APPENDIX A4-B
Instructions Related to Measuring Water Levels at Wells and a Sample USGS Ground-Water-Quality Field Form

All USGS personnel who sample or make water-level or water-quality measurements at wells must comply with requirements and be familiar with the guidelines provided by the USGS Office of Ground Water. Guidelines established by the Office of Ground Water related to measurement of well depth and water level have been adapted for water-quality work and are summarized in this appendix.

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Figure B1. Example of a USGS field form for ground-water-level measurements **APP.B7**

A4-B-3. Water-level measurement by **APP.B8**
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Figure B2. Example of a water-level measurement using a graduated steel tape **APP.B12**

A4-B-4. Water-level measurement by the air-line method **APP.B17**
Figure B3. Typical installation for measuring water level by the air-line method **APP.B20**

A4-B-5. Water-level measurement at flowing wells using low-pressure and high-pressure methods **APP.B21**

A4-B-6. Sample of the U.S. Geological Survey Ground-Water Quality Notes field form **APP.B25**

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Appendix A4-B

Equipment and Supplies All sections of appendix A4-B – common supplies A4-B-1 – Establishing a permanent measuring point on wells A4-B-2 – Well-depth measurement.	
All sections	GWSI site schedule, Form 9-1904-A
	Ground-water-level measurement field form and/or other field forms and/or handheld or field computer for data entry
	Pens, ballpoint with non-erasable blue or black ink, for writing on field forms and in equipment log books
	Field folder and well file
	Two wrenches with adjustable jaws and other tools for removing the well cap
	Clean rag
	Key(s) for opening locks
	Equipment-cleaning supplies (NFM 3). Tape-cleaning supplies: refer to NFM 3.3.8 for soap-and-water wash guidance and disinfection. If disinfecting, use either (a) commercially available hypochlorite wipes; or (b) prepare a dilute chlorine solution adding 1 mL of common household bleach to 900 mL of water (0.005-percent solution)
A4-B-1	**Establishing a permanent measuring point (MP)**
	Steel tape, graduated in feet, tenths, and hundredths of feet; calibrated for making field measurements
	Reference steel tape, graduated in feet, tenths, and hundredths of feet; designated for calibration of field steel and electric tapes
	Calibration and maintenance log book for each steel tape
	Spray paint (bright color) or casing-notching tool
A4-B-2	**Well-depth measurement with steel tape**
	Steel tape, graduated in feet, tenths, and hundredths of feet; calibrated for making measurements. A black tape is better than a chromium-plated tape. If a chromium-plated tape has to be used, paint the back of the tape with a flat black paint to make it easier to read the wetted chalk mark
	Reference steel tape, graduated in feet, tenths, and hundredths of feet; designated for calibration of field steel and electric tapes
	Steel-tape calibration and maintenance log book (one for each steel tape)
	Weight (stainless steel, iron, or other noncontaminating material) – not lead
	Strong ring and wire, for attaching weight to end of tape. Wire should be strong enough to hold weight securely, but not as strong as the tape, so that if the weight becomes lodged in the well the tape can still be pulled free
	Carpenters' chalk (blue)

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Appendix A4-B-1
Establishing a permanent measuring point on wells at which water level will be measured[1]

A permanent measuring point (MP) from which all water levels for a given well are measured must be established for each well at which USGS data are collected. The MP should be established when a monitor well is installed or an existing well is inventoried. The accuracy with which the MP is established depends on the accuracy of the water-level measurement being made. **For water level measured in hundredths of a foot, the MP is to be established to an accuracy of 0.01 foot.** This guidance assumes that:

- All water-level measurements from a given well must be referenced to the same datum to ensure data comparability.
- Land-surface datum (LSD) at the well was established by the person who made the initial water-level measurement at the well. LSD is an arbitrary plane chosen to be approximately equivalent to the average altitude of the ground around thewell. Because LSD around a well may change over time, the distance between the MP and LSD should be checked every 3 to 5 years, or more frequently because of land development or other changes.
- Measuring points can change from time to time, especially on privately-owned wells. Such changes must be documented and dated in field notes and in the data base(s) into which the water-level data are entered.

To establish a permanent measuring point:

1. Establish the location of the MP at a specific point within the top of the casing. The MP is measured in reference to LSD. If possible, position the MP at a point on the casing where a leveling rod could be set on it directly over the well and the measuring tape can hang freely when it is in contact with the MP. Locate the MP at the most convenient place from which to measure the water level.

