STANDARD OPERATING PROCEDURE FOR CALIBRATION, MAINTENANCE, AND USE OF MULTIPARAMETER WATER QUALITY SONDES

WATER QUALITY

State of Utah
Department of Environmental Quality
Division of Water Quality

Revision 2.1
Effective May, 2020

Foreword

Utah Division of Water Quality (DWQ) Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical experts. This document is intended primarily for internal DWQ use. This SOP should not replace any official published methods.

Any reference within this document to specific equipment, manufacturers, or supplies is only for descriptive purposes and does not constitute an endorsement of a particular product or service by DWQ. Additionally, any distribution of this SOP does not constitute an endorsement of a particular procedure or method.

Although DWQ will follow this SOP in most instances, there may be instances in which DWQ will use an alternative methodology, procedure, or process.

The methodology detailed below is the protocol followed by DWQ's monitoring staff and verified by DWQ's Quality Assurance officer.

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06/02/2020

Date

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Revision Page

Date	Revision #	Summary of Changes	Sections	Other Comments
5/1/14	0	Created document	N/A	Put previous procedures into new standardized format; began document control/revision tracking.
6/1/2019	1	Update with InSitu SmarTroll calibration	All	Updated with current multiparameter sonde protocols.
4/1/2020	2.0	Update with all DWQ multiparameter sonde calibrations	All	Combined YSI®, Hydrolab®, and In-Situ® multiparameter sonde SOPS. Standardized naming convention, and updated title to reflect this.
4/13/2020	2.1	Updated language, grammar, and structure	All	Clarified and revised sentence structure and grammar throughout the entire document. Added PDR language in lieu of a Surveyor® or Tablet.

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1.0 SCOPE AND APPLICABILITY

This document presents the Utah Division of Water Quality's (DWQ) Standard Operating Procedures (SOP) for the calibration, use, and maintenance of multiparameter water quality sondes during water sample collection. Reliable water quality field readings (also referred to as field water quality measurements or parameters) are an essential part of any water quality monitoring program. Field readings are typically measurements of current water quality conditions at the time of water sample collection. If deployed for longer periods, multiparameter sondes can be used to record temporal changes in water quality. In addition, a multiparameter water quality sonde's portable recording device (PDR) allows other field information (such as weather and flow conditions at the time of sampling) to be recorded electronically.

This SOP applies to any DWQ personnel, DWQ cooperator, or volunteer using a multiparameter sonde for routine water quality sampling of surface waters (lakes, streams, wetlands, etc.). Multiparameter sondes can be used for either long-term deployment or point measurements during sample collection. Use of Multiparameter sondes to develop lake depth-profiles is included in a separate SOP (see DWQ's SOP for *Lake Water Sampling and Data Collection*).

The information discussed in this SOP is not a substitute for specific multiparameter sonde user manuals or other technical documentation. Consult the appropriate manual for a complete guide to the proper use, calibration, maintenance, storage, deployment, and troubleshooting of multiparameter sonde instruments. This SOP can be used as a reference but the complete user manual should always accompany the operator.

Additional helpful references for multiparameter sonde instrument use:

- *General multiparameter sonde use*
  - United States Geological Survey's Field Manual (Gibs et al. 2007)
- *Long-term deployment of multiparameter sondes*
  - USGS technical guidance (Wagner et al. 2006)
- *Hach Hydromet website (includes training videos)*
  - https://www.hach.com/

DWQ utilizes the following multiparameter sonde equipment:

Sondes: In-Situ®, Hydrolab®, and YSI®

PDRs: tablets, Surveyor 4, and YSI 650 MDS

2.0 SUMMARY OF METHOD

At DWQ, multiparameter sondes are calibrated at least once daily during use, unless being used for longer-term deployment applications. Multiparameter sondes are maintained according to a regular maintenance schedule and on an as-needed basis. Multiparameter sondes are used by DWQ to simultaneously measure pH (standard units), dissolved oxygen (DO) concentration (mg/L), dissolved oxygen (DO) percent saturation (% sat), specific conductance (µS/cm), and temperature (degrees Celsius). Readings are recorded on field data sheets, stored electronically on the PDR, downloaded to DWQ's server, and then uploaded to DWQ's database after a monitoring trip is completed.

3.0 DEFINITIONS

Annotation: A series of text stored on the Hydrolab Surveyor® that identifies the DWQ site ID, project code, type of water being sampled, sampling organization, weather conditions, site conditions, etc.

BP: Barometric pressure

Calibration: Checking or adjusting (by comparison with a standard of known value) the accuracy of a measuring instrument; calibration errors lead to inaccurate results and measurement bias.

Deployment: Refers to long-term unattended monitoring of water quality parameters using the multiparameter sonde to log data at programmed intervals.

