

# FIELD PROCEDURE: MULTIMETER: DISSOLVED OXYGEN-TEMPERATURE-CONDUCTIVITY-SALINITY

## EQUIPMENT NEEDED:

**Note:** *Don't leave this equipment out in freezing temperatures unless you're using it. If the air temperature is below 23°F (-5°C), the YSI meter won't operate properly and your teammates probably won't either!*

- YSI-85 multimeter (with probe inside a copper calibration tube)
- Brunton ADC Summit pocket barometer
- watch with second hand or stopwatch
- 6 extra AA alkaline batteries
- data sheet, clipboard, pencil

**Where to sample:** Pick an area where the stream is flowing and appears to be well mixed. **Do not sample downstream of where your team has disturbed the bottom.**

## INITIAL INSTRUMENT PREPARATION:

1. Turn on the meter. The instrument will activate all segments of the display for a few seconds, then go through a self-test procedure that will last a few more seconds. A number will be displayed, along with the letters "CEL." That number should be between 4.8-5.2. If not, report the number on the data sheet and to the office staff.
2. If the unit displays "Err" at this point, and "Err" does not disappear after a few seconds, try turning the unit off and back on again. If it displays "LO BAT," replace the batteries and discard the old ones. If it displays other error messages, you will not be able to use the instrument—record the problem and let the staff know about it as soon as possible. If it displays number readings, "rcl," or "ErAS," the meter is functioning properly.
3. Remove the probe from the copper calibration tube. Look inside the tube to make sure there's no dirt or standing water in there and the sponge at the bottom isn't dry, soaking wet, or missing. *(If dry, add a few drops of purified water, let it soak in a*

*bit, and pour off the excess; if soaking wet, take it out with a pencil or screwdriver and wring it out; if missing, wet a small piece of rag and flatten it at the bottom of the chamber.)* Set the tube aside in the bag.

4. Check and tighten all connections along the cable, probe, and guard-piece at the end of the probe. Examine the probe. All holes should be clean of debris, and the gold cathode on the end should be shiny. The plastic membrane over the cathode should not be loose, wrinkled, or damaged, and there should be no bubbles under it. Rinse if dirty. Note any unsolvable problems on your data sheet and continue if possible with the procedure.
5. Place the probe in the stream. Set the meter in a safe place for 15 minutes to let the unit warm up and the probe stabilize to stream temperature.
6. **Record the barometric pressure**, to the nearest 0.01 in Hg (inches of mercury), plus sampler's initials.

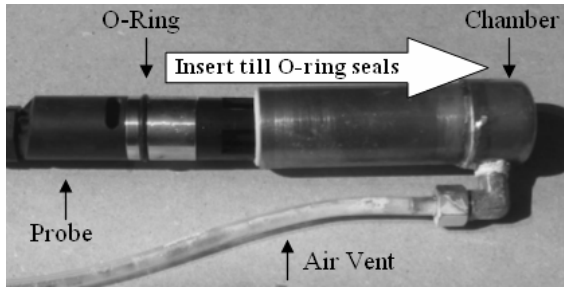
## TAKING MEASUREMENTS FOR DISSOLVED OXYGEN, TEMPERATURE, CONDUCTIVITY, AND SALINITY:

**BUTTON BUMMERS:** The YSI-85's buttons are slow to respond, so wait a few seconds after pressing any button to give the meter time to react. Otherwise, you may skip over the screen you want. Also, sometimes the buttons don't respond at all and you have to try again. Just be patient.

### 1. *Calibrate the meter:*

- a) Hold the copper calibration tube part-way down in the stream for awhile to get its temperature down; avoid getting water inside. Then take the probe out of the stream where it's been soaking, rinse off any dirt, and firmly flick water off the probe as if you were shaking down a fever thermometer. Place the probe into

the copper DO calibration tube, sealing the O-ring inside. (See picture below.)



- b) Crimp shut the open end of the plastic breather tube and hold it out of the water while you place the copper tube on the stream bottom in a safe spot, preferably out of the sun.

*If bubbles come out of the copper tube, there is a leak somewhere and you need to stop it:*

- Assess the source of the leak, then take the tube out of the water. Flick off the DO probe and wring out the sponge.
- If the leak is around the O-ring, try adjusting the placement of the probe inside the tube. If that fails to work, you may have to place the tube in the water only part-way, so that water can't get into it from the top.
- If the leak is somewhere else in the copper tube, try wrapping duct tape around the leak point.
- If the leak is very slight, you can solve the problem by putting the tube into the water with the bottom end facing upward; this way, water that leaks in won't impact the air-chamber around the DO membrane. Try to take the probe back out of the tube with the bottom side up, to avoid getting the sponge soaked.

