

## MANUAL GROUNDWATER LEVEL MEASUREMENTS

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**Purpose** This procedure states the responsibilities and describes the process for manually measuring the depth to groundwater and determining the groundwater elevation in an open borehole or cased monitoring well.

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**Scope** This procedure applies to all ENV-WQH, ENV-ECR, and contract personnel who manually measure groundwater levels.

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**In this procedure** This procedure addresses the following major topics:

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**Integrated Work Management** The work specified in this procedure shall be conducted in accordance with applicable Integrated Work Documents, in accordance with LANL IMP 300-00-00, Integrated Work Management for Work Activities

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First authorization review date is one year from group leader signature below;  
subsequent authorizations are on file in group office.

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## 1. General information about this procedure

**Attachments**  This procedure has the following attachments:

Number	Attachment Title	No. of pages
1	Measuring Point Diagram	1
2	Groundwater Level Measurement form	1
3	Water Level Meter Calibration and Maintenance form	1

### History of revisions

This table lists the revision history and effective dates of this procedure.

Revision	Date	Description Of Changes
0	6/20/05	New document. Supersedes RRES-WQH-SOP-045.0.

### Who requires training to this procedure

All ENV-WQH and ENV-ECR staff and contract personnel who use water level meters and manually measure groundwater levels require training before implementing this procedure.

### Training method

The training method for this procedure is read-training. Training is in accordance with group specific procedures for training. Retraining to this procedure is “self-study” (reading) and completed upon instruction of line manager.

Personnel who have not previously measured groundwater levels manually at LANL should be mentored before performing this procedure alone.

### Prerequisites

In addition to training to this procedure, comprehension of and authorization to the following is required:

- RRES-ES-Field, General Field Work for All
- RRES-ES-Driving, Driving, Towing, and Winching for All
- RRES-WQH-SOP-004, Radio and Cellular Phone Use

If using a water level meter with an electric reel and a small electric generator, training to the following is required:

- Electrical Safety Awareness Training

## 1. General information, continued

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### Definitions

Electric water level meter: a device designed for measuring depth to water in wells using a flat graduated measurement tape attached to a weighted stainless steel probe containing an electrode, which emits an audible and visible signal when contact is made with water. This is the most common and preferred device for manually measuring groundwater levels.

Land surface datum (LSD): the elevation in ft mean sea level (msl) of the ground surface at the well. Normally determined by survey methods, but may be estimated from topographical maps in the absence of a geodetic survey.

Measuring point (MP): reference point marked on a well casing from where all water levels are measured. This point may be the top of casing or may be a location permanently marked on the well casing. Because the MP may change from time to time, the MP must be documented for each groundwater level measurement.

Participant: ENV-WQH, ENV-ECR, or contractor personnel trained to this procedure and authorized to conduct the work prescribed in this procedure.

Reference point (RP): an arbitrary datum established by permanent marks, and used to check the MP or to re-establish the MP should the original MP be destroyed or changed.

Piezometer: an observation well with a short screened interval used to measure groundwater level. Piezometers are usually narrow diameter wells that do not allow for the collection of groundwater samples and may be nested at different depths within one well boring or casing.

Potentiometric surface: The level at which water stands in a well for a specific saturated zone; also called piezometric surface.

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### Background Information

Groundwater level measurements are generally used to construct potentiometric surface maps. Groundwater level data are also used to determine hydraulic conductivity, groundwater flow direction, flow velocity, hydraulic gradients, impacts due to pumping or other groundwater stresses

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## 1. General information, continued

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**References** The following documents are referenced in this procedure:

- RRES-ES-Field, General Field Work for All
- RRES-ES-Driving, Driving, Towing, and Winching for All
- RRES-WQH-SOP-004, Radio and Cellular Phone Use
- RRES-WQH-SOP-015, Down Hole Video Camera Use
- RRES-RS-QMP, Quality Management Plan for the LANL RRES Remediation Services Project
- LANL-ER-QP-2.2, Personnel Training Management
- LANL-ER-QP-3.5, Peer Review Process
- LANL-ER-QP-4.4, Record Transmittal to the Records Processing Facility
- LANL-ER-QP-4.9, Document Development and Approval Process

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**Note** Actions specified within this procedure, unless preceded with “should” or “may,” are to be considered mandatory guidance (i.e., “shall”, “must”).