DI: Deionized water

DO:	Dissolved oxygen
Hydrolab®:	A type of water quality multiparameter instrument by Hydrolab® that measures water quality parameters such as dissolved oxygen, pH, specific conductance, depth, and temperature.
SmarTROLL MP®:	A type of water quality multiparameter instrument by In-Situ that measures water quality parameters such as dissolved oxygen, pH, specific conductance, depth, and temperature.
µS/cm:	microsiemens per centimeter.
mg/L:	milligrams per liter.
mm Hg:	millimeters of mercury.
MSDS:	Material Safety Data Sheet.
Multiparameter Sonde:	An instrument combining several sensors on one piece of equipment, enabling simultaneous collection of several water quality parameters in the field. Generally, it measures dissolved oxygen, pH, specific conductance, depth, and temperature. Measurements may be instantaneous or logged over time.
PDR:	Portable Data Recorder. Any tablet, phone, or device used to record data from the multiparameter sonde.
SRM:	Standard Reference Material. A calibration standard used to verify sensor calibration.
Surveyor®:	The portable data recorder for the Hydrolab® sonde. It is attached to the sonde by a cord and is fully detachable. All annotations entered and data collected are stored within the Surveyor®. DWQ's Hydrolabs® are equipped with the Surveyor® 4 model.
Triple Rinse:	Fill a sample container ½ full with native or DI water, agitate, and empty three times. Triple-rinsing is an EPA verified procedure proven to remove and/or dilute contamination
YSI®:	A type of multiparameter sonde instrument manufactured by YSI that measures in-situ water quality parameters such as dissolved oxygen, pH, specific conductance, depth, and temperature. These are predominantly used by DWQ for long-term deployment.

4.0 HEALTH AND SAFETY WARNINGS

Hazardous conditions potentially exist at every waterbody. If unfavorable conditions are present at the time of sampling, it is recommended that the sampling be rescheduled. If hazardous conditions arise during sampling, such as lightning, high winds, rising water, or flash flood warning, personnel should cease sampling and move to a safe location.

When working in Utah and other warm climates, take steps to avoid heat induced illnesses such as heat stroke or heat exhaustion.

Use caution when working in waders as drowning hazards exist.

Take appropriate precautions when operating equipment and working on, in, or around water, as well as possibly steep and unconsolidated banks, bridges, or edges of ponds/lagoons. All field crews should follow DWQ health and safety procedures and be equipped with safety equipment such as proper wading gear, personal flotation devices (PFDs), gloves, first aid kits, cellular phone, etc.

Use caution when sampling from a bridge or boat and take appropriate actions to make the situation as safe as possible; suspend the sampling if conditions are unsafe.

Wear gloves or be sure to wash hands after sampling, especially when sampling wastewater discharges or ponds, lagoons, or other potentially contaminated sampling points at regulated facilities.

Take appropriate precautions when operating watercraft and working on, in, or around water. All boats should be equipped with safety equipment such as personal flotation devices (PFDs), oars, air horn, etc. Utah's "Boating Laws and Rules" shall be followed by all field personnel.

An electrical shock hazard exists if the multiparameter sonde is used in a wet or outdoor environment while powered via the external 115 VAC power supply. During field use, operate using battery power only. If it is necessary to power the multiparameter sonde with the 115 VAC power supply in wet/outdoor conditions, a Ground Fault Interrupt (GFI) circuit is required (installation must be performed by a licensed electrician).

Use caution if a sensor is broken during use: exposed parts may include sharp and broken glass and wires.

When loosening removable parts from a multiparameter sonde, point the instrument away from your body and other people. Pressure may build up under the removable parts, causing them to disengage with force, potentially causing bodily harm.

Take care during battery replacement to not mix depleted and fresh batteries, make sure batteries are installed in the correct orientation, and to open the compartment slowly and carefully – failure to do so may result in bodily harm and/or damage to the instrument.

Calibration standards are generally safe but skin contact should be avoided as a precaution. Also, avoid skin contact and inhalation of potentially hazardous solutions used for equipment cleaning such as isopropyl alcohol. Consult the MSDS for each solution used to become aware of any potential hazards.

5.0 CAUTIONS

The instructions in this SOP and in the applicable multiparameter user manual must be followed by all field personnel to avoid damage or loss of expensive equipment.

Use the supplied sensor guard to protect the sensors on the sonde during use. Failure to cover the sensors with the sensor guard could result in irreparable damage to the sensors.

Always store the sonde properly: between sampling sites, fill the plastic cup covering the sensors with a very small amount of tap water (no more than ½ inch) to keep the sensors moist, or keep a damp sponge in the bottom of the cup. If stored improperly for short periods of time (between sampling sites), the multiparameter sonde may give inaccurate readings. If stored improperly for long periods of time (the sensors are allowed to dry out completely), the sensors may be irreparably damaged. See **Section 9.5** for detailed storage instructions.

Use caution when suspending the multiparameter sonde from a bridge; be observant of debris coming from upstream that may damage the sonde or become entangled in the cable.

Take care when storing the multiparameter sonde in the field vehicle to ensure it is safe from breakage during transport.

If using the Hydrolab® multiparameter sonde, water can get trapped between the battery cap contact surface and the top of the battery compartment o-rings. To avoid water leaks into the battery compartment during maintenance or replacement, place the sonde horizontally on the work surface when removing the battery cap. If water leaks into the battery compartment, remove the batteries, pour the water out, and thoroughly dry the compartment with a hair dryer (on low heat) or a towel. Once dry, install new batteries.

It is recommended that the multiparameter sondes not be exposed to extreme temperatures below 1°C or above 50°C.

6.0 INTERFERENCES

The multiparameter sonde must be properly calibrated to ensure accurate results.

Inaccurate readings may result if the multiparameter sonde is lowered into bottom sediments or stagnant water versus flowing or open water. Collect readings after any disturbed sediments have been cleared by the current.

When sampling wetlands or other slow-flowing or non-flowing water bodies, avoid sediment stirred up from wading to the sampling point to ensure an accurate reading of field parameters. Lower the sonde from a boat in these situations.

7.0 PERSONNEL QUALIFICATIONS/RESPONSIBILITIES

DWQ personnel performing water sampling must be familiar with sampling techniques, safety procedures, proper handling, and record keeping. Samplers are responsible for attending refresher meetings held each spring/summer to review procedures and techniques. New staff will be trained in the field and lab by DWQ personnel.

