Manual Groundwater Level Measurements

Effective Date: 3/1/2017

Next Review Date: 3/1/2020

Hazard Class: ☐ Low ☒ Moderate ☐ High/Complex
Usage Mode: ☒ Reference ☐ UET ☐ Both UET & Reference

The Responsible Manager has determined that the following organizations' review is required for initial procedure release as well as subsequent major revisions. Review documentation is contained in the Document History File.

Procedure Owner	Waste Management
Technical Lead	Industrial Hygiene & Safety
Environmental Protection	M&TE
Quality Assurance	Training

Classification Review: ☒ Unclassified ☐ UCNI ☐ Classified

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Revision History

Document No./Revision No.	Issue Date	Action	Description
ENV-DO-202, R0	6/20/05	Major	New document. Supersedes RRES-WQH-SOP-045.0
SOP-5223, R0	10/29/08	Major	New procedure. Supersedes ENV-DO-202, R0.
ER-SOP-20243, R0	12/14/15	Major	New procedure. Supersedes SOP-5223. Complete Rewrite.
ER-SOP-20243, R1	9/14/2016	Minor	Updates to Groundwater Level Field Form. Steps consolidated to match new form.
ER-SOP-20243, R1 IPC-1	3/1/2017	IPC	Updates to Groundwater Level Field Form.

TABLE OF CONTENTS

1. 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.

2. SCOPE

This standard operating procedure (SOP) applies to all Los Alamos National Laboratory (LANL) Water Monitoring Group (ER-FS) and contract personnel who manually measure groundwater levels.

3. REFERENCES

- EP-AP-10003, *Records Management*
- ER-SOP-10010, *Pressure Transducer Installation, Removal, and Maintenance*
- P330-2, *Control and Calibration of Measuring and Test Equipment (M&TE)*

4. APPLICABILITY

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

5. DEFINITIONS AND ACRONYMS

5.1 Definitions

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 a water-sensitive electrode. The meter 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 feet 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.

5.1 Definitions (continued)

Measuring point (MP) – Reference point on a well casing from where groundwater 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.

Field team member (FTM) – Environmental Remediation-Field Services (ER-FS) 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 used to check the MP or to re-establish the MP should the MP be destroyed or changed; usually the brass cap marker set in cement at the base of a well.

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 have multiple well casings with screens nested at different depths within one well boring.

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

5.2 Acronyms

DI	deionized (water)
DTW	distance to water
ER-FS	Environmental Remediation-Field Services
FTM	field team member
GWE	groundwater elevation
LANL	Los Alamos National Laboratory
LSD	land-surface datum
MP	measuring point
MSL	mean sea level
MST	Mountain Standard Time
NIST	National Institute of Standards and Technology
RP	reference point
SOP	standard operating procedure
TD	total depth
WL	water level

6. PRECAUTIONS AND LIMITATIONS

- An electric (9-volt) water-level meter is used to measure groundwater levels in open boreholes, cased monitoring wells, and piezometers.

- Water-level meters should not be used to measure groundwater level in a deep (>500 ft) borehole, well, or access tube where a transducer or other equipment is installed on a cable unless a separate access tube is present to deploy the water-level meter.

- Transducers must be removed prior to measuring water level in deep wells equipped with a transducer that has no separate access tube for groundwater-level measurements. (See ER-SOP-10010, *Pressure Transducer Installation, Removal, and Maintenance*.) 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.

- Shallow alluvial wells, and intermediate wells of <500 ft, may be measured for groundwater levels with a transducer or pump installed where space in the well allows insertion of the water-level probe.

- Keep water-level meters used in open boreholes during drilling operations separate from the water-level meters used for routine groundwater-level measurements.

- Do not use water-level meters that are used for collecting routine groundwater-level measurements in water supply wells with turbine pumps because the oil used to lubricate the pump will contaminate the water-level meter probe and tape.

- Minimize potential for cross-contamination by ensuring the following:

    - **CLEAN** the water-level tape and probe by pulling through a clean cloth dampened with DI water as they are being retrieved from the well.

    - **MAINTAIN** the sounder in a clean environment while in transit between wells.

- 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, or
    - when a series of measurements are needed in quick succession, such as during aquifer tests.

