OPERATION OF THE WATER QUALITY MULTI-PARAMETER METERS

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1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes the procedures for assembly, calibration, usage and post-use verification of Multi-parameter Water Quality Meters. This SOP specifically covers the YSI® 650 MDS data logger with YSI 6920 sonde, which houses all the different sensors, and the Horiba® U-52, two of the typical units used by U.S. Environmental Protection Agency (EPA) Environmental Response Team (ERT) contractor personnel. These units consist of two pieces, the data logger and the sonde. These instruments are used to collect representative water quality data. The parameters that may be quantified include: temperature in degrees Celsius (°C), pH in standard units, dissolved oxygen (DO) in milligrams per liter (mg/L), conductivity in microsiemens per centimeter (µS/cm), turbidity in nephelometric turbidity units (NTU) and oxidation/reduction potential (ORP) in millivolts (mV). Always refer to each unit's operating manual for complete operating instructions. Due to the nature of this equipment and its use under different environmental conditions, data obtained will be considered screening data.

A Quality Assurance Project Plan (QAPP) in Uniform Federal Policy (UFP) format describing the project objectives must be prepared prior to deploying for a sampling event. The sampler needs to ensure that the methods used are adequate to satisfy the data quality objectives (DQOs) listed in the QAPP for a particular site.

The procedures in this SOP may be varied or changed as required, dependent on site conditions, equipment limitations or other procedural limitations. In all instances, the procedures employed must be documented on a Field Change Form and attached to the QAPP. These changes must be documented in the final deliverable.

2.0 METHOD SUMMARY

The multi-parameter water quality meters are used to obtain physical characteristics of both surface water and groundwater. Measurements can be collected by submerging the probe directly into the water, inserting the probe into a water sample, or through a flow cell. The instrument is calibrated prior to data collection and verified immediately following use in the field. Water quality measurements are transferred from the digital display into an equipment or site logbook or field datasheet. For further information refer to ERT SOP, *Logbook Documentation.* Data may be logged electronically for later download.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

When handling the data logger, it should be kept dry. Both the data logger and sonde should be protected from being damaged during routine fieldwork. Data loggers must be disconnected from the sonde before being stored. Sonde sensors must be stored with approximately 1/2 inch of tap water or pH 7 solution in the calibration and/or storage cup so that the sensors can remain moist without being immersed in liquid. The storage vessel must be sealed to minimize evaporation. The data logger and sonde must be stored at temperatures between -10 and 30°C with a relative humidity of under 80 percent (%), free from condensation. Additionally, the meter must be stored in areas void of dust, strong vibrations, or corrosive gases. The meters should not be stored in areas of extreme or fluctuating temperatures such as near air conditioners, direct sunlight, or in an area with strong wind.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Prior to field mobilization, the batteries of the unit should be checked and replaced or recharged as necessary. Batteries without sufficient charge may result in inaccurate measurements. If any parameter begins to drift during field measurements, consult the unit's operation manual or contact the manufacturer.
It is important to complete the instrument calibration and post-use verification procedures as soon as possible,

at or near the sampling location or site base station. Changes in barometric pressure, altitude, or ambient air temperature will affect the accuracy of the instrument.

Where possible, work in a shaded area as the readout may become obscured by bright sunlight. If the display is left in direct sunlight, the screen will become unreadable. Prolonged exposure to sunlight may damage the display.

If moisture gets inside the data logging unit, the unit may become inoperable.

Contaminated calibration solutions and/or air bubbles on the optical surface of the probe can lead to calibration errors when measuring turbidity. Negative turbidity readings may occur of clean water samples if the probe was not cleaned properly when last returned from the field and then recalibrated. Suspended particles in water may cause the turbidity readings to fluctuate.