## 2. Before leaving for the field

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**Materials and instruments** Suggested equipment for water level measurements includes:

- Electric water level meter with tape marked in 1 ft intervals and graduated to 0.01 ft length appropriate to well(s) being measured
- Groundwater Level Measurement form (Attachment 2)
- Waterproof pen
- Electrical tape
- Well location file notebook with well location map, measuring point diagram, and as-built diagram of well construction with Land Surface Datum (LSD)
- Deionized water and Kim Wipes
- AA batteries or 9-volt batteries, as needed
- Keys for the well
- Small generator (if electric reel is being used)
- Field notebook
- Hand-held calculator
- Protective gloves and safety glasses with side shields
- Nitrile gloves

**Establish working condition of water level meter**

Before using a water level meter, **participant** establishes the working condition of the meter by filling a bucket, length of tubing, or similar container with fresh tap water.

- Insert the water level meter into the container and check that the audible tone device and/or the lighted signal device operate properly when the sensor contacts the water.
- If there is no response by the water level meter, follow manufacturer instructions for checking and replacing the batteries and repeat the test.
- If there is still no response, check for corrosion in the battery compartment and all electrical connections and contacts between the reel and the tape and the tape and the sensor unit.
- Follow manufacturer instructions for cleaning and maintenance of the water level meter.

## 2. Before leaving for the field, continued

**Calibration** **Participant** shall check and calibrate all water level meters any time after a meter has been hung up or kinked during use. Record calibration on the Water Level Meter Calibration and Maintenance Form (Attachment 3) and maintain form in the equipment files. Attach a calibration tag to the water level meter with any measurement-offset instructions.

To perform calibration, **participant** shall perform the following steps:

Step	Action
1	Measure the distance from the top of a container to the water with a tape measure graduated in 0.01 ft increments. Check that the depth to water measured by the water level meter corresponds to the measured depth to water.
2	Check the total length of the water level meter for accuracy using an acceptable steel tape that is maintained in the office for use only for calibrating tapes (NIST Standard).
3	If the measured distance between the sensor point and the tape markings do not coincide (step 1) and/or if the length of the water level meter does not correspond with the steel tape (step 2): <ul style="list-style-type: none"> <li>• note the measurement discrepancy(ies) on the Water Level Meter Calibration and Maintenance Form (Attachment 3) and</li> <li>• mark and affix a tag to the water level meter with the measurement calibrated offset distance in ft.</li> </ul>

**Note:** When planning to collect water level measurements from a number of wells, it is prudent to begin with those wells that are the least contaminated and proceed toward wells having increasing levels of contamination.

**Water Level Meter Maintenance:** To maintain the water level meter tape in good working condition, **participant** shall:

- Periodically check the tape for breaks, kinks, and possible stretching.
- Do not let the tape rub across the top of the casing.
- Clean tape, probe, and reel while retrieving from the well to avoid possible contamination of other wells. Pull the tape through a clean cloth dampened with deionized water.

## 2. Before leaving for the field, continued

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**Assessing data** Criteria for assessing data accuracy are as follows:

**accuracy and  
limitations**

- Water level measurements should be repeated at least three times to establish the repeatability, precision, and accuracy of the measurement. Repeat the measurement by raising the tape about 0.5 ft and lowering until the water level meter senses contact with the water.
- Repeated measurements of static water level using the same electric water level meter tape should agree within  $\pm 0.02$  ft for groundwater depths less than about 200 ft.
- Repeated measurements of static water level using the same electric water level meter tape should agree within  $\pm 0.05$  ft for groundwater depths from 200 to about 750 ft.
- Repeated measurements of static water level using the same water level meter tape should agree within  $\pm 0.1$  ft for groundwater depths from 750 ft to 2,000 ft.

The accuracy with which the measuring point (MP) measurement is established corresponds to the accuracy of the resulting groundwater elevation measurements. Where water levels are measured to 0.01 ft, establish the MP to an accuracy of 0.01 ft. Where water levels are measured to 0.1 ft, establish the MP to an accuracy of 0.1 ft.



### 3. Establishing a measuring point

- Assumptions** The following assumptions are made when establishing a permanent measuring point (MP).
- For consistency, groundwater level measurements are routinely measured from the same MP.
  - The land-surface datum (LSD) of the well is determined by geodetic survey when the well is installed or is estimated by a team leader responsible for the initial water level measurement in the well.
  - Because the MP of a well may change over time, routinely check the distance between the MP and LSD and document the MP height on the Groundwater Level Monitoring Form (Attachment 2).
  - MPs should not normally change; if a new MP must be established, indicate why the point was moved and the location of the new point on the Measuring Point Diagram (Attachment 1).

**Establish a measuring point** At the completion of installation of a monitoring well, or when inventorying an existing monitoring well, establish a MP. The MP must be as permanent as possible, clearly defined, marked, and easily located. The MP is measured in reference to LSD and is the most convenient point from which to measure the groundwater level in a well.