[1]From the USGS Office of Ground Water, Ground-Water Procedure Document 3.

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2. Clearly mark the MP, either with an arrow sprayed with bright-colored paint or with a notch cut into the top of the casing. The MP must be as permanent as possible and be clearly visible and easily located. Location of the MP must be described in the well file.
3. Measure the height of the MP in feet above or below LSD. For USGS studies, record the folbwing information into GWSI (figure B1):
   - Height and detailed description of the MP. Note that values for measuring point below land surface should be preceded by a minus sign (-).
   - Date the MP was established.
4. For most water-quality studies, the LSD and MP should be surveyed in.
5. Establish at least one clearly displayed reference mark (RM) in a location near the well; for example, a lag bolt set into a nearby telephone pole. The RM is an arbitrary datum established by permanent marks and is used to check the MP or to re-establish an MP should the original MP be destroyed or need to be changed.
6. Clearly locate the MP and RM on a detailed site sketch that goes into the well folder; the sketch commonly is made on the back of the paper GWSI form. If possible, photograph the site, including the RM and MP locations; draw an arrow to the RM and MP on the photograph(s) using an indelible marker, and place the photos in the well file.

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Appendix A4-B-2
Well-depth measurement[2]

This method uses a graduated steel tape to measure the total depth of a well below land-surface datum. Select a graduated steel tape that is accurate to 0.01 foot. The steel tape should be calibrated against a reference steel tape. A reference steel tape is one that is maintained in the office and designated solely for tape calibration.

- If the well casing is angled, instead of vertical, the well depth will have to be corrected.
- When measuring wells of depth greater than 200 feet (deep wells), expansion and stretch of the steel tape must be considered and accounted for (see Garber and Koopman, 1968).
- Use of a steel tape is **not** recommended for measuring the depth of pumping wells.
- A weight usually is attached to the end of a steel tape to allow it to hang plumb. The weight should not be constructed of lead or other material that potentially could contaminate water in the well.
- Well obstructions could cause errors in the measurement if the steel tape cannot hang plumb.

To measure well depth:

1. Using a clean, calibrated steel tape, measure from the zero point on the tape to the bottom of the weight. Record this number as the length of the weight interval.
2. Lower the weight and tape into the well until the weight reaches the bottom of the well and the tape slackens.
3. Partially withdraw the tape from the well until the weight is standing in a vertical position, but still touching the bottom of the well. A slight jerking motion will be felt as the weight moves from the horizontal to the vertical position.
4. Repeat step 3 several times by lowering and withdrawing the tape to obtain a consistent reading.
5. Record the tape reading held at the measuring point (MP).

[2]From the USGS Office of Ground Water, Ground-Water Procedure Document 11.

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6. Withdraw the tape from the well 1 to 2 feet, so that the weight will hang freely above the bottom of the well. Repeat steps 2-4 until two consistent depth readings are obtained.
7. Calculate total well depth below land-surface datum (LSD) as follows:

a. Tape reading held at the MP	84.3 feet
b. Length of the weight interval	+ 1.2 feet
c. Sum of a + b	85.5 feet
d. MP correction	- 3.5 feet
e. Total well depth below LSD	82.0 feet

8. After completing the well-depth measurement, clean the exposed portion of the tape using the procedures described in NFM 3.3.8. To prevent microbial cross-contamination of other wells, disinfect the tape using commercially available hypochlorite wipes or a dilute (0.005-percent) chlorine solution.
9. Record depth data to the nearest 0.01 foot. USGS well-depth data should be recorded in GWSI and on the Ground-Water Level Notes (fig. B1) and other field forms that are kept in the field folder.

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February 2006

USGS

FIELD ID _____

GROUND-WATER LEVEL NOTES

Station No. _____ Field ID _____

Station Name _____

Project No. _____ Proj Name _____

Measurement made by: _____

Signature _____ Date _____

WELL___ SPRING___ MONITOR___ SUPPLY___ OTHER _____

SUPPLY WELL PRIMARY USE: DOMESTIC___ PUBLIC SUPPLY___ IRRIGATION___ OTHER _____

Casing Material: _____ Altitude (land surface) _____ ft abv MSL

Measuring Point: _____ ft abv blw LSD MSL MP Well Depth _____ ft abv blw LSD MSL MP

Sampling condition (72006) pumping (8) flowing (4) static (n/a)