5.0 EQUIPMENT/APPARATUS

The following equipment is necessary for field operation:

- Water Quality Meter (data logger, sonde and connection cable)
- Storage/calibration cup
- Flow-through cell (optional based on sample type)
- Logbook
- Soft paper wipes
- Two gallon bucket (or similar)

The following equipment is necessary for calibration:

- Altimeter/barometer, calibrated in accordance with manufacturer's recommendations
- Scissors or pocket knife (for trimming DO membrane)
- National Institute of Standards and Technology (NIST) traceable thermometer (glass, -1 to 51°C)
- Ring stand
- Clamp

6.0 REAGENTS

The following reagents are required for proper calibration:

- Deionized or distilled water, for use as a "0" NTU turbidity standard, rinsing calibration cups and determining DO
- Potassium Chloride (KCl) Solution for replacement of DO membrane
- NIST-traceable pH buffer solutions, (4.00, 7.00, and 10.00 standard units [S.U.]), for the YSI
- NIST-traceable turbidity standard solutions, 100 NTU or 126 NTU standards – based on specific sonde, for the YSI
- NIST-traceable conductivity standard solution, 0.9 to 9.9 millisiemens per centimeter (mS/cm) standard
- NIST-traceable ORP powder, for the YSI and Horiba
- Multi-parameter calibration solution, for the Horiba U-52
- Sodium Sulfite powder for zero DO calibration.

7.0 PROCEDURES

7.1 Assembly

The three major components of multi-parameter water quality meters are the data logger, data cable and sonde, which houses the probes. To assemble, first connect the data cable to the sonde by aligning the key on the data cable male connector to the slot in the sonde's connector head. Then connect the other end of the data cable to the data logger without forcing the pins into the connector. The meter is now ready for calibration.

7.2 Calibration

Calibration and/or verification and inspection of the water quality meter should be performed on a daily basis when in the field to adjust for changing field conditions.

The inspection and calibration of the water quality meters includes:

- Testing and calibration of probes
- Inspection and cleaning of seal areas
- Replacement of damaged O-rings
- Replacement of membranes and electrolytes, as needed
- Battery check or replacement
- Documentation of calibration and maintenance in equipment or site logbook

Refer to each unit's operation manual prior to calibration as calibration procedures vary. A multi-parameter solution can be used to calibrate the Horiba U-52 for pH, conductivity, turbidity, and dissolved oxygen or individual solutions can be used, also referred to as auto-calibration. See the Horiba U series manual for more information on auto calibration. The YSI uses individual solutions to calibrate the various sensors. For further information, follow sections 7.2.1 through 7.2.6 listed below.

7.2.1 Temperature Verification

Verification of the temperature sensor, the sensor is inserted into a bucket filled with water of a known temperature by using the NIST-traceable thermometer. Wait five minutes to allow the sensor probe and NIST-traceable thermometer to stabilize. Document the reading in the equipment or site logbook. Verification should be performed annually. If the displayed temperature is greater than (>) ±5°C from the reference thermometer, the unit should be returned to the manufacturer.

7.2.2 Dissolved Oxygen Calibration

Dissolved Oxygen (DO) is calibrated differently by the YSI and the Horiba instruments. For complete step by step details, refer to each unit's specific user manuals. The DO calibration should be performed every two months when not in normal use to verify that the probe is operational. During field use the calibration must be made daily to adjust for atmospheric and other changes that can alter DO readings.

YSI

The DO probe is calibrated using either the Winkler titration method of an aqueous solution or the Percent Saturation method in air. The latter method avoids the use of additional chemicals and hardware and is summarized here. Consult the YSI *User Manual* for a detailed description of both methods.

Prior to DO calibration, determine the local barometric pressure in millimeters of mercury (mm Hg) with a calibrated altimeter/ barometer. The YSI meter will prompt the user to enter the barometric pressure. Place approximately three milliliters (mL) of water, or a damp sponge, in the bottom of the calibration cup. Place the probe end of the sonde into the cup, being careful not to submerge either the DO or temperature probe into the water. Ensure the DO probe is vented to the atmosphere by engaging only one or two threads into the calibration cup. Wait approximately 10 to 15 minutes for the air in the calibration cup to become saturated with water vapor and for the temperature to stabilize. The DO calibration procedure will also automatically calibrate the probe in milligrams/liter (mg/L). Document in the equipment or site logbook the barometric pressure and whether or not, the sensor calibrated.

