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Using Electrical Conductivity and Total Dissolved Solids Meters to Field Test Water Quality

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Water always contains some dissolved minerals, which commonly are referred to as total dissolved solids (TDS) or sometimes as total dissolved salts. Some of these minerals can be toxic if present at high enough concentrations.

In the laboratory, the standard method for measuring TDS is evaporating all the water from a 0.1-liter sample and weighing the residual minerals left in the vessel. However, collecting a sample and waiting for laboratory analysis can take time.

An electrical conductivity (EC) or TDS meter is a quick method to estimate TDS. Water conducts electricity, but the dissolved minerals (ions) in water are what actually conduct the electricity. Pure (distilled) water is a very poor conductor of electricity, so the more dissolved minerals in the water, the more conductive the water becomes.

The units for TDS usually are expressed as milligrams per liter (mg/l), which is the same as parts per million (ppm). Some meters show TDS as parts per thousand (ppt), which is equal to 1,000 ppm.

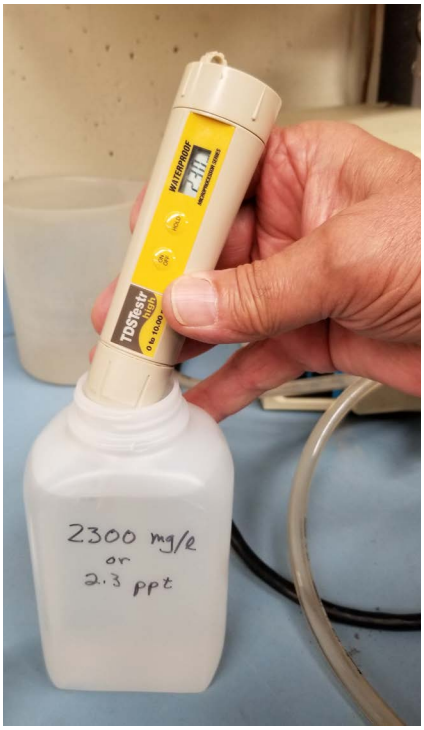
The EC is a proxy measurement to determine the TDS in water. Some of the confusion with using EC is that it can be expressed in different units. The units might be referenced as micromhos per centimeter (µmhos/cm) and millimhos per centimeter (mmhos/cm) or microSeimens per centimeter (µS/cm) and milliSeimens per centimeter (mS/cm). Thus, 1 mmho/cm = 1 mS/cm = 1,000 µmhos/cm = 1,000 µS/cm.

Most EC meters can change modes to read salinity in grams per liter, EC in µS and TDS in mg/l or ppt. The meter calculates an estimate of TDS by multiplying the EC reading with a conversion factor. In the chart below, note that the conversion factor changes as the EC readings increase.

To ensure an accurate reading, EC meters must be calibrated regularly. The accuracy of the EC meter should be checked with a calibration solution in the spring each year, prior to sampling. Calibrate again after adding new batteries or after the meter has been dropped on a hard surface.

We recommend you use a manufacturer-supplied calibration mixture and procedure, but you can make your own calibration solution using table salt (NaCl). Follow these instructions to create a known calibration solution.

Electrical Conductivity				Approximate TDS	Conversion Factor[1]
µmhos/cm	mmhos/cm	µS/cm	mS/cm	mg/l or ppm	
100	0.1	100	0.1	50	0.50
500	0.5	500	0.5	300	0.60
1,000	1.0	1,000	1.0	650	0.65
1,500	1.5	1,500	1.5	1,050	0.70
2,000	2.0	2,000	2.0	1,450	0.72
2,500	2.5	2,500	2.5	1,850	0.74
3,000	3.0	3,000	3.0	2,250	0.75
3,500	3.5	3,500	3.5	2,650	0.76
4,000	4.0	4,000	4.0	3,050	0.77
4,500	4.5	4,500	4.5	3,500	0.78
5,000	5.0	5,000	5.0	3,950	0.79
6,000	6.0	6,000	6.0	4,740	0.79
6,500	6.5	6,500	6.5	5,135	0.79
7,000	7.0	7,000	7.0	5,600	0.80
8,000	7.5	7,500	7.5	6,075	0.81
10,000	10.0	10,000	10.0	8,200	0.82