Cooperators are required to read this SOP annually and acknowledge they have done so via a signature page (see **Appendix 1**) that will be kept on-file at DWQ along with the official hard copy of this SOP.

Note: The procedures discussed in this SOP can change over time as a result of the technological changes being implemented; such information generally is available from the manufacturer, either online or in an updated user manual or other technical guidance document. Monitors operating multiparameter sondes must stay current as to how their instrument operates and is maintained.

8.0 EQUIPMENT AND SUPPLIES

- ❑ Copy of this SOP
- ❑ Site portfolio
- ❑ Copy of project-specific SAP (Sampling and Analysis Plan)
- ❑ Multiparameter Sonde Calibration sheet (see **Appendix 2**)
- ❑ Multiparameter Sonde case
- ❑ PDR
- ❑ PDR charging cables and batteries
- ❑ Maintenance tool kit
- ❑ Multiparameter Sonde calibration cup and cap
- ❑ Multiparameter Sonde sensor guard
- ❑ Barometer (if Surveyor® is not equipped with a barometer)
- ❑ Tap water
- ❑ DI water
- ❑ Certified pH calibration standard solutions (also called buffer)
    - ❑ pH 7 and 10
    - ❑ temperature correction chart
- ❑ pH SRM or other certified pH standard (generally a pH 9) to check calibration
- ❑ Certified conductivity calibration standard solutions
    - ❑ 500 and 1413 µS/cm (generally)
- ❑ Aquarium air pump with a bubbler stone
- ❑ Container of tap water at room temperature
- ❑ Container of tap water (gallon or half gallon jug) at ambient field temperature
- ❑ Lint-free cloth (such as Kimwipes)

9.0 PROCEDURE

9.1 PRE-SAMPLING TRIP PREPARATION

1. Review the project-specific SAP to confirm the sampling locations and the targeted sampling conditions.

2. Coordinate with other monitors to make sure equipment is available for use.

3. Charge the PDR prior to sampling. On longer sampling trips, the PDR should be charged each night before use the next day.

4. Replace or charge sonde batteries if needed.

5. Obtain any necessary permission for site access.

9.2 CALIBRATION

In order to ensure reliability of readings, the instruments are calibrated each morning prior to sampling and at any time during the day following a reading that may be unusual or exceeding physical standards set forth in R317-2 Standards of Quality for Waters of the State.

Ideally, choose calibration standards that are close to or bracket values expected in the field. To ensure accuracy, discard used calibration standards after use; do not reuse calibration standards. Do not use calibration standards after their stated expiration date.

Buffers should be protected against wide temperature variations, whether in transit, during use, or in storage. Buffers that experience extreme heat or freezing temperatures are assumed to be compromised. Discard compromised buffer solutions appropriately and notify the DWQ monitor responsible for purchasing new buffer solutions. Store buffer solutions in coolers while in the field to protect them from extreme heat or cold, if necessary.

For optimum calibration, allow time for thermal stabilization of the calibration standards and equipment. For example, if calibrating indoors, and the standards have been kept overnight in a truck outdoors in cooler air, allow the standards and equipment to come to room temperature. To reduce the time for stabilization, keep all calibration standards and equipment stored at the same temperature prior to calibration. Perform calibrations in a controlled setting.

Before calibration, inspect the sensors and perform any necessary cleaning or maintenance.

Never insert a sensor into a buffer stock solution bottle during calibration; pour the buffer solution off into a separate container.

Because pH buffer solutions typically have conductivities higher than conductivity standards or environmental waters, sondes should be calibrated first with conductivity solutions and then pH solutions.

Reference DWQ's Calibration Sheet (**Appendix 2**) for any further questions.

9.2.1 GENERAL

1. Prepare a calibration sheet (**Appendix 2**) by recording calibration solution values, expiration dates, and SRM values.

2. Make sure the sonde and field data recorder are on and connected (via cord or Bluetooth)

3. Verify the time and date and record on the calibration sheet

9.2.2 TEMPERATURE

The temperature sensor is factory-calibrated and no adjustment is necessary. Accuracy should be checked with an NIST (National Institute of Standards and Technology) traceable thermometer annually, and if inaccurate readings are suspected at any time.

9.2.3 SPECIFIC CONDUCTANCE

For conductivity, choose calibration standard value that is near the expected environmental values. At DWQ, the two conductivity measures generally used are 1413 and 500 µS/cm. See **Appendix 2** for more information about calibration ambient temperature offsets.

This calibration should be done first.

1. Find the conductivity calibration section on the portable data recorder (PDR).

2. Triple rinse the cup used for calibration using the calibration solution

    a. (500 or 1413 µS/cm).

3. Start the calibration procedure on the PDR.

4. Wait for stabilization and accept the calibration value.

5. Verify calibration with appropriate SRM (either 500 or 1413 µS/cm).

6. Record verification value on the calibration sheet.

For Example:

Sampling is occurring at Utah Lake which generally has a higher conductivity, so 1413 µS/cm is the closest conductivity to the expected field conditions. Calibrate to 1413 µS/cm. After calibration, verify conductivity against the 500 µS/cm. **The verification reading must be within 10% of 500.** If it is not, the calibration has failed and the parameter needs to be re-calibrated. See **Table 1** for more information on troubleshooting issues involved in sonde calibration and use.

9.2.4 PH (TWO-POINT CALIBRATION)

See **Appendix 2** for more information about calibration ambient temperature offsets.