Horiba

The DO calibration requires a two-point calibration. The first is a zero calibration using deionized water or tap water. The second point uses a mixture of 50 grams (g) of sodium sulfite to 1000 milliliters (mL) of water. DO concentrations are reported in mg/L and are temperature dependent. Refer to the chart in the Horiba user manual, which lists DO concentrations at a standard range of temperatures. Further information on preparing the proper span calibration can be found in the Horiba user manual. Document the whether or not the sensor calibrated in the equipment or site logbook.

7.2.3 Conductivity Calibration

For units manufactured by both YSI and Horiba, rinse the calibration cup and probes with deionized or distilled water followed by a small amount of the conductivity solution. Fill the calibration cup with a conductivity standard between 0.9 mS/cm and 9.99 mS/cm and then immerse the probe end of the sonde into the solution until past the vent hole. Allow the temperature to equilibrate and conductivity readings to stabilize for at least one minute before proceeding. Enter the theoretical calibration value used during calibration (e.g., 10 mS/cm) into the unit.

Following calibration, rinse the sonde in tap or deionized/distilled water. If the sensor fails to calibrate it may need to be replaced. For the complete step-by-step process and for troubleshooting, refer to the specific unit's operation manual. Document in the equipment or site logbook the concentration of conductivity solution used, its lot number and expiration date, and whether or not the sensor calibrated.

7.2.4 pH Calibration

Calibration procedures for pH are similar for the YSI and the Horiba instruments. For complete step-by-step details, refer to each unit's specific user manuals. A two-point calibration is performed within a specific calibration range, either the 4-7 range or the 7-

10 range. Before beginning the two-point calibration procedure, the anticipated pH to be measured should be known. or either calibration range, record the calibration solutions used, their lot numbers and expiration dates in the equipment or site logbook.

Two-Point Calibration: Range 4 – 7

Rinse the calibration cup and sonde with deionized or distilled water. Fill the cup above the pH probe with the pH 7 buffer solution. Enter the actual pH value based on the calibration temperature. Document the pH value on the meter once the reading has stabilized. Rinse the cup with deionized or distilled water. Fill the cup with pH 4 buffer solution. Again enter the actual pH value based on the calibration temperature. Document the pH value on the meter once the reading has stabilized. Remove the sonde and rinse both the cup and the sonde with deionized or distilled water. The pH sensor is now calibrated and ready for use.

If the sensor fails to calibrate, the probe may need to be replaced. For troubleshooting, refer to the meter's operation manual.

Two-Point Calibration: Range 7 – 10

Rinse the calibration cup and sonde with deionized or distilled water. Fill the cup above the pH probe with the pH 7 buffer solution. Enter the actual pH value based on the calibration temperature. Document the pH value on the meter once the reading has stabilized. Rinse the cup with deionized or distilled water. Fill the cup with pH 10 buffer solution. Again enter the actual pH value based on the calibration temperature. Document the pH value on the meter once the reading has stabilized. Remove the sonde and rinse both the cup and the sonde with deionized or distilled water. The pH sensor is now calibrated and ready for use.

If the sensor fails to calibrate, the probe may need to be replaced. For troubleshooting, refer to the meter's operation manual.

7.2.5 Turbidity Calibration

YSI

A two-point calibration is performed to calibrate the turbidity sensor. First, rinse the calibration cup with deionized or distilled water. Fill the cup with 0 NTU distilled or deionized water past the turbidity probe. Agitate the sonde making sure no air bubbles adhere to the probe. Once calibrated, rinse the calibration cup with deionized or distilled water. Rinse the cup with a small amount of the 100 or 126 NTU turbidity standard, depending on which sensor is installed. Fill the cup above the turbidity probe with the 100 or 126 NTU turbidity standard. Agitate the sonde, making sure no air bubbles adhere to the probe. Once the reading has stabilized, confirm the calibration. The unit is now calibrated and ready for use.