[1] Conversion factor is for natural waters

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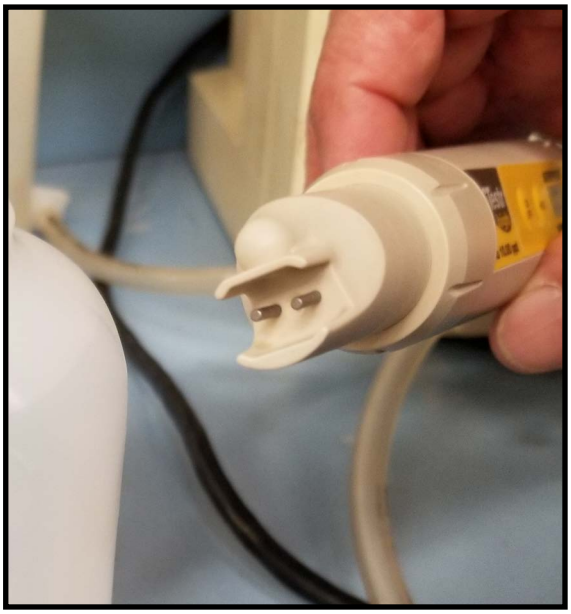
Making Table Salt (NaCl) Calibration Mixtures to Check EC and/or TDS Meters



What you need:

- Table salt (not much)
- ¼ teaspoon measuring spoon
- A measuring cup that holds at least 2 cups water
- A mixing container that holds at least 4 cups of water and rinsed with distilled water
- 1 gallon distilled water
- An EC meter

A ¼-teaspoon measuring spoon has a volume of about 1.25 milliliters (ml). A leveled ¼ teaspoon of salt weighs about 1.7 grams or 1,700 milligrams. One cup of water is equal to 0.236 liter or 236 milliliters, and 4 cups is equal to 0.94 liter. We will make a calibration salt mixture with a TDS of about 2,600 mg/l because this is the level that begins to have adverse effects on livestock.

Carefully add salt to the ¼-teaspoon measuring spoon and level it off with a straight edge. Put the salt in the dry container. Set the measuring cup on a level surface and carefully measure 4 cups of distilled water as accurately as possible; add to the container. Mix until the salt is dissolved. Let it stand for about five minutes to make sure the salt thoroughly dissolved.

The salinity of this mixture will be about 1.8 grams per liter, and the EC can be from 3,200 to 3,600 µS/cm, depending on the quality of the table salt. Now change the conversion factor on the EC meter to 0.76 (see chart above). Set the mode on the EC meter to measure TDS. Insert the probe in the water and swirl gently.

The reading on the EC meter should be between 2,400 and 2,700 mg/l. If the meter reads in parts per thousand (ppt), it should show 2.4 to 2.7. Make a new mixture each time you check the accuracy of the EC meter.

Notice on the chart that the conversion factor doesn't change much above 2,700 mg/l, so the calibrated EC meter now will provide reliable readings for natural water concentrations that are greater than 2,700 mg/l (ppm).

Field Testing

Once your meter is calibrated, you are ready to begin testing.

1. Collect the sample from the area of concern, such as the area where livestock are drinking.
2. Collect the sample in a clean plastic or glass container to get a representative sample of the water column.
3. Rinse the container several times using the water to be sampled.
4. Fill the container, being sure to collect water from both deeper in the water and the surface.
5. Test water using an EC or TDS meter.
6. Submit sample for laboratory analysis if EC is equal to or greater than 6,000 or TDS is equal to or greater than 4,500 ppm.
7. Follow the "NDSU Extension Livestock Water Testing Guidelines" for the sample submittal. See https://tinyurl.com/WaterQualityTesting-NDSU for more information.

For more information on this and other topics, see www.ag.ndsu.edu

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