To establish a permanent MP, **participant** shall perform the following steps:

Step	Action
1	Designate a convenient point at the top of the outer or riser-casing as the MP.
2	Position the MP at an accessible point on the casing.
3	Clearly mark the MP. Do not allow engravings or filings to enter the well.
4	Measure the height of the MP in feet above or below the LSD (Attachment 1).
5	Record the height of the MP on the Groundwater Level Measurement form (Attachment 2) and in the field logbook.
6	Record the date the MP was established, the height of the MP above or below the LSD, and a detailed description of the MP on the Measuring Point Diagram (Attachment 1) and in the field logbook.
7	Depending on the purpose of the groundwater level measurements, it may be desirable to obtain a geodetic survey for the LSD and the MP.

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### 3. Establishing a measuring point, continued

**Establish a measuring point, cont'd**

Step	Action
8	Establish at least one clearly marked reference point (RP) somewhere near the well. At most wells, the brass cap in the concrete pad will be used as the RP.
9	Make a detailed sketch of the MP and the RP on the Measuring Point Diagram (Attachment 1) and if possible, take a photograph and include in the well location file. Mark the MP and the RP on the photograph.

**Recording data**

**Participant** shall record all MP data on the Measuring Point Diagram and the Groundwater Level Measurement form. The completed forms are maintained in the well files.

Note: If no MP can be found at a well, **participant** shall establish and document the MP used to measure the groundwater level on the Groundwater Level Measurement Form.

## 4. Measuring groundwater level with a water level meter

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**Conditions for Participant** shall use an electric water level meter to measure static groundwater using a water level meter levels in the following wells:

- Open boreholes
- Cased monitoring wells
- Piezometers

Water level meters may be used with less precision and accuracy in the following circumstances:

- When water is dripping into the well or condensing on the inside casing walls.
  - In wells that are being pumped, particularly with large-discharge pumps.
  - When a series of measurements are needed in quick succession, such as in aquifer tests.
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**Caution** **Participant** shall not use a water level meter to measure water level in a borehole, well, or access tube where a transducer is installed unless a separate access tube is present for deployment of the water level meter. Use of a water level meter in a well or tube with a transducer or other type of cable or tubing may lead to tangling of the water level meter probe with the cable.

To measure the water level in a well equipped with a transducer and no separate access tube for water level measurement, **participant** shall remove the transducer from the well before measuring the water level. Re-install the transducer in the well after obtaining the water level measurement.

A water level meter may be used in a shallow alluvial well equipped with a transducer. Use care to avoid tangling.

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**Down Hole Video Camera** A down hole video camera may be used in place of a water level meter to measure the water level in a borehole or well. **Participant** shall follow this procedure and RRES-WQH-SOP-015, *Down Hole Video Camera Use* to measure the water level visually. Complete the Manual Groundwater Level Measurement Form (Attachment 2), noting the precision with which the winch mechanism used with the down hole video camera is capable of measuring depth.

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**Assumptions** The following assumptions are made when preparing to use an electric water level meter for water level measurements:

- An established MP exists and the distance from the MP to LSD is known. Reference Attachments 1 and 2.
- All established MPs and well data will be maintained in the WQH well files.
- Tape stretch is negligible for groundwater level measurements.

## 4. Measuring groundwater level with a water level meter, continued

**Measuring groundwater level cont'd** To measure groundwater level with a water level meter, **participant** shall perform the following steps:

Step	Action
1	<p>Unlock the protective steel well-head cover and remove the well cap. Note the well name, date, and time of day in the field notebook or on the Groundwater Level Measurement Form (Attachment 2).</p> <p>Locate the Measuring Point (MP) of the well and document the MP and the LSD on the Groundwater Level Measurement Form.</p> <p>Measure the MP height from the LSD and record the height on the Groundwater Level Measurement Form or reference well location file for MP height.</p> <p>Note in the comments field of the Groundwater Level Measurement Form if air is moving in or out of the well.</p>
2	<p>Clean the probe with DI water and dab dry prior to entry into a well.</p>
3	<p>Turn on the water level meter and check that the audible/visual signal operates.</p> <p>Lower the water level meter probe slowly into the well until the audible/visual signal indicates that the water surface is encountered.</p> <p><b>Note:</b> for wells equipped with a pump assembly and a water level access tube, insert the water level meter probe into the small diameter access tube at the wellhead assembly.</p> <p><b>Note:</b> Pump assemblies should NOT be temporarily raised or lowered to perform water level measurements. If the water level is below “top of pump,” then record information accordingly. Do not force a water level probe past pumps or other obstructions in a well.</p>

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## 4. Measuring groundwater level with a water level meter, continued