If the sensor fails to calibrate, the probe may need to be replaced. For specific step-by-step instructions and troubleshooting, follow the each unit's operation manual. In the equipment or site logbook, record the calibration solutions used, their lot numbers and expiration dates along with whether or not the sensor calibrated in the field equipment or site logbook.

Horiba

Turbidity is divided into three measurement ranges: 0.0 to 9.9 NTU, 10 to 100 NTU, and over 100 NTU. Calibration procedures are dependent on the range(s) of the water to be measured. For most field applications, only the 0.0 to 9.9 NTU range is necessary, which requires a two-point calibration (one zero point and one span calibration). The first standard is 0 NTU deionized or distilled water. Fill the cup with the 0 NTU distilled or deionized water past the turbidity probe. Agitate the sonde, making sure no air bubbles adhere to the probe. Once calibrated, rinse the calibration cup with deionized or distilled water followed by a small amount of the reference standard solution.

For calibration within the 0.0 to 9.9 NTU range, a known concentration of solution must be within the 0.0 to 9.9 NTU range. Instructions on the preparation of the 8.0 NTU standard solution is found in the Horiba operation manual. Also found in the operation manual are calibration procedures for other calibration ranges and multiple point calibrations. In the site logbook, record the lot and expiration dates of the turbidity standards used.

7.2.6 Oxidation-Reduction Potential Calibration

Horiba

First prepare the ORP calibration solution by agitating 250 mL of deionized water with one bag of ORP standard powder. For further details on preparing the solution, refer to the Horiba user manual. Rinse the calibration cup and sensor with deionized or distilled water, followed by a small amount of the ORP solution. Fill the calibration cup with ORP solution until just above the ORP sensor. Agitate the sonde, making sure no air bubbles adhere to the probe. Do not leave the ORP standard solution in the open air for more than an hour; doing so will require that the solution be discarded and replaced with fresh solution.

If sensor fails to calibrate, the probe may need to be replaced. For specific step by step instructions and troubleshooting, follow the each unit's operation manual.

YSI

There is no calibration of the ORP sensor for the YSI meter; however, the ORP sensor should be verified that it is functioning correctly. Using a 3682 Zobell solution, readings should be between 221 and 241 mV at normal ambient temperature. If the reading is outside of this range, then it should be returned to the manufacturer for service.

7.3 Field Measurements

7.3.1 Submersion

For collecting measurements directly from a water body, remove the storage cup and thread on the weighted guard, then immerse the probe. Use a rope or string to lower and raise the probe into the water. Never use the data cable to lower and raise the sonde into and out of water as this may damage the cable. Allow several minutes for the readings to stabilize to ensure accurate readings. Record the parameter values in a site logbook. When measurements are complete, remove the weighted guard and replace the storage cup.

7.3.2 Sample Cup

The sample cup may be used to make measurements of grab samples. Fill the cup approximately ¼ full of the water to be sampled, agitate and discard the water. Then, fill the cup until it's nearly full, with the probe sensors completely covered. After allowing time for the values to stabilize, record the parameter values in a site logbook.

7.3.3 Flow-Through Cell

The flow-through cell is used to collect multi-parameter measurements while purging a groundwater monitoring well during low-flow sampling. Prior to collecting measurements, the first couple minutes of purging must be done outside of the flow-through cell to prevent sediments from entering the cell. This will help prevent possible false turbidity readings. The pumping rate must be adjusted so that no air bubbles are present. Measurements can be made at periodic intervals either manually or by programming the data logger. Parameter values are then recorded in a site logbook.

7.4 Post-Use Verification

Follow the same procedures for initial calibration, except for the adjustment of parameter values. Instead, record the readings for each parameter and document in a logbook. Post-verification ensures the reliability of the field measurements by demonstrating that the instrument calibration did not drift during the monitoring period. Any significant deviations (+/- 10%) in the calibration status of the instrument should be incorporated into the final interpretation of the water quality data.