7. PREREQUISITE ACTIONS

7.1 Special Tools and Equipment, Parts, and Supplies

Required equipment for groundwater-level measurements includes the following:

- Water-level meter with tape marked in 1-foot (ft) intervals and graduated to 0.01-ft length appropriate to well(s) being measured and with MT&E calibration information
- Waterproof pen
- Electrical tape
- Well location field notes
- Measuring-point diagram, and as-built diagram of well construction with land surface datum (LSD), as needed
- Deionized (DI) water and Kimwipes
- AA batteries or 9-volt batteries, as needed
- Keys for the well
- Generator (if electric reel is being used)
- Groundwater Level Field Forms and current work package
- Groundwater Level Field Form from last measurement
- Hand-held calculator
- Nitrile gloves
- Well-head tape roller guide or tripod
- Measuring tape
- Bennett Reel
- Bennett Reel accessories
- Laptop
- PPE, as required

7.2 Training

Workers will complete all required training for performance of this procedure. Training will be determined through analysis and tracked in Utrain.

8. PERFORMANCE—MANUAL GROUNDWATER LEVEL MEASUREMENT

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

8.1 Establishing Working Condition of Water-Level Meter

Field Team Member

[1] **CHECK** water-level meter alarm by wetting with tap water (not DI water) on a wet paper towel and pressing alarm test button.

[2] **ENSURE** water-level meter is operating with charged batteries free of corrosion or loose wires.

[3] **FOLLOW** manufacturer's instructions for operation, cleaning, and maintenance of water-level meter.

8.2 Downloading Data from the Transducer

NOTE *All entries on Attachment 1, Groundwater Level Field Form should be entered using Mountain Standard Time (MST).*

Field Team Member

[1] **UNLOCK** the protective steel well-head cover and **REMOVE** the well cap or **REMOVE** transducer cable from telemetry box.

[2] **CONNECT** laptop to transducer cable and **START** live feed.

[3] **COMPLETE** Part 1: Well Site Information of Attachment 1, except for data file name.

[4] **STOP** logging activity.

NOTE *Do not perform data download until logging has stopped.*

[5] **DOWNLOAD** data and **RECORD** data file name on Attachment 1.

[6] **STOP** live feed and **DISCONNECT** laptop from cable.

[7] **IF** well has upper and lower transducers,
THEN REPEAT 8.2 [2] through 8.2 [6] for the second transducer.

8.3 Removing the Transducer

NOTE *Transducer removal is performed in accordance with ER-SOP-10010, Transducer Installation, Removal, and Maintenance.*

Field Team Member

[1] **TURN ON** generator.

[2] **CONNECT** meter reel cable to transducer cable and **ENSURE** there are two points of contact for support.

[3] **PLACE** cushion between cable and meter reel to prevent pinching and puncturing of cable.

[4] **BEGIN** reeling cable up and **CLEAN** cable using DI water on a paper towel as it is pulled from the well.

[5] **REMOVE** transducer and **SECURE** transducer.

8.4 Measuring Groundwater Level with a Water-Level Meter

Field Team Member

[1] **CLEAN** the probe with DI water and dab dry before it is inserted into the well.

[2] **TURN ON** the water-level meter and **CHECK** that audible/visual signals are operating and batteries are working, if applicable.

NOTE 1 *Pump assemblies should NOT be temporarily raised or lowered to perform water-level measurements. Water level below "top of pump" should be recorded accordingly.*

NOTE 2 *Do not force a water-level probe past pumps or other obstructions in a well. Removal of a pump assembly from a well to measure the groundwater level should be recorded on Attachment 1.*

[3] **IF** measuring a well equipped with a pump assembly and a water-level access tube, **THEN INSERT** the water-level meter probe into the small-diameter access tube at the well-head assembly.

[4] **POSITION** probe and measuring tape over the well.

[5] **LOWER** the water-level meter tape and probe slowly into the well until the audible/visual signal indicates that the water surface is contacted.

[6] **IF** measuring the groundwater level of water supply wells,
THEN DOCUMENT when the well was last operated in the comments section of Attachment 1.

[7] **ALLOW** water to settle for 3 to 5 minutes.

[8] **RAISE** and **LOWER** the probe manually into the well, noting at the MP the measured depth where the signal sounds.

[9] **REPEAT** 8.4 [7] and [8] until the depth results are reproduced at least three times. (See 8.6, Assessing Data Accuracy and Limitations.)

8.4 Measuring Groundwater Level with a Water-Level Meter (continued)

[10] **IF** the check measurement does not agree with the original measurement within the accuracy given in 8.6,
THEN CONTINUE to take measurements until the reason for the lack of agreement is determined or until the results are shown to be repeatable.

NOTE 1 *Measurements should be recorded to 0.01 ft. or comment provided why the measurement was not obtainable to this precision.*

NOTE 2 *When using a measuring tape with measurement offset, determined either by the manufacturer or through field calibration, the offset must be used in the groundwater elevation calculation. Offset values must be recorded in the comments section of Attachment 1.*

NOTE 3 *Measurement of total depth (TD) is not appropriate for regional or intermediate wells. Refer to the well construction diagram or well summary sheet for as-built well TD information.*

[11] **COMPLETE** Part 2: Manual Measurements of Attachment 1, except for TD.