[see QWDATA User Manual for additional fixed-value codes]

Water Level: _____ ft blw LSD (72019) ft blw MP (61055)

ft abv MSL (NGVD 29) (62610) ft abv MSL (NAVD 88) (62611)

Comments:

Depth to Water and Well Depth	1ST	2ND	3RD (optional)
Time			
Hold (for DTW)			
- Cut			
= DTW from MP			
– Measuring point (MP)			
= DTW from LSD			
Hold (for well depth)			
+ Length of tape leader			
= Well depth below MP			
– MP			
= Well depth below LSD			

WATER-LEVEL DATA FOR GWSI

DATE WATER LEVEL MEASURED (C235) __ __ - __ __ - __ __ __ __ (Month Day Year) TIME (C709) __ __ __ __

WATER LEVEL TYPE CODE (C243): L (below land surface) M (below meas. pt.) S (sea level)

WATER LEVEL (C237/241/242) __ __ __ __ . __ __

MP SEQUENCE NO. (C248) __ __ __ (Mandatory if WL type=M)

WATER LEVEL DATUM (C245) (Mandatory if WL type=S): NGVD 29 (National Geodetic Vertical Datum Of 1929); NAVD 88 (North American Vertical Datum Of 1988); Other (See GWSI manual for codes)

SITE STATUS FOR WATER LEVEL (C238): A atmos. pressure; B tide stage; C ice; D dry; E recently flowing; F flowing; G nearby flowing; H nearby recently flowing; I injector site; J injector site monitor; M plugged; N measurement discontinued; O obstruction; P pumping; R recently pumped; S nearby pumping; T nearby recently pumped; V foreign substance; W well destroyed; X affected by surface water; Z other

METHOD OF WATER-LEVEL MEASUREMENT(C239): A airline; B analog; C calibrated airline; E estimated; F transducer; G pressure gage; H calibrated pres. gage; L geophysical log; M manometer; N non-rec. gage; O observed; R reported; S steel tape; T electric tape; V calibrated elec. tape; Z other

WATER LEVEL ACCURACY (C276): 0 foot; 1 tenth; 2 hundredth; 9 not to nearest foot

SOURCE OF WATER-LEVEL DATA (C244): A other gov't; D driller's log; G geol. lit.; L geophysical log; M memory; O owner; R other reported; S reporting agency; Z other

PERSON MAKING MEASUREMENT (C246) (WATER-LEVEL PARTY) _____

MEASURING AGENCY (C247) (SOURCE) _____

RECORD READY FOR WEB (C858): Y checked; ready for web display; C not checked; no web display; P proprietary; no web display; L local use only; no web display

COMPILED BY: _____ DATE _____ ENTERED INTO GWSI BY: _____ DATE _____

CHECKED BY: _____ DATE _____ ENTERED INTO QWDATA BY: _____ DATE _____

GW Water Level Form ver. 1

Figure B1. Example of a USGS field form for ground-water-level measurements.

Appendixes A4-B-3(a) and (b) Water-level measurement by (a) steel tape, or (b) electric tape

A4-B-3: Equipment and Supplies A4-B-3(a) – Water-level measurement by graduated steel tape A4-B-3(b) – Water-level measurement by electric tape	
A4-B-3(a + b)[1]	Steel tape, graduated in feet, tenths, and hundredths of feet; calibrated for making water-level measurements
A4-B-3(a) [1]	Reference steel tape, graduated in feet, tenths, and hundredths of feet. A reference steel tape is one that is maintained in the office and designated solely for tape calibration
A4-B-3(a)	Steel-tape calibration and maintenance log book (one for each steel tape). Field forms, paper and/or electronic; ballpoint pens (blue or black, non-erasable) for recording information in the log book and on paper field forms
A4-B-3(a)	Weight (stainless steel, iron, or other noncontaminating material – do not use lead)
A4-B-3(a)	Strong ring and wire, for attaching weight to end of tape. Wire should be strong enough to hold weight securely, but not as strong as the tape, so that if the weight becomes lodged in the well the tape can still be pulled free
A4-B-3(a)	Carpenters' chalk (blue)
A4-B-3(a + b)	Tape-cleaning supplies: refer to NFM 3.3.8 for soap-and-water wash guidance and disinfection. Disinfect using either commercially available hypochlorite wipes or a dilute (0.005-percent solution) chlorine solution
A4-B-3(b)[2]	An electric tape, double-wired and graduated in feet, tenths, and hundredths of feet, accurate to 0.01 ft. 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
A4-B-3(b)	Electric-tape calibration and maintenance log book; manufacturer's instructions. Field forms, paper and/or electronic; ballpoint pens (non-erasable blue or black ink) for recording information in the log book and on paper field forms
A4-B-3(b)	Replacement batteries, charged
A4-B-3(a + b)	Clean rag
A4-B-3(a + b)	Two wrenches with adjustable jaws or other tools for removing the well cap