7.5 Decontamination

The following steps should be followed to decontaminate the unit after each field mobilization:

1. Clean the entire sonde and the data cable with a cloth and mild liquid detergent solution and then rinse with deionized or distilled water. If necessary, a soft brush or cotton swab may be used to clean between the probes. Repeat this step as many times as necessary to remove all visible contamination.

2. Add deionized or distilled water to the storage cup and fasten to the sonde.

3. Agitate the instrument gently to further remove any contaminants or detergent.

4. Wipe the pH probe with lens cleaner or a cotton swab. Do not use abrasive cloths to wipe the probe.

5. Repeat Steps 2 through 4 until the probes are clean. **Do not use acetone, organic solvents, nitric acid or harsh detergents to clean the instrument**. Once the unit is decontaminated, it is ready for calibration or storage. If calibrating, refer to Section 7.2 for calibration instructions. If storing the unit, refer to Section 3.0.
6. Due to limitations on decontamination methods, no samples should be collected directly from the water quality parameter device. Once the sample stream has achieved steady state conditions required for sampling, the water quality device must be removed prior to sampling.

7.6 Maintenance

Maintenance schedules are followed as outlined by manufacturers' guidelines. The replacement of probes should be done by a qualified individual. See each unit's operation manual for maintenance schedules.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/QUALITY CONTROL

Specific quality assurance/quality control (QA/QC) activities that apply to the implementation of these procedures will be listed in the QAPP prepared for the applicable monitoring event. The following general QC procedures will also apply:

- Equipment will be calibrated prior to field use and post-verified after field use as per Sections 7.2 and 7.4.
- All data must be documented in equipment or site logbooks as per ERT SOP, *Logbook Documentation.*
- Record the manufacturer lot numbers and expiration dates of all calibration standards used in the instrument logbook. Ensure all standards and solutions are not expired.
- The units are inspected quarterly in the equipment logbook to ensure they are functioning properly. This will allow the user time to find and replace defective probes or components before going into the field. If units are rented, a copy of the preventive maintenance and calibration done by the environmental rental company will be requested. Renting the unit does not reduce the number of QC checks that need to be performed.
- Records must be maintained, documenting the training of the operators that use the instrumentation and equipment for the collection of environmental information.

10.0 DATA VALIDATION

Results of the post-verification checks will be evaluated for instrument drift. This information will be used to qualify the environmental sample results according to the project's data quality objectives. There is no formal data validation procedure.

Data verification (completeness checks) must be conducted to ensure that all data inputs are present for ensuring the availability of sufficient information. This may include but is not limited to: location information, water quality parameter measurements, purging start and end times, water levels, depth to groundwater measurements, purge method and total volume pumped. These data are essential to providing an accurate and complete final deliverable. The Environmental Response Team (ERT) contractor's Task Leader is responsible for completing the UFP-QAPP verification checklist for each project.

11.0 HEALTH AND SAFETY

Based on Occupational Safety and Health Administration (OSHA) requirements, a site-specific health and safety plan (HASP) must be prepared for response operations under the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard, 29 CFR 1910.120. Field personnel working for EPA's ERT should consult the Emergency Responder Health and Safety Manual currently located at https://response.epa.gov/_HealthSafetyManual/manual-index.htm for the development of the HASP, required personal protective equipment (PPE) and respiratory protection.

12.0 REFERENCES

Horiba, Ltd. April 2009. Multi Water Quality Checker U-50 Series Instruction Manual. Website access, April 22, 2015.

YSI Incorporated. November 2011. 6-Series Multiparameter Water Quality Sondes, Revision J. Website access, April 22, 2015.

13.0 APPENDICES

A – Water Quality Meter Figures

APPENDIX A
Water Quality Meter Figures
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FIGURE 1.Water Quality Meters

Example of the YSI 650 MDS data logger and 6920V2 sonde

Example of the Horiba U-52 Water Quality Meter