GROUNDWATER LEVEL DATA PROCESSING, REVIEW, AND VALIDATION

Purpose

This Water Quality and Hydrology (ENV-WQH) Group procedure describes the process for the review and validation of groundwater level data obtained from pressure transducers.

Scope

This procedure applies to all ENV-WQH personnel, students, and contract personnel who work with groundwater level data obtained from pressure transducers.

In this procedure

This procedure addresses the following major topics:

Signatures

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General Information about This Procedure

Attachments

This document has the following attachments:

Number	Attachment Title	No. of pages
1	Groundwater Level Data Review and Validation Form	1
2	Database Change Documentation Form	1

History of revision

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

Revision	Date	Description Of Changes
0	09/04	New document.
1	12/05	Updated text, revised Attachment 1

Who requires training to this procedure

The following personnel require training before implementing this procedure:

- All ENV-WQH staff, students, and contract personnel who perform groundwater level calculations using data derived from pressure transducers.

Training method

The training method for this procedure is "self-study" (reading), which is documented in accordance with the procedure for training (ENV-WQH-QP-024, *Personnel Training)*. In addition, mentoring by a previously trained individual is required.

Prerequisites

In addition to training to this procedure, the following training is also required for all personnel performing the procedure:

- Training Plan # 7563, Conduct Groundwater Level Review & Validation
- Westbay® WinGT® and MLOG® software familiarity
- In-Situ, Inc. Win-Situ® and/or Data Manager® software familiarity
- Data logging software from other transducer or data logger manufacturers as appropriate

General Information about This Procedure, continued

Terminology

Absolute pressure: the total or absolute pressure measured by a sensor without correction for atmospheric pressure. A pressure measurement that includes atmospheric pressure is an absolute pressure. Units are expressed in psia (pounds per square inch absolute).

Barometric efficiency: The ratio of the pressure head variation due to water level fluctuations in a well to the change in atmospheric pressure during an arbitrary period of time.

Calculated data files: Groundwater level data files that result from calculation of the raw data files into groundwater elevation data using the proprietary software provided by the transducer manufacturer. Calculated data files can be comma separated value (csv) text files (or similarly separated values, such as tab or space separated), spreadsheet files, database files, etc.

Gage pressure: the pressure measured relative to atmospheric pressure. Measurements exclude atmospheric pressure and are said to be compensated or gaged for atmospheric pressure. A vented or gage pressure transducer sensor utilizes a vent tube in the cable that exposes one side of the pressure sensor to atmospheric pressure, measuring pressure of the water column only. Units are expressed in psig (pounds per square inch gage).

Ground elevation: The elevation of the ground surface of the well expressed in feet above mean sea level. If the well has a concrete surface pad, usually the elevation of the top of the concrete pad. If a brass cap is present to identify a well, usually the elevation of the brass cap in the concrete pad.

Pressure head: The height in feet of a column of water measured by a transducer at a point in a well.

Pressure transducer (transducer): A device that measures pressure. There are two types of pressure transducers, those that measure absolute pressure, and those that measure gage pressure.

Total Head (Head): 1) The elevation to which the water at a specific point in an aquifer will rise; 2) The water elevation calculated from pressure data; the sum of the elevation of the port and the pressure head.

General Information about This Procedure, continued

Terminology (continued)

Pi: Pressure measured inside the Westbay® casing usually at a specific measurement port, designated by 'arm out' motor position of the transducer. Pi measured above the deionized water column in the Westbay® casing is equal to atmospheric pressure at a given port elevation; calculated head will approximate the elevation of the port. Pi measured below the deionized water level inside the Westbay® casing will be the pressure head of the deionized water column; calculated head will be that of the elevation of the top of the deionized water column.

Po: Pressure measured of the formation outside the Westbay® casing at a specific monitoring port, designated by 'shoe out' motor position of the transducer. Po of 'dry' monitoring ports will approximate Pi at that port if the port is above the DI water column. Po of 'wet' monitoring ports should not normally equal the Pi of the port. Calculated head represents the piezometric water level at the location of the monitoring port.

psi: Unit of pressure measurement in pounds per square inch.

psia: Unit of pressure measurement in pounds per square inch absolute, see absolute pressure.

psig: Unit of pressure measurement in pounds per square inch gage, see gage pressure.

Raw data files: Electronic pressure transducer data files that are obtained from pressure transducers or data loggers at a well site. Raw data files are often binary computer files that can be opened, read, and interpreted only by software developed by the transducer manufacturer. The raw data files must be stored and archived appropriately in order to secure the original data from the pressure transducer. Raw data files contain the raw pressure measurements and date/time stamp from the transducer and may also contain information entered into the transducer software program at the time of installation, such as well name, date/time, measurement interval, reference water elevation at the time of installation, etc.

Reference level: The elevation of the surface of the water in a well at the time of installation of the transducer. Determined by manual measurement of the groundwater elevation according to ENV-DO-202, *Manual Groundwater Measurements.*

Water elevation: The elevation of the surface of the water in a well, expressed in feet above mean sea level.

