

GWPD 4—Measuring water levels by use of an electric tape

VERSION: 2010.1

PURPOSE: To measure the depth to the water surface below land-surface datum using the electric tape method.

Materials and Instruments

1. An electric tape, double-wired and graduated in feet, tenths and hundredths of feet. Electric tapes commonly are mounted on a hand-cranked and powered supply reel that contains space for the batteries and some device (“indicator”) for signaling when the circuit is closed (fig. 1).
2. An older model electric tape, also known as an “M-scope,” marked at 5-foot intervals with clamped-on metal bands (fig. 2) has been replaced by newer, more accurate models. Technical procedures for this device are available from the procedures document archives.
3. A steel reference tape for calibration, graduated in feet, tenths and hundredths of feet
4. Electric tape calibration and maintenance equipment logbook
5. Pencil or pen, blue or black ink. Strikethrough, date, and initial errors; no erasures
6. Water-level measurement field form, or handheld computer for data entry
7. Two wrenches with adjustable jaws or other tools for removing well cap
8. Key for well access
9. Clean rag
10. Cleaning supplies for water-level tapes as described in the National Field Manual (Wilde, 2004)
11. Replacement batteries

Data Accuracy and Limitations

1. A modern graduated electric tape commonly is accurate to ± 0.01 foot.
2. Most accurate for water levels less than 200 feet below land surface.
3. The electric tape should be calibrated against an acceptable steel tape. An acceptable steel tape is one that is maintained in the office for use only for calibrating tapes, and this calibration tape never is used in the field.
4. If the water in the well has very low specific conductance, an electric tape may not give an accurate reading.
5. Material on the water surface, such as oil, ice, or debris, may interfere with obtaining consistent readings.
6. Corrections are necessary for measurements made from angled well casings.
7. When measuring deep water levels, tape expansion and stretch is an additional consideration (Garber and Koopman, 1968).

Advantages

1. Superior to a steel tape when water is dripping into the well or condensing on the inside casing walls.
2. Superior to a steel tape in wells that are being pumped, particularly with large-discharge pumps, where the splashing of the water surface makes consistent results by the wetted-tape method impossible. Also safer to use in pumped wells because the water is sensed as soon as



Figure 1. An electric tape or cable, double wired and marked the entire length in feet, tenths and hundredths of feet, that can be considered accurate to 0.01 foot at depths of less than 200 feet. Electric tapes commonly are mounted on a hand-cranked and powered supply reel that contains space for the batteries and some device (“indicator”) for signaling when the circuit is closed. Brand names are for illustration purposes only and do not imply endorsement by the U.S. Geological Survey. (Photographs used with permission of vendors.)

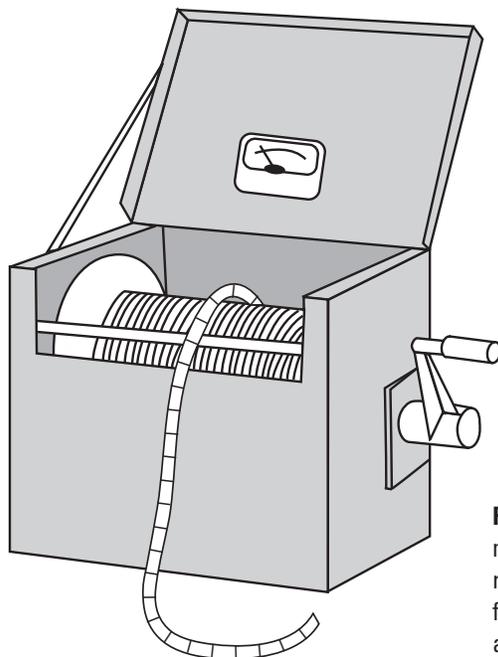


Figure 2. Older model electric tape, also known as “M-scope” marked at 5-foot intervals with clamped-on metal bands, has been replaced by newer, more accurate models. Technical procedures for this device are available from the procedures document archives.

the probe reaches the water surface and there is less danger of lowering the tape into the pump impellers.

3. Superior to a steel tape when a series of measurements are needed in quick succession, such as in aquifer tests, because the electric tape does not have to be removed from the well for each reading.

Disadvantages

1. Harder to keep calibrated than a steel tape.
2. Electric connections require maintenance.
3. Requires battery power.
4. Cable jacket is subject to wear and tear. Continuity of the electrical circuit must be maintained.

Assumptions

1. An established measuring point (MP) exists and the distance from the MP to the land-surface datum (LSD) is known. See GWPD 3 for the technical procedures on establishing a permanent MP.
2. The MP is clearly marked and described so that a person who has not measured the well will be able to recognize it.
3. The well is free of obstructions that could affect the plumbness of the steel tape and cause errors in the measurement.
4. The same field method is used for measuring depth below the MP, or depth relative to vertical datum, but with a different datum correction.
5. The tape is calibrated against a steel reference tape.
6. Field measurements will be recorded on paper forms. When using a handheld computer to record field measurements, the measurement procedure is the same, but the instructions below refer to a specific paper field form.

Tape Calibration And Maintenance

Before using an electric tape in the field, calibrate it against a steel reference tape. A reference tape is one that is maintained in the office only to calibrate other tapes.