1. Find the pH calibration section on the PDR
2. Triple rinse the cup used for calibration using the 7.0 pH calibration solution
3. Start the calibration procedure on the PDR
4. Wait for stabilization and accept the calibration value
5. Repeat steps 10-12 with 10.0 pH calibration solution
6. Verify calibration with appropriate SRM (pH 9.0)
7. Record verification value on the calibration sheet.

For Example:

Calibrate to 7.0 and 10.0 pH. After calibration, verify pH against a 9.0 pH. **The verification reading must be within 5% of 9.0 pH.** If it is not, the calibration has failed and the parameter needs to be re-calibrated. See **Table 1** for more information on troubleshooting issues involved in sonde calibration and use.

9.2.5 DISSOLVED OXYGEN

Accurate dissolved oxygen calibration depends on accurate barometric pressure readings. Barometers should be checked if inaccurate readings are suspected during use.

Depending on the multiparameter sonde, Dissolved Oxygen can be calibrated using water saturated air (In-Situ® Sondes), or air saturated water (YSI® and Hydrolab® Sondes).

Water Saturated Air Method

This sensor is calibrated by immersing the probe into a vented calibration cup with a water saturated sponge. Calibration of DO % Saturation also calibrates DO mg/L.

1. In the vented calibration cup, saturate a small sponge with tap water.
2. Put the sonde into the vented calibration cup.
3. Start the calibration procedure on the PDR
4. Wait for stabilization and accept the calibration value
5. Verify calibration
6. Record verification value on the calibration sheet.

For Example:

Calibrate to 100% saturation. After calibration, verify the 100% saturation. **The verification reading must be within 5% of 100%.** If it is not, the calibration has failed and the parameter

needs to be re-calibrated. See **Table 1** for more information on troubleshooting issues involved in sonde calibration and use.

Air Saturated Water Method

This sensor is calibrated by immersing the probe into a container of tap water which has been saturated with air by an air pump with a bubbler stone and then calibrating to the local corrected BP. Calibration of DO % Saturation also calibrates DO mg/L.

1. Fill up a container with tap water at least 12 hours prior to calibration. This allows for the water to stabilize to room temperature.

Note: Changes in water temperature while calibrating will cause errors in the calibration results. If water temperature changes more than 0.5°C during calibration, it is recommended to recalibrate the sensor.

2. Prior to the calibration for conductivity and pH, put an air pump into the container of tap water and turn it on.

3. After aerating the water for a minimum of 5 minutes, unplug the pump and proceed with calibration. If the pump is left on during calibration, oversaturation will occur and cause errors in the calibration results.

Note: If calibrating in the field, it is not necessary to pack a bubbler. Instead, create air-saturated tap water by filling a ½ gallon container with tap water stabilized to the ambient temperature and vigorously shake it for 40 seconds prior to using. Calibrate the probe in a shaded area so heating of the water from the sun does not affect the calibration results.

4. Hold the sonde vertical with the sensors pointing up; keep the calibration cup on but remove the cap.

5. Fill the cup with air-saturated water up to the level of the cup threads, immersing the probe. Cover the calibration cup with the cap inverted. Allow the readings to stabilize. Do not screw the cap on as this will yield an inaccurate calibration result.

6. Wait for stabilization and accept the calibration value

7. Type the BP reading from the display or handheld barometer. (Specific to Hydrolab®)

8. Verify calibration.

9. Record verification value on the calibration sheet.

For Example:

Calibrate to 100% saturation. After calibration, verify the 100% saturation. **The verification reading must be within 5% of 100%.** If it is not, the calibration has failed and the parameter needs to be re-calibrated. See **Table 1** for more information on troubleshooting issues involved in sonde calibration and use.

9.3 Routine Field Use

The following steps may be altered based on the project specific SAP.

1. Name the site on the PDR based on DWQ's site IDs.

2. At the sampling site, remove the calibration cup.

3. Position the sonde in the waterbody. The multiparameter sonde may be positioned in the waterbody to be sampled using the following methods:

4. Wading into a flowing waterbody and positioning the sonde in the thalweg.

5. Positioning the sonde in water along a bank/edge (preferably a location with good flow) if waterbody cannot be waded.

6. Lowering the sonde into a waterbody from a bridge or a boat, ensuring that the sonde is upstream from any other sampling activity.

7. Use a cable of appropriate length, place the sonde in water that is well-mixed whenever possible, avoid laying the sonde in bottom sediments or between large rocks on stream bottoms, and allow the sonde to orient itself to the flow (sensors will face downstream in a flowing waterbody).

8. While the readings stabilize, look over the water quality readings displayed on the PDR to make sure they are reasonable. For example, a very low specific conductance (or a value of zero) may indicate an air bubble trapped in the conductivity cell or that the multiparameter sonde is placed in a riffle.

9. **Recalibration:**

    a. Repeat and record the calibration in the event of a violation of a water quality standard based on numeric criteria (i.e. pH <6.5 or >9, DO <6.5 mg/L). Note that waterbodies may be listed as impaired for field readings outside of Utah's Water Quality Standards numeric criteria for pH and DO.

    b. Note the true (actual) BP at the sampling location either using the Sondes' barometer or a separate barometer if your Sonde is not equipped with a barometer. If the BP has changed from the value used for calibration by ≥ 5 mm Hg, DO should be recalibrated in the field prior to sampling because the DO saturation % will no longer be accurate. Some SAPs may call for calibrating DO at each field site.

    c. Verify specific conductance. If the value measured is greater than 10 times or less than 1/10 the standard used for calibration the standard solution chosen was not close enough to the field value and the sonde needs to be verified using a standard within this range.