[1]A black tape is better than a chromium-plated tape. If a chromium-plated tape has to be used, paint the back of the tape with a flat black paint to make it easier to read the wetted chalk mark.

[2]An older model electric tape, also known as an "M-scope", marked at 5-foot intervals with clamped-on metal bands has been replaced by newer, more accurate models.

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A4-B-3(a) Steel tape[3]

The graduated steel-tape (wetted-tape) procedure is considered to be the most accurate method for measuring a depth to the water surface at nonflowing wells. A graduated steel tape is commonly accurate to 0.01 foot. When measuring deep water levels, however, tape expansion and stretch is a necessary consideration (Garber and Koopman, 1968). The method is most accurate for water levels less than 200 feet below land surface. This method is **not** recommended for measuring pumping levels in wells.

- May be impossible to get reliable results if water is dripping into the well or condensing on the well casing.
- If the well casing is angled, instead of vertical, the depth to water will have to be corrected.
- The steel tape shouldbe calibrated against a reference steeltape. A reference steel tape is one that is maintained, in the office, for use only for calibrating steel tapes.
- Check that the well is free of obstructions that can affect the plumbness of the steel tape. Amccurate measurement cannot be made if the tape does not hang plumb.

Before making a measurement:

1. Ensure that the steel tape for field use has been calibrated, using a reference steel tape (see the Equipment and Supplies table for Appendix A4-B-3, above). Check the equipment log book for the designated steel tape for calibration information.
2. Maintain the tape in good working condition by periodically checking the tape for rust, breaks, kinks, and possible stretch. Record all calibration and maintenance data associated with the steel tape in its calibration and maintenance log book.
3. If the steel tape is new, be sure that the black sheen on the tape has been dulled so that the tape will retain the chalk.
4. Attach a weight to the tape that is constructed of stainless steel or other noncontaminating material to protect ground-water quality in the event that the weight is lost in the well.
5. Place any previous measured water-level data for the well into the field folder.

[3]From the USGS Office of Ground Water, Ground-Water Procedure Document 1.

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6. Check that the measuring point (MP) is clearly marked on the well and accurately described in the well file or field folder. If a new measuring point needs to be established, follow the procedures in Appendix A4-B-1 but do not use paint or create casing-material filings until after sampling has been completed for the day.
7. Prepare the Ground-Water Level Notes and Water-Level Data for GWSI field forms (fig. B1). The measurement process will be repeated at least twice and recorded in the respective column (refer to the unshaded portion of the box at the upper right of fig. B1). Record the time of measurement, using the column headed "1st" for the initial set of measurements. Water-level data are to be recorded to the appropriate accuracy for the depth being measured.
8. Spread clean plastic sheeting around the well to prevent the well tape from contacting the ground and introducing dirt into the well.

To measure water level using a steel tape:

1. Chalk the lower few feet of the tape by pulling the tape across a piece of blue carpenter's chalk (the wetted chalk mark identifies that part of the tape that was submerged).
2. If water level was measured previously at the well, use the previous measurement(s) to estimate the length of tape that should be lowered into the well.
3. Slowly lower the weight and tape into the well until the bottom end of the tape is submerged below the water. Work carefully to avoid splashing. Continue to lower the end of the tape into the well until the next graduation (a whole foot mark) is opposite the MP and record this number on the field form (fig. B1) next to "Hold (for DTW)" as illustrated on fig. B2.
4. Rapidly bring the tape to the surface before the wetted chalk mark dries and becomes difficult to read. Record the number as the "Cut."
5. Subtract the "Cut" from the "Hold" and record the difference as "DTW from MP" (Depth To Water from MP). The difference between these two readings is the depth to water below the MP.
6. Record the MP correction, subtract it from "DTW from MP," and record the result as "DTW from LSD" (depth to water from land-surface datum).

