. Interferences
   1. To guarantee readings are accurate, ensure a clean sensor guard is attached before taking readings. This includes calibrations.

D. Troubleshooting
   1. Refer to the ProDSS calibration guide and to the ProDSS user manual for troubleshooting tips when using the ProDSS sonde.
   2. Refer to the EXO handheld display manual for troubleshooting tips when using the EXO sonde.

3.0. Roles

3.1. Responsibilities

A. Crew chief
   1. Calibration and maintenance of YSI multiparameter data sondes

2. Creation of calibration fluids

B. Field crew
   1. Calibration and maintenance of YSI multiparameter data sondes
   2. Creation of calibration fluids

3.2. Training requirements

C. Calibration and maintenance of YSI multiparameter data sondes
   1. Crew chief
   2. Field crew

D. Creation of calibration fluids
   1. Crew chief
   2. Field crew

4.0. Required Forms, Equipment, and Reagents

4.1. Forms

A. Sonde Maintenance and Calibration Log (Appendix A)

4.2. Equipment

A. YSI ProDSS sonde and ProDIGITAL handheld display
B. YSI EXO sonde and EXO handheld display

4.3. Reagents

A. Potassium chloride (conductivity standard)
B. pH buffer 4.0 (if necessary)
C. pH buffer 7.0
D. pH buffer 10.0

Note: pH buffers are made from Hydrion® Buffer Chemvelopes from Microessential Laboratory

5.0. Records Management

5.1. The Sonde Maintenance and Calibration Logs are kept in a binder in the survey's lab for a period of five years.

5.2. After five years these logs are scanned into the Virtual File Cabinet (VFC).

6.0. Definitions

6.1. Virtual File Cabinet (VFC) – The agency's electronic document management repository. This repository has all the functionality necessary to capture, store, file, index, redact, reassemble, and securely access electronic documents of all types both received and created by the various

programs within the agency and allows public viewing, searching, and printing capabilities.

6.2. Multiparameter data sonde (MDS) – An instrument that collects water quality data with multiple replaceable sensors (Figures 4 and 5). Each sensor measures its parameter via a variety of electrochemical, optical, or physical detection methods. Data is stored onboard the sonde. Data can be transferred to a data collection platform or relayed directly to a PC or a handheld display. Users typically communicate with the sonde via a cable assembly (also called a field cable) to a handheld display.

Figure 4. Image of a ProDSS sonde with cable assembly and calibration cup attached and an EXO sonde with calibration cup attached.

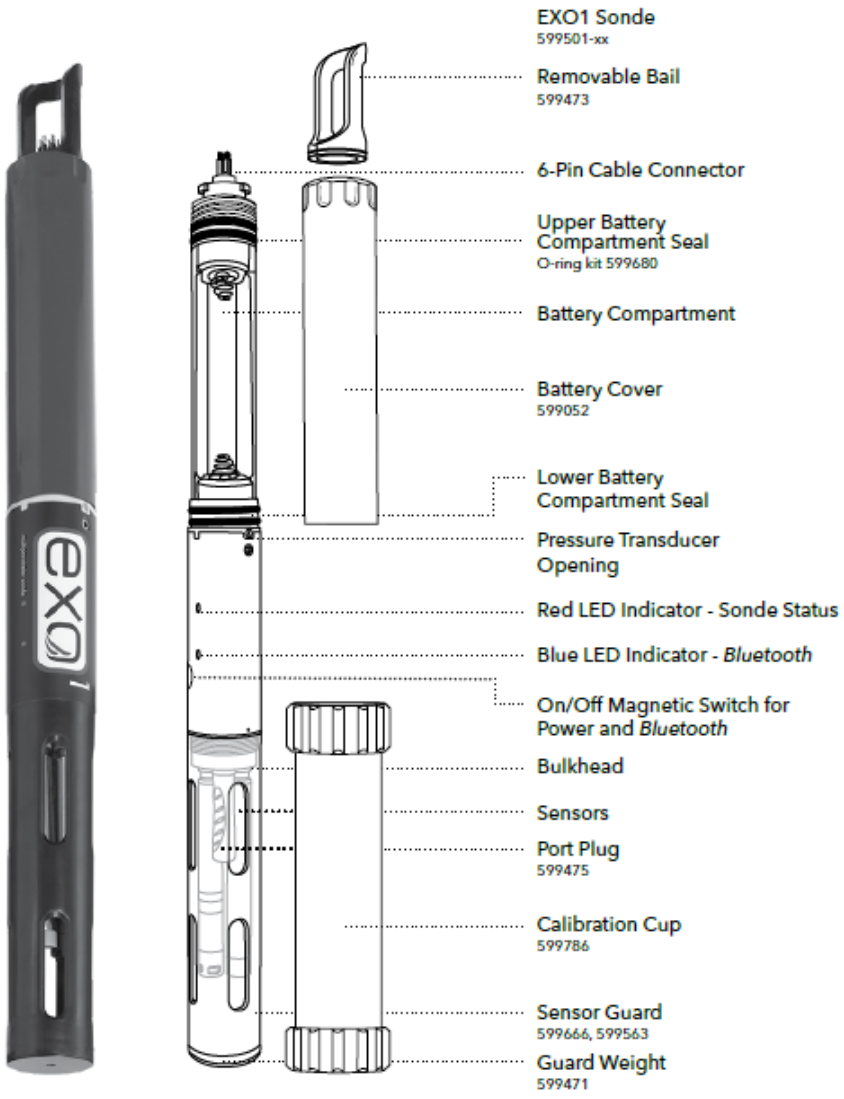


Figure 5. Diagram of an EXO sonde.

6.3. Handheld display – A microcomputer-based instrument that allows the user to display sonde readings, configure sondes, store, and retrieve data, and transfer data from sondes to a computer (Figure 6).

Figure 6. YSI ProDSS and YSI EXO handheld displays.

7.0. Quality Assurance and Quality Control

7.1. Calibration of a multiparameter data sonde is good for one week.

7.2. Failures during calibration should be recorded in the comments section on the Sonde Maintenance and Calibration Log.

8.0 References

8.1 (Xylem 2018) YSI ProDSS User Manual English. ITEM# 626973-01REF, Revision F

8.2 (Xylem 2017) ProDSS Calibration Guide. Version W89 0117

8.3 (Xylem 2016) EXO Handheld Operation Guide. E117 Mini-Manual, Revision A

8.4 (IDEM 2019) IDEM Hazard Communication (HazCom) Plan.

8.5 (IDEM) OWQ Watershed Assessment and Planning Branch Laboratory Safety Plan.

Appendix A: Sonde Maintenance and Calibration Log

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
SONDE MAINTENANCE AND CALIBRATION LOG

Revised 6-2023

YSI Model: ________________ Unit # / Serial#: ________________

			CALIBRATION													
Date/ Initials	DO Y/N	DO Drift	DO Gain in GLP After Cal (0.75 to 1.50)	pH Y/N	pH 7 Drift	pH 10 Drift	pH mV Buffer 7 (-50 to 50 mV)	pH mV Buffer 10 (-165 to -185 mV From pH 7 Buffer mV Value)	pH Slope in GLP After Cal (abt. 55-60, ideal 59)	Spec Cond Y/N	Spec Cond Drift	Spec Cond Cal Const. in GLP (4.5-6.5)	Cal Fluids Used	Manufacturer/ Lot#	Date Made	Date Expired
													pH 7.0			
													pH 10.0			
													718 uS/cm			
Comments																
													pH 7.0			
													pH 10.0			
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