1. Calibration of electric tape:

- Check the distance from the probe's sensor to the nearest foot marker on the tape to ensure that this distance puts the sensor at the zero-foot point for the tape. If it does not, a correction must be applied to all depth-to-water measurements.
 - Compare length marks on the electric tape with those on the steel reference tape while the tapes are laid out straight on level ground, or compare the electric tape with a known distance between fixed points on level ground.
 - Compare water-level measurements made with the electric tape with those made with a calibrated steel tape in several wells that span the range of depths to water that is anticipated. Measurements should agree to within ± 0.02 foot. If measurements are not repeatable to this standard, then a correction factor based on a regression analysis should be developed and applied to measurements made with the electric tape.
2. Using a repaired/spliced tape: If the tape has been repaired by cutting off a section of tape that was defective and splicing the sensor to the remaining section of the tape, then the depth to water reading at the MP will not be correct. To obtain the correct depth to water, apply the following steps, which is similar to the procedure for using a steel tape and chalk. Using the water-level measurement field form (fig. 3) to record these modifications:
 - Ensure that the splice is completely insulated from any moisture and that the electrical connection is complete.
 - Measure the distance from the sensing point on the probe to the nearest foot marker above the spliced section of tape. Subtract that distance from the nearest foot marker above the spliced section of tape. That value then becomes the "tape correction." For example, if the nearest foot marker above the splice is 20 feet, and the distance from that foot marker to the probe sensor is 0.85 foot, then the tape correction will be 19.15 feet. Write down the tape correction on the water-level measurement field form (fig. 3). Periodically recheck this value by measuring with the steel reference tape.
 3. Maintain the tape in good working condition by periodically checking the tape for breaks, kinks, and possible stretch.
 4. Carry extra batteries, and check battery strength regularly.
 5. The electric tape should be recalibrated annually or more frequently if it is used often or if the tape has been subjected to abnormal stress that may have caused it to stretch.

Instructions

1. Check the circuitry of the electric tape before lowering the probe into the well by dipping the probe into tap water and observing whether the indicator needle, light, and (or) beeper (collectively termed the “indicator” in this document) are functioning properly to indicate a closed circuit. If the tape has multiple indicators (sound and light, for instance), confirm that they are operating simultaneously. If they are not, determine the most accurate indicator.
2. Make all readings using the same deflection point on the indicator scale, light intensity, or sound so that water levels will be consistent among measurements.
3. Lower the electrode probe slowly into the well until the indicator shows that the circuit is closed and contact with the water surface is made (fig. 4). Place the nail of the index finger on the insulated wire at the MP and read the depth to water.
4. Record the date and time of the measurement. Record the depth to water measurement in the row “Hold” (fig. 3). If the tape has been repaired and spliced or has a calibration correction (see the section above on using a repaired/spliced tape), subtract the “Tape Correction” value from the “Hold” value, and record this difference in the row “WL below MP” (fig. 3).
5. Record the MP correction length on the “MP correction” row of the field form (fig. 3). Subtract the MP correction length from the true “WL below MP” value to get the depth to water below or above LSD. The MP correction is positive if the MP is above land surface and is negative if the MP is below land surface (GWPD 3). Record the water level in the “WL below LSD” column of the water-level measurement field form (fig. 3). If the water level is above LSD, record the depth to water in feet above land surface as a negative number.
6. Pull the tape up and make a check measurement by repeating steps 3–5. Record the check measurement in column 2 of the field form. If the check measurement does not agree with the original measurement within 0.02 foot, continue to make measurements until the reason for lack of agreement is determined or the results are shown to be reliable. If more than two measurements are made, use best judgment to select the measurement most representative of field conditions. Complete the “Final Measurement for GWSI” portion of the field form.
7. After completing the water-level measurement, disinfect and rinse that part of the tape that was submerged below the water surface as described in the National Field Manual (Wilde, 2004). This will reduce the possibility of contamination of other wells from the tape. Rinse the tape thoroughly with deionized or tap water to prevent tape damage. Dry the tape and rewind onto the tape reel.

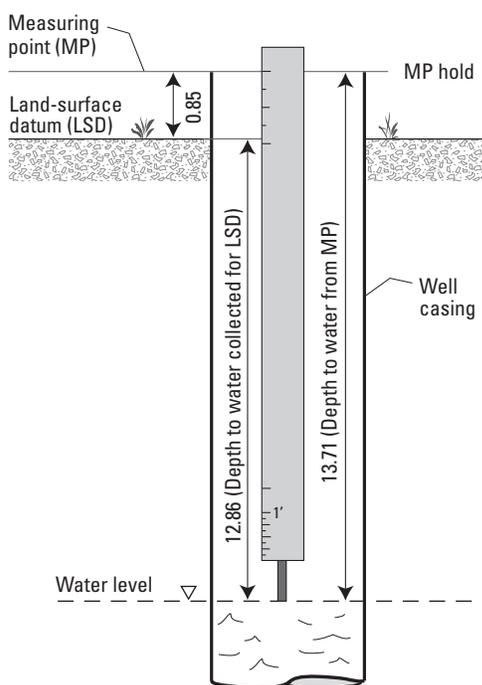


Figure 4. Water-level measurement using a graduated electric tape.

Data Recording

All calibration and maintenance data associated with the electric tape being used are recorded in the calibration and maintenance equipment logbook. All data are recorded in the water-level measurement field form (fig. 3) to the appropriate accuracy for the depth being measured.

References

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