[12] **DOCUMENT** unusual occurrences, such as water cascading into the well, recent pumping of the well, or pumping of a nearby well, in the comments section of Attachment 1.

[13] **IF** appropriate, with the equipment available and upon completion of the well,
THEN MEASURE the TD of well by lowering the probe to the bottom of the well.

[14] **IF** the TD is not measured because of well construction or interference with the pump,
THEN INDICATE that it wasn't measured on Attachment 1 by writing NA (not applicable) and **GO TO** 8.4 [19] in this procedure.

[15] **IF** not measuring an alluvial well,
THEN GO TO 8.4 [18] in this procedure.

[16] **IF** measuring an alluvial well,
THEN TURN OFF the water-level sensing signal before lowering the probe.

[17] **MEASURE** the TD in alluvial wells by manually raising and lowering the probe and determining the depth where the probe comes in contact with solid surface (top of pump or bottom of well).

8.4 Measuring Groundwater Level with a Water-Level Meter (continued)

[18] **RECORD** the TD of well.

[19] **COMPLETE** Part 3: Transducer Information and Part 4: Transducer Drift/Error Acceptance of Attachment 1.

8.5 Reinserting the Transducer

NOTE *Transducer installation is performed in accordance with ER-SOP-10010, Pressure Transducer Installation, Removal, and Maintenance.*

Field Team Member

[1] **TURN OFF** the water-level meter.

NOTE *Water-level meter tape should be checked any for breaks, kinks, or stretching, and should be prevented from rubbing on the side of casing as it is pulled from the well.*

[2] **RETRIEVE** the water-level meter tape and probe carefully from the center of the well casing by winding the tape onto the meter reel.

[3] **CLEAN** the water-level meter tape and probe using DI water and dabbing dry with a paper towel.

[4] **LOWER** transducer into well.

[5] **REPLACE** O-ring to original position.

[6] **ENSURE** zip ties are properly installed on Kellims grip.

[7] **CONNECT** laptop to transducer cable.

8.5 Reinserting the Transducer (continued)

[8] **SET** program manually to read pressure, temperature, and elevation, unless otherwise instructed.

[9] **ENTER** manually the new reference level and current depth.

[10] **COMPLETE** Part 5: Programming of Attachment 1.

[11] **VERIFY** the programming summary is correct.

[12] **REPEAT** data reading after 3 minutes and **RECORD** results on Attachment 1.

[13] **DOCUMENT** any comments and unusual occurrences in the comments box on Attachment 1.

[14] **DISCONNECT** laptop and **REPLACE** cable desiccant with a new desiccant.

[15] **SECURE** well cap and lock.

[16] **DISPOSE** of any contact waste generated while performing this procedure by following the requirements in the applicable waste characterization strategy form or waste profile form for each well.

8.6 <u>Assessing Data Accuracy and Limitations</u>

Field Team Member

[1] **ASSESS** data accuracy using the following criteria:

- Repeated measurements of a groundwater level should generally be within 0.01% of the measurement.
- Repeated measurements of groundwater level using the same water-level meter tape should agree within ±0.02 ft for groundwater depths less than about 200 ft.
- Repeated measurements of static water level using the same water-level meter tape should agree within ±0.05 ft for groundwater depths of 500 ft.
- Repeated measurements of static water level using the same water level meter tape should agree within ±0.1 ft for groundwater depths of 1,000 ft.

8.7 Water-Level Meter Maintenance

NOTE 1 *All water-level meters in use by ER-FS should be checked and field-calibrated, or replaced, at least annually.*

NOTE 2 *All water-level meters in use by ER-FS will be calibrated in accordance with P330-2, Control and Calibration of Measuring and Test Equipment (M&TE).*

Field Team Member

[1] **FILL** a 5-gallon bucket with water.

[2] **RECORD** date, time, inspector name, and serial number on Attachment 2, Water-Level Meter Calibration and Maintenance Form.

[3] **RECORD** meter tape total length.

[4] **MEASURE** the DTW with measuring tape and **RECORD** results on Attachment 2.

[5] **CHECK** that probe is working by placing a wet paper towel on bottom of probe.

[6] **LOWER** probe into water manually and **RECORD** the DTW from water-level meter.

[7] **MEASURE** the TD with measuring tape and **RECORD** results on Attachment 2.

[8] **LOWER** probe into water manually and **RECORD** the TD from water-level meter.

[9] **REMOVE** probe from water and dry with a paper towel.

[10] **DOCUMENT** equipment condition, comments, and description of maintenance on Attachment 2.