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6. Check that the measuring point (MP) is clearly marked on the well and accurately described in the well file or field folder. If a new measuring point needs to be established, follow the procedures in Appendix A4-B-1 but do not use paint or create casing-material filings until after sampling has been completed for the day.
7. Prepare the Ground-Water Level Notes and Water-Level Data for GWSI field forms (fig. B1). The measurement process will be repeated at least twice and recorded in the respective column (refer to the unshaded portion of the box at the upper right of fig. B1). Record the time of measurement, using the column headed "1st" for the initial set of measurements. Water-level data are to be recorded to the appropriate accuracy for the depth being measured.
8. Spread clean plastic sheeting around the well to prevent the well tape from contacting the ground and introducing dirt into the well.

To measure water level using a steel tape:

1. Chalk the lower few feet of the tape by pulling the tape across a piece of blue carpenter's chalk (the wetted chalk mark identifies that part of the tape that was submerged).
2. If water level was measured previously at the well, use the previous measurement(s) to estimate the length of tape that should be lowered into the well.
3. Slowly lower the weight and tape into the well until the bottom end of the tape is submerged below the water. Work carefully to avoid splashing. Continue to lower the end of the tape into the well until the next graduation (a whole foot mark) is opposite the MP and record this number on the field form (fig. B1) next to "Hold (for DTW)" as illustrated on fig. B2.
4. Rapidly bring the tape to the surface before the wetted chalk mark dries and becomes difficult to read. Record the number as the "Cut."
5. Subtract the "Cut" from the "Hold" and record the difference as "DTW from MP" (Depth To Water from MP). The difference between these two readings is the depth to water below the MP.
6. Record the MP correction, subtract it from "DTW from MP," and record the result as "DTW from LSD" (depth to water from land-surface datum).

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- To obtain the depth to water below land surface if the MP is above land surface: the distance between the MP and land surface datum is subtracted from the depth to water from the MP.
- To obtain the depth to water below land surface if the MP is below land surface: precede the MP correction value with a minus (-) sign and subtract the distance between the MP and land surface datum from the depth to water from the MP.
- If the water level is above LSD, record the depth to water in feet above land surface as a negative number.

7. Make a check measurement by repeating steps 2 through 6, recording check measurements in the second ("2nd") column (fig. B1).
   - The check measurement should be made using a different MP hold value than that used for the original measurement.
   - If the check measurement does not agree with the original measurement within 0.01 or 0.02 of a foot, make a third check measurement, recording this measurement in the third column. Make repeated check measurements until the reason for the lack of agreement is determined or until the results are shown to be reliable.
   - If more than two readings are taken, record the average of all readings.
8. In some pumped wells, a layer of oil may float on the water surface.
   - If the oil layer is a foot thick, read the tape at the top of the oil mark and use this data for the water-level measurement instead of the wetted chalk mark. The measurement will differ slightly from the water level that would be measured were the oil not present.
   - If several feet of oil are present in the well,or if it is necessary to know the thickness of the oil layer, a commercially available water-detector paste can be used that will detect the presence of water in the oil. Apply the paste to the lower end of the tape. The top of the oil shows as a wet line, and the top of the water shows as a distinct color change. Since oil density is about three-quarters that of water, the water level can be estimated by adding the thickness of the oil layer times its density to the oil-water interface elevation.
9. Record water-level data to the nearest 0.01 foot. Record USGS water-level data on field forms (kept in the field folder) and in GWSI, using the appropriate method code(s) (fig. B1).

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10. After completing the water-level measurement, clean the exposed portion of the tape using the procedures described in NFM 3.3.8. To prevent microbial cross-contamination of other wells, disinfect the tape using commercially available hypochlorite wipes or a dilute chlorine solution (1 mL of bleach added to 900 mL water) (NFM 3.3.8). Rinse with DIW and dry the tape after each use. Do not store a steel tape while dirty or wet.