10. Once the readings have been verified by the operator and all parameters have stabilized, select "Store" and choose the appropriate file to record the readings on the PDR.

11. Record readings on the trip sheet (see **Appendix 3**). This serves as a backup in case the PDR loses data.

12. Be sure to safely store the multiparameter sonde in the field vehicle for transport between sites. Also, ensure sensors do not dry out between sites. *Do not* store the sensors in DI water between sites, *do not* allow the sensors to dry out, and *do not* allow any storage medium to freeze around the sensors.

9.4 Post-Sampling Trip Activities

1. Download the data from the PDR

2. Format the parameters into the DWQ hydrofile format (see appendix x)

3. Verify that the values, site IDs, and sample date are accurate

4. **See DWQ's data management guidelines document for a workflow of this process**

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9.5 Multiparameter Sonde Storage

Short Term Storage: one to three weeks

- Store the probes in a low pH buffer solution (<6) or tap water as a storage solution. If the sonde has a low ionic strength pH reference sensor, fill the rubber cap with pH reference solution and slide it snugly over the sensor.

- Do not allow the storage solution to freeze around the sensors. Do not store the sensors in DI water or environmental water.

Long Term Storage: one month or longer

- If the sonde has batteries in it used for long term deployment, remove the batteries during long term storage. Leave the lithium clock battery inside the sonde.

- Store the probes in a low pH (<6) buffer or calibration solution. If the sonde has a low ionic strength pH reference sensor, fill the rubber cap with pH reference solution and slide it snugly over the sensor.

- Do not allow the storage solution to freeze around the sensors. Do not store the sensors in DI water or environmental water.

- When sonde is taken out of storage soak the probes in tap water for approximately 30 mins.

- After soaking in tap water the probes must be serviced again as per the maintenance schedule.

Cable Storage

- Store the cables in coils of at least 6" diameter or larger. Never knot cables.
- Use the protective plugs when the cables are stored making sure the ends are well lubricated with silicone grease. **Do not use any other kind of grease.**

9.6 Troubleshooting

Table 1: Multiparameter Sonde Calibration Issues

Calibration Issues?		
In-Situ®	**Hydrolab®**	**YSI®**
Conductivity: sensor built into sonde • Check for debris or bubbles around the sensor • Recalibrate • If failed again, call *In-Situ®*	**Conductivity:** sensor built into sonde • Check for debris or bubbles around the sensor • Recalibrate • If failed again, call *HydroTech*	**Conductivity:** sensor built into sonde • Check for debris or bubbles around the sensor • Recalibrate • If failed again, call *YSI®*
pH: removable probe • Replace reference solution • Inspect and replace pH reference junction • If failed again, replace sensor	**pH:** removable probe • Replace reference solution • Inspect and replace pH reference junction • If failed again, replace sensor	**pH:** removable probe • Replace reference solution • Inspect and replace pH reference junction • If failed again, replace sensor
DO: removable probe • Double check BP and recalibrate • Inspect DO cap for damage and replace if necessary • If failed again, replace sensor	**DO:** removable probe • Double check BP and recalibrate • Inspect DO cap for damage and replace if necessary • If failed again, replace sensor	**DO:** removable probe • Double check BP and recalibrate • Inspect DO cap for damage and replace if necessary • If failed again, replace sensor

Table 2: Multiparameter Sonde Annual Maintenance

Annual Maintenance		
In-Situ®	**Hydrolab®**	**YSI®**
Temperature: • Verify with NIST thermometer • Lightly clean temperature sensor with a non-abrasive brush	**Temperature:** • Verify with NIST thermometer • Lightly clean temperature sensor with a non-abrasive brush	**Temperature:** • Verify with NIST thermometer • Lightly clean temperature sensor with a non-abrasive brush
Conductivity: • No additional maintenance	**Conductivity:** • No additional maintenance	**Conductivity:** • No additional maintenance
pH: • Replace reference solution, or as needed when pH is slow to equilibrate • Replace reference junction when dirty (should appear white)	**pH:** • Replace reference solution, or as needed when pH is slow to equilibrate • Replace reference junction when dirty (should appear white)	**pH:** • Replace reference solution, or as needed when pH is slow to equilibrate • Replace reference junction when dirty (should appear white)
DO: • Replace DO cap when PDR indicates, based upon use. There is a countdown maintained (~18 months)	**DO:** • Replace DO cap	**DO:** • Replace DO cap

- If a multiparameter sonde needs repair or a replacement part contact appropriate DWQ staff to arrange the service.

- If the "Calibration Failed" message is displayed during sensor calibration, check that calibration standards are within expiration dates and have been stored properly. If there are no problems with calibration standards, attempt to recalibrate. If the calibration fails a second time, clean the sensor (see **Table 1**) and repeat the calibration. If calibration fails again, the sensor likely needs maintenance or repair. Refer to **Table 2**.

- If the Surveyor® display shows a warning message, do not use the sensor until the error has been identified and corrected.

- Consult the multiparameter sonde user manual for additional troubleshooting assistance.

9.7 Schedule of Maintenance Activities

Maintenance schedules for DWQ's multiparameter sondes should be recorded on the spreadsheet maintained by the DWQ Monitor in charge of Sonde Tracking (See **Appendix 4**).

Always rinse the multiparameter sonde with clean tap water soon after leaving the field site.

Weekly Maintenance Activities

Cleaning: Sondes should be cleaned off with soap and water. Clean the casing with a sponge and clean the sensors with an extra soft toothbrush and cotton swabs. Clean calibration cups and sensor guards with soap and water.