### Measuring groundwater level cont'd

Step	Action
4	<p>When the water surface is contacted, slowly raise and lower the probe in the well, noting at the MP the measured depth where the signal sounds. Repeat this step of the measurement until the depth results are reproduced at least three times. Reference Assessing Data Accuracy and Limitations on page 6 of this document.</p> <ul style="list-style-type: none"> <li>• If the check measurement does not agree with the original measurement within the accuracy given in the data accuracy section, continue to make check measurements until the reason for the lack of agreement is determined or until the results are shown to be repeatable.</li> <li>• Document unusual occurrences such as water cascading into the well, etc. on the Groundwater Level Measurement form.</li> </ul> <p>Record the measured depth to water (DTW) at the MP in the "Measured Depth to Water" column of the Groundwater Level Measurement form.</p> <p><b>Note:</b> Measurement should be recorded to 0.01 ft, or provide comment why the measurement was not obtainable to this precision.</p>

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## 4. Measuring groundwater level with a water level meter, continued

### Measuring groundwater level (cont'd)

Step	Action
5	<p>If appropriate with the equipment available and completion of the well, measure total depth (TD) of well by lowering the weighted water level probe (or video camera) to the bottom of the well. Record the TD of the well on the Groundwater Level Measurement form.</p> <ul style="list-style-type: none"><li>• Do not remove or adjust the pump or otherwise disturb the water column to accomplish this measurement.</li><li>• Disable the water level sensing signal before lowering the probe.</li><li>• Measure TD by manually raising and lowering the probe and determining the depth where the weight of the probe is no longer sensed. Note: this method is not appropriate for wells deeper than about 300 ft. <b>Note:</b> Be sure to add additional probe length from sensor to bottom of probe as this is not accounted for on the measuring tape.</li><li>• Refer to the well construction diagram or well summary sheet for as-built well TD information.</li></ul>
6	<p>When measurements are complete, turn off the water level meter and carefully remove the water level meter tape from the well by winding onto the meter reel. Clean the water level meter tape and probe using DI water and dabbing dry with a paper towel.</p> <p><b>Note:</b> Use caution when retrieving the water level probe from the well. Retrieve the tape and probe in the center of the casing, do not allow the tape or probe to contact casing if possible, and do not allow the probe to swing wildly upon retrieval from the well.</p>

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## 4. Measuring groundwater level with a water level meter, continued

### Measuring groundwater level (cont'd)

Step	Action
7	<p>Calculate water elevation from measurement data and enter water elevation on the Groundwater Level Measurement form (Attachment 2).</p> <p>Groundwater Elevation = Land Surface Datum (LSD) + Measurement Point (MP) Height above LSD – Depth to Water Measurement from Measurement Point.</p> <p>Refer to the well construction diagram for the depth and elevation of the bottom of the screen interval (note that well construction diagrams are usually referenced to the LSD, not the MP).</p> <ul style="list-style-type: none"> <li>• Check that the measured groundwater level is within the screen interval or the range of prior measurements.</li> <li>• If the groundwater elevation is below the bottom the screen, note on the Groundwater Level Measurement form that water is present in the sump but not present in the well.</li> </ul>

### Recording data

**Participant** shall maintain calibration and maintenance data associated with each water level meter in the Water Level Meter Calibration and Maintenance form files.

- All groundwater measurement data are recorded in the Groundwater Level Measurement form to the appropriate accuracy for the depth being measured.
- The Groundwater Level Measurement forms will be maintained in the WQH well files. Refer to “Assessing data accuracy and limitations” in this document.

## 5. Lessons Learned

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**Review lessons learned** Before performing work described in this SOP, **participants** shall go to the Department of Energy Lessons Learned Information Services home page, located at <http://www.tis.eh.doe.gov/ll/ll.html>, and/or to the LANL Lessons Learned Resources web page, located at [http://www.lanl.gov/projects/lessons\\_learned/](http://www.lanl.gov/projects/lessons_learned/), and search for applicable lessons.

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**Provide lessons learned** During work performance and/or after the completion of work activities, **participants**, as appropriate, shall identify, document, and submit lessons learned in accordance with the LANL, Lessons Learned System located at [http://www.lanl.gov/projects/lessons\\_learned/](http://www.lanl.gov/projects/lessons_learned/).