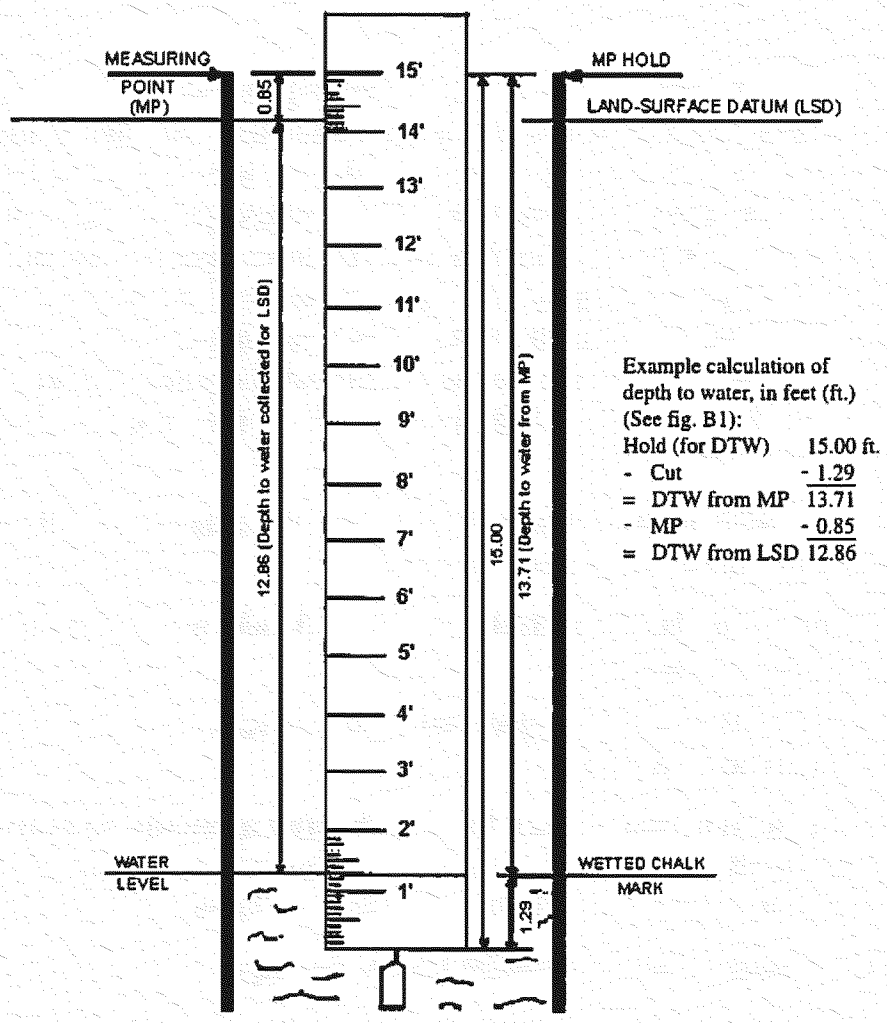

Figure B2. Example of a water-level measurement using a graduated steel tape.

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A4-B-3(b) Electric tape[4]

The electric-tape procedure for measuring depth to the water surface in a nonflowing well is especially useful in wells that are being pumped with large-discharge pumps, when making a series of measurements in rapid succession (for example, during purging or aquifer tests), and in wells with condensation or dripping water. Use of an electric tape minimizes the danger of tape entanglement in the pump impellers because the probe signals when the water surface is reached.

The accuracy of electric-tape measurements depends on the type of tape used and whether or not the tape has been stretched out of calibration after use. Tapes that are marked the entire length with feet, tenths, and hundredths of a foot can be considered accurate to ± 0.01 ft and are most accurate for water levels less than 200 ft below land surface. Electric tapes are harder to keep calibrated than are steel tapes. When measuring deep water levels, tape expansion and stretch is an additional consideration (see Garber and Koopman, 1968). The electric tape should be calibrated against a reference steel tape (see the Equipment and Supplies table above for Appendix A4-B-3.

- If the water in the well has very low specific conductance, the tape may not give an accurate reading.
- Material on the water surface, such as oil, may interfere with obtaining consistent readings.
- If the well casing is angled, instead of vertical, the depth to water will have to be corrected.
- **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.

Before measuring water level with the electric tape:

1. The electric steel tape requires an initial calibration before using it in the field. Calibrate the electric tape against a reference steel tape as follows:
   a. 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. Record this in the equipment log book and on the field form.

[4]From the USGS Office of Ground Water, Ground-Water Procedure Document 4, version 2007.1.

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b. Compare length marks on the electric tape to those on the reference tape with the tapes laid out straight on the ground, or compare the electric tape against the known distance between fixed points on the ground.

c. Compare water-level measurements made with the electric tape to those made with the reference steel tape (or one that has recently been calibrated against it) in several wells that span the range of depths to water that are anticipated. For water levels of less than 500 ft below the MP, measurements should agree to within +/- 0.01 ft. For water levels greater than 500 ft below the MP, measurements should agree to within 1 part in 1000. If these accuracies are not met, then a correction factor based on a regression analysis should be developed.

d. Record all calibration and maintenance data in the calibration and maintenance log book for the electric tape.