Probe Maintenance:

- **DO** – Inspect the sensor to determine whether it needs maintenance. Clean DO sensor with soapy water and cotton swab; DO NOT USE ALCOHOL.
- **pH** – After returning from a monitoring run, gently clean outside of the sensor with isopropyl alcohol, and replace electrode solution with 4 molar KCL solution.
- **Other sensors** – Clean with soap, water, and cotton swab. Fill the calibration cup with a small amount of clean tap water for storage, never DI.

NOTE: Wait 24 hours before calibrating sensors after changing pH solution or reference junction.

Monthly Maintenance Activities

- **pH –** Change the Teflon Reference Junction every three months. Detailed instructions are included in the user manual.
- **Conductivity –** Use cotton swabs to clean between cells.

Miscellaneous – Soak sensors and sensor guards in vinegar for 20 minutes if hard water stains are present. Clean the outside of all sensors with isopropyl alcohol, except the LDO sensor which should be cleaned with soap only.

9.7.1 Repair

If a sonde or sensor needs repair, report the issue to the DWQ monitor responsible for multiparameter sonde maintenance and repair.

10.0 DATA AND RECORDS MANAGEMENT

During calibration, fill out the multiparameter sonde calibration sheet (**Appendix 2**) completely and accurately. On the multiparameter sonde calibration sheet note any problems that arose during calibration or in the field and whether it was resolved or not. If the problem cannot be resolved, the person responsible for multiparameter sonde maintenance is to be notified and the multiparameter sonde calibration sheet with the problem noted on it given to them so they can conduct the repairs or have the unit sent off for repair if necessary. Also note any equipment issues or purchasing needs in the field notes.

During routine water sampling, record all multiparameter sonde field readings on the Trip Sheet (see **Appendix 3**). The Trip Sheet is important as a backup for the electronic field data and is used by QA Staff for data review and verification. The Trip Sheet is scanned and stored in DWQ's shared folders.

Downloaded multiparameter sonde files are to be saved into the "Monitors" folder in the DWQ shared drive (which is backed up routinely onto DEQ servers). Multiparameter sonde data must be edited before it can be uploaded into the DWQ's Water Quality database. See DWQ's guidance for Field Data Management for current, detailed instructions on data reduction, calculations, verification, and formatting.

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11.0 QUALITY ASSURANCE AND QUALITY CONTROL

Multiparameter sondes must be calibrated before use and calibration (and recalibration) must be documented as described in this SOP or other project-specific documentation.

Project-specific QAQC requirements are described in project-specific Sampling and Analysis Plans (SAPs) and should be communicated to the field team by the Project Manager.

Representative water-quality data is to be collected according to the sampling conditions required under the project-specific SAP. Multiparameter sonde operators should not alter designated sampling locations or times unless otherwise directed by a project manager. If hydrologic conditions are significantly different from those targeted in the SAP, operators should contact the project manager for further instructions. Operators should record in field notes any site conditions that may lead to an unrepresentative field reading and should take site photographs to record these observations.

12.0 REFERENCES

Gibs, Jacob, Wilde, F.D., and Heckathorn, H.A., 2007, Use of multiparameter instruments for routine field measurements (ver. 1.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6, section 6.8, August, available only online at http://water.usgs.gov/owq/FieldManual/Chapter6/6.8.html.

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Surveyor 4a – User Manual. 2004. Hach Company. Catalog Number 003070HY, eac/dp 12/04 Edition 2. http://www.hydrolab.com/web/ott_hach.nsf/gfx/Surveyor4a-Manual.pdf/$file/Surveyor4a-Manual.pdf

Swanson, T. 2010. Standard operating procedures for Hydrolab DataSonde® and MiniSonde® Multiprobes. Washington State Department of Ecology Environmental Assessment Program. Version 1.0.

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., Smith, B.A. 2006. Guidelines and standard procedures for continuous water-quality monitors; Station operation, record computation, and data reporting (ver. 1.0): U.S. Geological Survey Techniques and Methods 1 - D3, 96 p., available only online at http://pubs.usgs.gov/tm/2006/tm1D3.

Wilde, F.D., editor. Variously-dated. Field measurements: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6, with sec. 6.0–6.8, accessed at http://pubs.water.usgs.gov/twri9A6/.

Related DWQ SOPs:

Standard Operating Procedure for Lake Sampling and Data Collection
SOP for Water Chemistry Sample Collection in Streams
Monitoring Section Guidelines for Managing Field Data and E. coli Data

Mulitparameter Sonde User Manual

Hydrolab®

- https://www.hach.com/

In-Situ®

- https://in-situ.com/us/

YSI®

- https://www.ysi.com/

13.0 APPENDICES

Appendix 1- SOP Acknowledgment and Training Form (front and back)

SOP Acknowledgement Form

This SOP must be read and acknowledged annually, and this form must be kept on file at DWQ.

Document Title:	
Document Revision Number:	
Document Revision Date:	

Please sign below in accordance with the following statement:

"I have read and understood the above referenced document. I agree to perform the procedures described in this SOP in accordance with the document until such time that it is superseded by a more recent approved revision."