[11] **MARK** clearly each water-level meter removed from service with a tag indicating the date it was removed from service.

[12] **ATTACH** a calibration tag noting any measurement offset to the water-level meter.

8.8 Establishing the MP on New or Reconfigured Wells

NOTE 1 *The LSD of the well is determined by geodetic survey when the well is installed or is estimated by a project leader responsible for the initial groundwater-level measurement in the well.*

NOTE 2 *MPs should not normally change; the MP is measured in reference to LSD.*

NOTE 3 *The accuracy of the MP measurement corresponds to the accuracy of the resulting groundwater-elevation measurements. Where groundwater levels are measured to 0.01 ft, the MP should be established to an accuracy of 0.01 ft.*

Field Team Member

[1] **IF** a new MP must be established,
THEN DOCUMENT why the point was moved and the location of the new point on Attachment 1.

[2] **ESTABLISH** an MP at the completion of installation of a monitoring well, or when inventorying an existing monitoring well by performing the following steps:

[3] **DESIGNATE** at least one clearly marked reference point (RP) somewhere near the well, usually the brass cap in the concrete pad at base of well.

[4] **DESIGNATE** a point as the MP, usually the top of the outermost casing or riser casing on the corner of the well closest to the brass cap.

[5] **MARK** the MP, keeping engravings or filings from entering well, and **ENSURE** the MP is permanent, clearly defined, and easily located.

[6] **MEASURE** the height of the MP in feet above or below the LSD and **RECORD** the height of the MP on Attachment 1.

[7] **RECORD** the date that the MP was established and the height of the MP above or below the LSD on Attachment 1.

[8] **OBTAIN** a geodetic survey for the LSD and the MP, if desirable, depending on the purpose of the groundwater-level measurements.

[9] **MAKE** a detailed sketch of the MP and the RP on Attachment 1, and if possible, **TAKE** a photograph and **MARK** the MP and the RP on the photograph.

9. ATTACHMENTS

Attachment 1, Groundwater Level Field Form

Attachment 2, Water-Level Meter Calibration Maintenance Form

ATTACHMENT 1
Page 1 of 1
Groundwater Level Field Form

IPC-1

Groundwater Level Field Form

PART 1: Well Site Information					
Well Name :		Date:	Time onsite (MST):	Activity:	
Personnel:				Cable Length(ft):	Cable SN:
Telemetry: Yes \ No	Pull Transducer: Yes \ No	New Transducer Needed: Yes \ No New LT SN:		Memory % remaining:	Battery % remaining:
Connect Time:	Transducer SN:	New LT PSI Rating:	Manufacture Date:	Log Note Memory %	Log Note Battery %
Water Level (ft)		P (psi):	T [C]	Stop Test: Yes \ No	Change Desicant: Yes \ No \ NA
Last Start Date:		Data File Name:			

PART 2: Manual Measurements				
Measuring Point: TOC (top outer casing) TIC (inner)		Stick-up Measured on Site ☐	Previous MP Used ☐	
Time (MST):		Water Level Meter Serial No		***Notes:***
DTW (ft bMP):		Measurements in feet		
Time (MST):		LSD ft.		
DTW (ft bMP):		MP Height ft.	+	
Time (MST):		MP Elevation	=	
DTW (ft bMP):		DTW:	-	
Time (MST):		Groundwater Elevation (GWE) Reference Level		
TD (ft bMP):				
		Zip Tie on Kellim's Grip:		

Transducer Performance and Programming					
Part 3: Transducer Error\Drift Acceptance		Part 4: Programming & Final Readings			
WL Reading Time (MST):		Progamming Time:		Time (MST):	Reading
WL (transducer reading) (ft):		New Test Name:			
GWE from MM		Reference Level :			
Difference in value:		Current Depth:			
Error tolerance of transducer:		Meas. Interval:			
☐ Within Error Tolerance		Start Date:			
☐ Outside Error Tolerance		Start Time:			
15 PSI-0.03ft. 30 PSI-0.07 ft. 100 PSI-0.23 ft. 500 PSI-1.16 ft.			Synch Clocks: Yes \ No		
Deleted Tests:					QA: Date and Initial:

Example

ATTACHMENT 2
Water Level Meter Calibration and Maintenance Form

Los Alamos National Laboratory
Water Stewardship Program
Water Level Meter Calibration and Maintenance Form

			Water Level Meter				Calibration				
Date	Time	Inspector Name	Manufacturer	Serial Number	Total Length (ft)	Alarm Operates (Y/N)	DTW with NIST Tape (ft)	DTW with WLM (ft)	TD with NIST Tape (ft)	TD with WLM (ft)	Equipment Condition, Comments, Describe Maintenance

ENV-DO-202