Once you're sure there are no leaks, open the end of the breather tube and lay it somewhere up on the bank, using the attached clamp as needed to secure it to vegetation or a stake.

- c) Erase prior readings from the meter:

- Press the MODE button as many times as needed for "ErAS" to appear on the screen.
- Press the DOWN ARROW and ENTER buttons simultaneously for approximately 5 seconds.
- When "DONE" flashes on the screen for 1-2 seconds, the data have been erased, and the meter will automatically return to normal operation (DO % Saturation screen).

- d) Wait for stabilization of the meter inside the calibration tube, defined as follows:

**STABILIZATION CRITERION:**

**During a period of 2 minutes, both DO Sat % and temp (°C) stay within 0.1 of their initial readings.**

**TROUBLESHOOTING THE DO METER:** If the meters don't stabilize within 10 minutes of observation, try each of these steps in the following order, trying again to stabilize after each step:

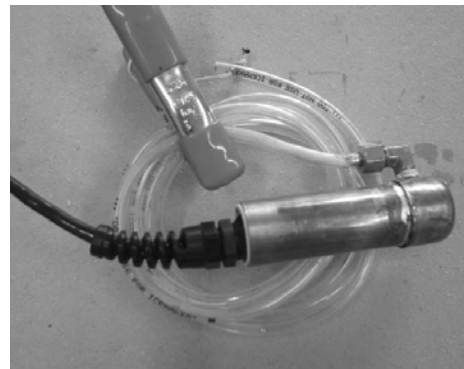
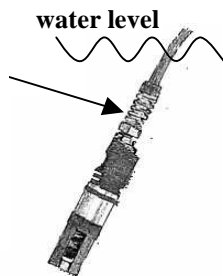
- Take the tube out of the water and the probe out of the tube. Pour off any excess water from the tube, wring out the sponge, and shake off the probe. Turn the meter off and then on.
- Turn off the meter, take out the batteries, wipe them and the inside of the battery cover-plate with a cloth, and re-insert them in a different order (but according to the diagram on the inside of the tubes).
- Try the above step again. Yep, again!
- Replace the batteries with the fresh batteries in the "Treasure Box" of your kit's Clean Bag.

If problems persist, note on your data sheet the variation in readings within your last stabilization observation period, and proceed.

- e) When stabilization criteria have been achieved, press both UP and DOWN ARROW buttons at the same time. The screen should then read zero; if needed, use the UP or DOWN ARROW buttons to make it zero. Then press ENTER.
- f) The meter will now show CAL & 100.0 in the lower part of the display. Make sure the % reading is still stable, then press ENTER. The display should show "SAVE" and then a reading near 100%. The instrument is now calibrated for DO.

2. **Take the tube out of the water and the probe out of the calibration chamber.** Check for water leakage into the tube or droplets on the membrane big enough to roll off; if either is the case, see the previous troubleshooting tips and recalibrate. You can now put the tube up on the bank.
3. **Re-check the barometric pressure,** to the nearest 0.01 in Hg (inches of mercury). If not the same as the earlier reading, record both readings.
4. **Insert the probe in the stream:** Standing downstream or to the side of the probe, hold it in the current, facing the probe upstream, in a place with steady flow, adequate depth, good mixing, and no surface turbulence. If the current is < 1 ft/sec, hold the probe halfway down in the water column and stir back and forth so that water moves over it at the rate of at least 1 ft/sec; but do not create bubbles. Keep the entire probe below water level—see following diagram.
4. **Stabilize and save the readings:** Wait for stabilization according to the following criteria: **Both readings have stopped any steady rise or fall; and during a 30 second observation, they don't vary by more than 0.5% DO and 0.1°C.** Then press ENTER and hold for 2 seconds. The meter will flash SAVE on the display along with a site number (which should be 01 if you erased previous readings). You have now saved readings for all parameters.
5. **Shake off the probe, rinse with purified water if the stream water is dirty, and replace the probe in its tube.** Then coil up both the probe's cable and the plastic tubing and secure them either with the clamp attached to the end of the tubing (see photo), or the Velcro strap attached to the cable.

Water level should be at least up to the cable connection—but be careful not to kink the wire at this stress point!