Date	Printed Name	Signature

SOP Training Form

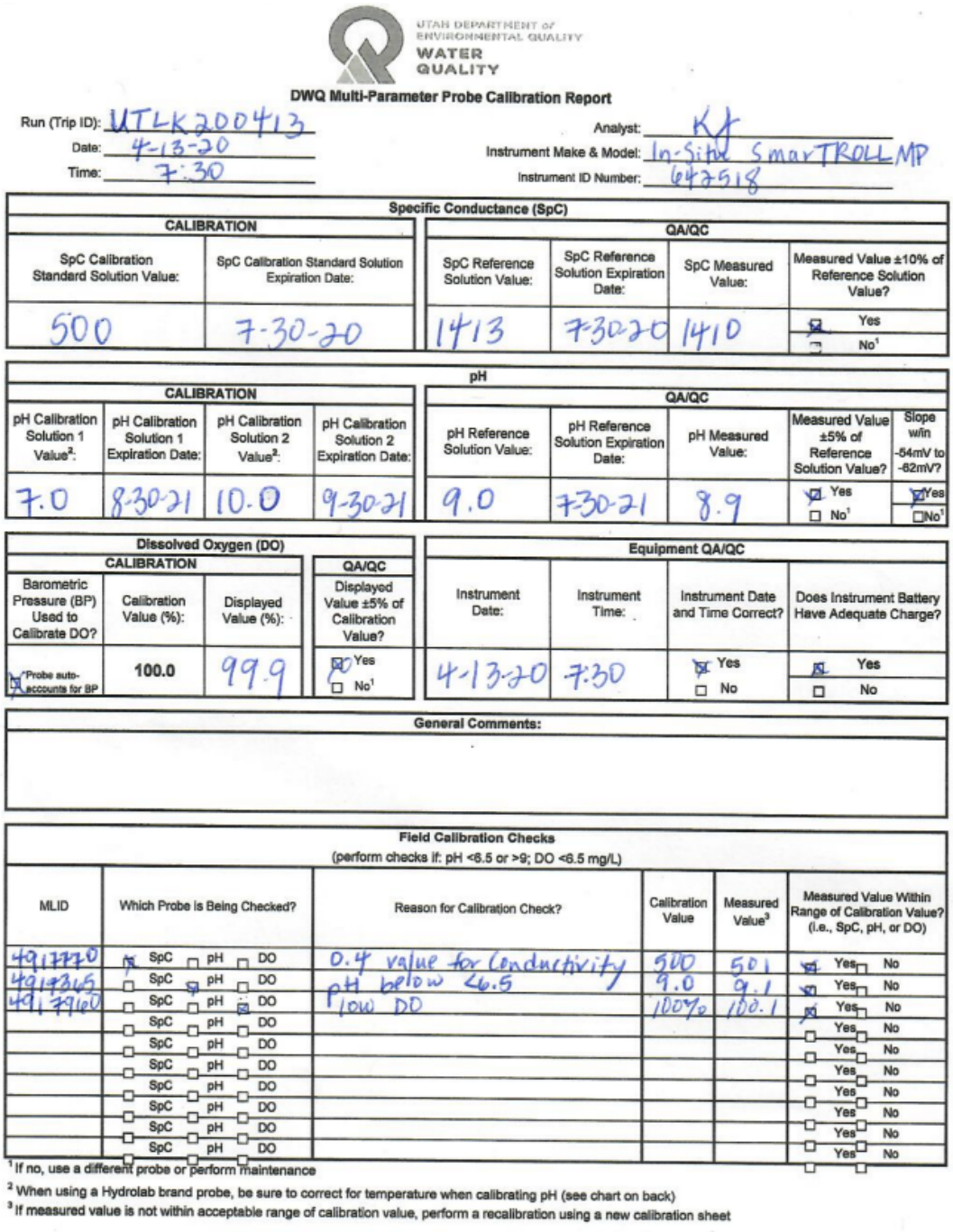
Training is required for all new samplers and Refreshers are required annually.

Trainee: Sign below to acknowledge that training on this SOP was received, understood, and all questions/concerns were addressed by the trainer.

Trainer: Sign below to acknowledge that training on this SOP was completed for the individual listed and that trainee is competent to perform the procedures described within.

Date	Trainee Printed Name	Trainee Signature	Trainer Printed Name	Trainer Signature
Management Approval				
Printed Name:				
Signature:				
Date:				

Appendix 2: Multiparameter Sonde Calibration Sheet (front)
(U:\WQ\PERMITS\MONITORS\Forms)



UTAH DEPARTMENT of ENVIRONMENTAL QUALITY
WATER QUALITY

DWQ Multi-Parameter Probe Calibration Report

Run (Trip ID): UTLK200413
Date: 4-13-20
Time: 7:30

Analyst: KJ
Instrument Make & Model: In-Situ SmarTROLL MP
Instrument ID Number: 647518

Specific Conductance (SpC)

CALIBRATION		QA/QC			
SpC Calibration Standard Solution Value:	SpC Calibration Standard Solution Expiration Date:	SpC Reference Solution Value:	SpC Reference Solution Expiration Date:	SpC Measured Value:	Measured Value ±10% of Reference Solution Value?
500	7-30-20	1413	7-30-20	1410	☒ Yes ☐ No[1]

pH

CALIBRATION				QA/QC				
pH Calibration Solution 1 Value[2]:	pH Calibration Solution 1 Expiration Date:	pH Calibration Solution 2 Value[2]:	pH Calibration Solution 2 Expiration Date:	pH Reference Solution Value:	pH Reference Solution Expiration Date:	pH Measured Value:	Measured Value ±5% of Reference Solution Value?	Slope w/in -54mV to -62mV?
7.0	8-30-21	10.0	9-30-21	9.0	7-30-21	8.9	☒ Yes ☐ No[1]	☒ Yes ☐ No[1]