2. Check the circuitry of the electric tape before lowering the probe into the well. To determine proper functioning of the tape mechanism, dip the probe into tap water and observe whether the indicator needle, light, and/or beeper (collectively termed the "indicator" in this document) indicate a closed circuit. For an electric tape with multiple indicators (sound and light, for instance), confirm that the indicators operate simultaneously. If they do not operate simultaneously, determine which is the most accurate and use that one.

3. Inspect the electric tape before using it in the field.

   a. Check the tape for wear, kinks, frayed electrical connections and possible stretch; the cable jacket tends to be subject to wear and tear.

   b. Test that the battery and replacement batteries are fully charged.

4. Place any previous measured water-level data for the well into the field folder.

5. After reaching the field site, check that the measuring point (MP) is clearly marked on the well and is accurately described in the well file or field folder. If a new measuring point needs to be established, follow the procedures in Appendix A4-B-1, but do not use paint or create casing-material filings until after sampling has been completed to avoid sample contamination.

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6. Prepare the Gound-Water Level Notes and Water-Level Data for GWSI field forms (fig. B1). The measurement process will be repeated at least twice and recorded in the respective column (refer to the unshaded portion of the box at the upper right of fig. B1). Record the time of measurement, using the column headed "1st" for the initial set of measurements. Data are to be recorded to the appropriate accuracy for the depth being measured.
7. Prevent the well tape from contacting the ground and introducing dirt into the well by spreading a clean plastic sheet around the well.

To measure water level using an electric tape:

1. 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. Avoid letting the tape rub across the top of the well casing. Place the tip or nail of the index finger on the insulated wire at the MP and read the depth to water.
   - Record the depth to water measurement in the first data-entry column, as "DTW from MP."
   - Record the date and time of the measurement.
   - Make all readings using the same deflection point on the indicator scale, light intensity, or sound so that water levels will be consistent between measurements.
   - If the tape has been repaired and spliced go to the section onusing a repaired/spliced tape (step 6).
2. Apply the MP correction to get the depth to water in feet below or above LSD. If the MP is below land surface, precede the MP correction value with a minus (-) sign to obtain the MP height. In all cases, subtract the MP height from the water level to obtain the depth to water (DTW from LSD). Referring to the non-shaded section of the Ground-Water Level Notes field form (fig. B1) in the "Depth to Water and Well Depth" table, record this value in the first (1st) data-entry column as "DTW from LSD." If the water level is above LSD, enter the water level as feet above land surface preceded by a minus sign (-).
3. Make a check measurement by repeating steps 1 and 2 and record the measurement in the second data column of fig. B1. If the check measurement does not agree with the original measurement within 0.01 or 0.02 of a foot, make a third check measurement, recording this measurement in the third (3rd) column. Make repeated check measurements until the reason for the lack of agreement is determined or until the results are shown to be reliable. If more than two readings are taken, record the average of all readings.

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4. Water-level data are recorded to the nearest 0.01 foot. Record USGS water-level data on field forms and in GWSI, using the appropriate method code(s) (fig. B1).
5. After completing the well measurement, wipe down the section of the tape that was submerged in the well water, using the cleaning and/or disinfection method of choice (NFM 3.3.8). If disinfecting the tape, rinse the tape thoroughly with deionized or tap water after disinfection Dry the tape and rewind it onto the tape reel. Do not rewind or otherwise store a dirty or wet tape.
6. **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.
   a. Ensure that the splice is completely insulated from any moisture and that the electrical connection is complete.
   b. 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 point then becomes the "tape correction." For example, if the nearest foot marker above the splice is 20 feet, and the distance to the probe sensor is 0.85 ft, then the tape correction will be 19.15 feet. Record the tape correction on a field form. Periodically recheck the tape-correction factor by measuring the spliced electric tape with a reference steel tape.
   c. 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. Place the tip or nail of the index finger on the insulated wire at the MP and read the depth to water. Record the depth-to-water measurement and the date and time of the measurement on the field form.
   d. Subtract the "Tape Correction" value from the "Hold" value and record the result as DTW from LSD (fig. B1).
   e. Return to Step 2.

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