#### IN LOW OR SLOW WATER CONDITIONS...

- Try to find a little pool in which to stir the probe back and forth without disturbing the bottom; or
- Look for a little riffle in which the water cascades between a couple of rocks, creating enough "head" to lodge the probe between the rocks and have the water flow on top of it. Confirm that the velocity is at least 1 ft/sec at this point by floating a twig, counting "one one thousand," and seeing if the twig travels a foot during this time. Then wedge the probe into the rocks with the conductivity-sensor holes facing up and the tip of the probe upstream of any place you've touched the rocks.

6. **Record the number or name written on the meter** (e.g., "1" or "OPI"). And if you are not submitting the data to Clallam County, record the latest calibration dates for DO ("Winkler"), conductivity, and temperature, which should be written on stickers on the meter.
7. **Record the time** on your data sheet, to the nearest minute, and **sampler's initials**.
9. **Record the readings:** Press MODE repeatedly until "rcl" (recall) is displayed on the screen. The number below "rcl" should be the same site number the meter gave when it saved your data. (If not, use the "Up" arrow to find that site number, or retake your readings!) Then press ENTER successively to record the following readings, in the following order, using our

rounding convention as necessary (see Quality Assurance protocol):

- a) **Temperature:** to nearest 0.1°C.
- b) **DO % Saturation:** to nearest 0.1%.
- c) **DO Concentration:** to nearest 0.1 mg/L.
- d) **Conductivity:** You will see a screen with a figure in “µS” or “mS” and the “°C” symbol **not flashing**. (This indicates that the parameter being measured is non-temperature-compensated conductance.) Record to the nearest whole number of µS

(microSiemens). (If you go too far, work your way around again.) If the reading is in mS (milliSiemens), multiply by 1000 (i.e., move the decimal place 3 places to the right) to convert to µS, and record to the nearest whole number.

- e) **Salinity:** Skip over the next screen, which shows a conductivity reading with the “°C” symbol flashing (temperature-compensated conductivity, which we don’t record). Then read and record the next screen, which shows a “ppt” symbol, to the nearest tenth. This is the salinity in parts per thousand.

#### 10. **Record the sampler’s initials.**

#### **COMMON SENSE AND EXPECTED RANGES:**

Please compare your readings with the expected ranges on the datasheet. If you’re outside the expected range, consider re-sampling or troubleshooting with your fellow samplers.

Conductivity readings in particular have a nasty habit of being wacky. Stream conductivity is rarely lower than 25 µS. If your readings are lower than this, you’ll need to troubleshoot:

- If the reading is 0.0 or 0.1, you might be reading the salinity (“ppt”) screen rather than the proper conductivity screen; if so, scroll through the screens again (by pressing ENTER) until you get to the right one.
- You might not have held the probe completely underwater. Try taking another set of readings.
- The readings might be in mS rather than µS (see above).

#### **MEASURED VS. CORRECTED READINGS:**

The data for DO saturation and concentration will get adjusted once entered into the database, according to the pressure, temperature, and salinity you recorded. This formula avoids a built-in error in the YSI-85, which assumes “normal” atmospheric pressure for a given altitude, when actually that pressure can vary from normal by 5% or more.

#### **ELECTRONIC PROBLEMS?**

If the YSI meters stop showing all the decimals, show wacky readings, or don’t respond when you press buttons, try the battery tricks described above. They’ll probably work! If not, note what happened on your data sheet and notify program staff.

#### **SAMPLER’S INITIALS**

Be sure to put all the initials of one sampler taking responsibility for the data; this should be someone who has been properly trained (see “Quality Assurance” protocol).

11. If you are collecting **replicates** at this site, gather another set of readings, including barometric pressure; recalibration not needed. Then see the “Water Chemistry—General” protocol to see if your pairs of readings are within the acceptable precision limits, and resample as needed.

#### 12. **Turn off the meter.**

**ALTERNATIVE MULTIMETER PROCEDURE FOR POOR CONDITIONS:** If the weather is severe and you wish to minimize your time on the creek, you may do the following:

- Calibrate the YSI-85 at home, in water as close to stream temperature as possible; note both water temperature and barometric pressure.
- At each site, be sure to warm up the meter for 15’ before taking readings (or just keep it on all day); note barometric pressure at each site.
- Explain the deviance from normal procedures on your data sheet. Staff will have to adjust your data because of pressure differences between calibration and sampling sites.