Dissolved Oxygen (DO)

CALIBRATION			QA/QC	Equipment QA/QC			
Barometric Pressure (BP) Used to Calibrate DO?	Calibration Value (%):	Displayed Value (%):	Displayed Value ±5% of Calibration Value?	Instrument Date:	Instrument Time:	Instrument Date and Time Correct?	Does Instrument Battery Have Adequate Charge?
☒ *Probe auto-accounts for BP	100.0	99.9	☒ Yes ☐ No[1]	4-13-20	7:30	☒ Yes ☐ No	☒ Yes ☐ No

General Comments:

Field Calibration Checks
(perform checks if: pH <6.5 or >9; DO <6.5 mg/L)

MLID	Which Probe is Being Checked?	Reason for Calibration Check?	Calibration Value	Measured Value[3]	Measured Value Within Range of Calibration Value? (i.e., SpC, pH, or DO)
491770	☒ SpC ☐ pH ☐ DO	0.4 value for Conductivity	500	501	☒ Yes ☐ No
491345	☐ SpC ☒ pH ☐ DO	pH below 6.5	9.0	9.1	☒ Yes ☐ No
491760	☐ SpC ☐ pH ☒ DO	low DO	100%	100.1	☒ Yes ☐ No
	☐ SpC ☐ pH ☐ DO				☐ Yes ☐ No
	☐ SpC ☐ pH ☐ DO				☐ Yes ☐ No
	☐ SpC ☐ pH ☐ DO				☐ Yes ☐ No
	☐ SpC ☐ pH ☐ DO				☐ Yes ☐ No
	☐ SpC ☐ pH ☐ DO				☐ Yes ☐ No
	☐ SpC ☐ pH ☐ DO				☐ Yes ☐ No
	☐ SpC ☐ pH ☐ DO				☐ Yes ☐ No

[1] If no, use a different probe or perform maintenance
[2] When using a Hydrolab brand probe, be sure to correct for temperature when calibrating pH (see chart on back)
[3] If measured value is not within acceptable range of calibration value, perform a recalibration using a new calibration sheet

Multiparameter Sonde Calibration Sheet (back)

Specific Conductance Check Buffer Acceptability Range

SC Buffer Value	Acceptable 10% Range
100 µS/cm@25°C	90 - 110
500 µS/cm@25°C	450 - 550
1413 µS/cm@25°C	1272 - 1554
3000 µS/cm@25°C	2700 - 3300
20000 µS/cm@25°C	18000 - 22000

pH Buffer Solution Temperature Correction and Check Buffer/On-site Calibration Check Acceptability Range

pH 4.00		
°C	Value	Acceptable 5% Range
15	4.00	3.80 - 4.20
20	4.00	3.80 - 4.20
25	4.00	3.80 - 4.20
30	4.01	3.81 - 4.21

pH 5.80		
°C	Value	Acceptable 5% Range
15	5.79	5.50 - 6.08
20	5.80	5.51 - 6.09
25	5.80	5.51 - 6.09
30	5.80	5.51 - 6.09

pH 7.00		
°C	Value	Acceptable 5% Range
15	7.04	6.69 - 7.39
20	7.02	6.67 - 7.37
25	7.00	6.65 - 7.35
30	6.99	6.64 - 7.34

pH 9.00		
°C	Value	Acceptable 5% Range
15	9.10	8.65 - 9.56
20	9.05	8.60 - 9.50
25	9.00	8.55 - 9.45
30	8.97	8.52 - 9.42

pH 10.00		
°C	Value	Acceptable 5% Range
15	10.11	9.60 - 10.62
20	10.05	9.55 - 10.55
25	10.00	9.50 - 10.50
30	9.95	9.45 - 10.45

pH Slope
A functioning pH probe will have a slope between **-54mV and -62mV**. If out of this range, perform maintenance or use another Sonde. The meter will often provide the slope in a calibration report. Otherwise, use the mV to calculate the slope using this equation: Slope = (pH7 mV - pH10 mV)/3.

Field Calibration Checks	
pH	<6.5 or >9?
Dissolved Oxygen	<6.5 mg/L?
If yes, check the sensor to ensure it is still working or recalibrate as needed.	

Appendix 3: Trip Sheet Example

Monitoring Run Sample Summary

Trip ID :

Samplers:

Sampler Contact Information (name and phone number):

Trip Comments:

Seq. #	Project/ Cost Code	Monitoring Location ID	Station Desc.	Date	Time	W Temp units: °C	pH	SpC uS/cm	DO mg/L
1									
2									
3									
4									

Appendix 4: DWQ Sonde Tracking Form Example

DWQ Monitoring Sonde Sonde Sign-In/Out List: This will track our DWQ Probes and who has what.

Sonde-InSitu	Sonde Serial #	Does it work	Whats wrong	Status	Battery Serial #	Status	Cable Serial #
In-Situ	642518				663313	replaced 681517	619504
In-Situ	595936	new battery			630843	replaced 614661	610575
In-Situ	527707	Works			524880	at shop	
In-Situ	615647	Works			435314	at shop	
In-Situ	643814	Works					
In-Situ						**Marshall cubicle**	
In-Situ					463445	??	
In-Situ	640462	Works			631634	at shop	
In-Situ	642538				630853	at shop	
In-Situ	615645	Works			463429	at shop	
In-Situ					**686672**	**Marshall cubicle**	
In-Situ					**663313**	**Marshall cubicle**	
					612980		

Tablet only	Sonde Serial #				Condition		
Tablet only	NA				NA		