## 6. Records resulting from this procedure

**Records**      The **participant** shall ensure that the following records, generated as a result of this procedure, shall be permanently stored with ENV-WQH in accordance with RRES-WQH-QP-025, Records Management.:

- Measuring Point Diagram form
- Groundwater Level Measurement form
- Water Level Meter Calibration and Maintenance form

[Click here to record “self-study” training to this procedure.](#)



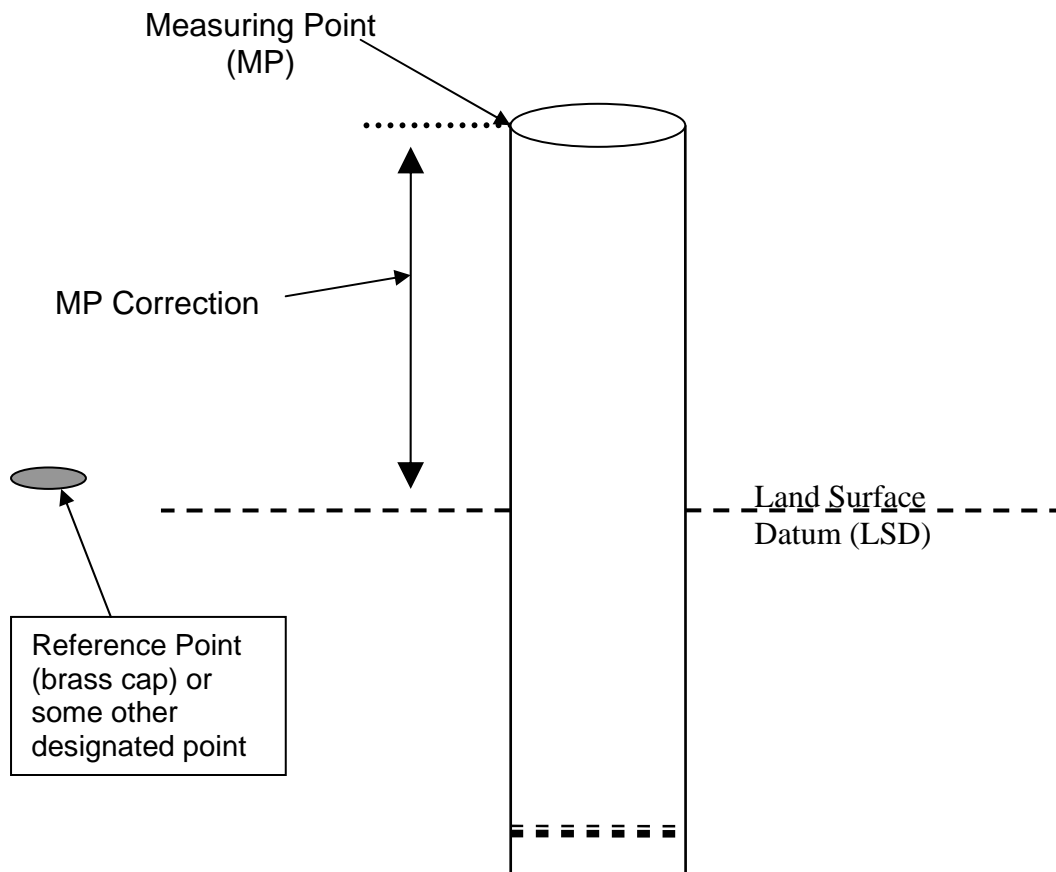
## MEASURING POINT DIAGRAM

Well Name = \_\_\_\_\_

MP Description = \_\_\_\_\_

MP Height (ft) = \_\_\_\_\_  
(note: (+) = above LSD, (-) = below LSD)

LSD (ft) = \_\_\_\_\_ LSD Description: \_\_\_\_\_





**Los Alamos National Laboratory  
Water Quality and Hydrology  
Groundwater Level Measurement Form**

Sheet \_\_\_ of \_\_\_

Technical Area \_\_\_\_\_

Project Name: \_\_\_\_\_

Location/Field: \_\_\_\_\_

Personnel: \_\_\_\_\_

Signature: \_\_\_\_\_

Well Name	Date	Time	Measuring Point (MP)				Water Level		Total Depth	Comment <sup>3</sup>
			A Land Surface Datum (LSD) (Ft MSL) <sup>1</sup>	B Document MP (LSD or TOC) <sup>2</sup>	C MP above (+) or below (-) LSD (Ft)	D Measured Depth to Water (DTW) (Ft)	Measured Depth of Well from MP (Ft)	= C - B	= A + B - C	

Measurement Method and Water Level Meter Type: \_\_\_\_\_

Water Level Meter Serial Number: \_\_\_\_\_

Additional Comments:  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

1) Note the Land Surface Datum (LSD) of the well, usually the elevation of the brass cap or ground level  
 2) MP = Measuring Point; TOC = Top of Casing; State MP if other  
 3) Include any pertinent information about the water level measurement