Water level: 1) Depth to water (DTW) in a well below ground elevation expressed in feet, or 2) The Water Elevation expressed in feet above mean sea level. Refer to ENV-DO-202, *Manual Groundwater Measurements,* for information about measuring groundwater level in a well.

General Information for Data Processing, Review, and Validation

Temperature Corrected Water Density Values

Use the correct density value of water during processing of the raw transducer data to reduce the amount of error introduced by the calculation process.

Some transducer manufacturer software programs, such as recent versions of the Data Manager® program by In-Situ, Inc., allow user input of water density values. Water density is dependent on the quantity of dissolved minerals or contaminants and temperature (In-Situ, Inc, 2000). The density of water containing relatively few dissolved minerals or contaminants, such as most groundwater at Los Alamos, is primarily dependant on temperature.

Temperature of the water is typically measured by transducer equipment and is usually available during processing of the raw data files. Use the table below for selecting appropriate water density values based on the average temperature of the water derived from the transducer measurements.

Density Values of Pure Water as function of Temperature

Temp (C)	Density (g/cc)		Temp (C)	Density (g/cc)		Temp (C)	Density (g/cc)
1	0.9999		11	0.9996		21	0.9980
2	0.9999		12	0.9995		22	0.9978
3	1.0000		13	0.9994		23	0.9975
4	1.0000		14	0.9992		24	0.9973
5	1.0000		15	0.9991		25	0.9970
6	0.9999		16	0.9989		26	0.9968
7	0.9999		17	0.9988		27	0.9965
8	0.9998		18	0.9986		28	0.9962
9	0.9998		19	0.9984		29	0.9959
10	0.9997		20	0.9982		30	0.9956

Source: In-Situ, Inc. (2000)

Latitude and Elevation Correction Parameters for Water Density

If user input of latitude and elevation values for correction of acceleration due to gravity on the water level calculation is required, use the following parameters as a guide for utilizing this correction.

- The elevation of the groundwater is obtained from manual measurement (see ENV-DO-202, *Manual Groundwater Measurements*). Input the groundwater elevation to the nearest 10 ft as appropriate.
- Approximate latitude of the Los Alamos area is 36 degrees north.
- Document parameters used to calculate water level data in the calculated data file.

General Information for Data Processing, Review, and Validation, continued

Calculating water levels in Westbay® wells

As a general guideline for calculating water levels in Westbay® wells that utilize absolute pressure measurement transducers, select the fixed value option for atmospheric pressure in the WinGT® software to calculate total head from the absolute pressure measurements.

- The barometric efficiencies of recently tested intermediate and regional aquifer wells at LANL have been shown to be 90 to 100%, indicating that the aquifer response to atmospheric pressure fluctuations is minimal.
- Therefore, as a general guideline, use a fixed atmospheric pressure that exists at the approximate elevation of the surface of the saturated zone for which the water level calculation is being prepared, to calculate total head. The Pi value of monitoring ports located near the top of an intermediate zone or at the top of the regional aquifer will typically measure the atmospheric pressure near the top of a saturated zone. The average Pi value of an appropriate port may be used if multiple measurements are available.

  Caution: Be certain that the port for the Pi measurement nearest the surface of the saturated zone is above the deionized water inside the Westbay® casing.

- If Pi values are not available for the surface of the saturated zone, it is possible to calculate atmospheric pressure at a specific elevation: For the standard atmosphere, variation of pressure with elevation is approximately linear in the elevation range 8202 ft to 4921 ft, which correspond to 10.83 psi and 12.26 psi, respectively, for a slope of 4.36x10-4 psi/ft. The correction for increased pressure is Patm at saturated surface (psi) = Patm at ground surface + [4.36x10-4 psi/ft x depth to water (ft)].
- Atmospheric pressure fluctuates daily and seasonally due to temperature changes in the atmosphere and passing weather fronts. Using a fixed rather than fluctuating atmospheric pressure will prevent introduction of potential error in the resulting head data.

General Information for Data Processing, Review, and Validation, continued

Calculating water levels in Westbay® wells, continued

- The type of atmospheric pressure data to select for calculating total head may be different for different wells and for different zones within a well, depending on the barometric efficiency of each zone in the well. It may be necessary to construct overlapping time series plots of monitoring port pressure data and atmospheric pressure data measured at the well to determine, for example, if there is an immediate or delayed response in the aquifer to atmospheric pressure fluctuations at each monitoring port, in order to determine how best to calculate total head. In a shallow well in an unconfined aquifer where barometric efficiency is 0%, it may be appropriate to use the well's own atmospheric pressure data measured at ground surface for calculating total head.
- General guidelines to follow for selecting the atmospheric pressure to use to calculate total head include the following: Deeper zones of saturation, such as those in the Los Alamos area, typically do not exhibit immediate responses to atmospheric pressure changes (barometric efficiency = 100%), and therefore it is not appropriate to use the time series of atmospheric pressure data measured at the surface of the well to calculate total head.
- As mentioned above, if in doubt, use the fixed average atmospheric pressure (Pi) measured at, or calculated for, the surface of each zone of saturation .

Raw Data File Handling

Policy

The raw electronic transducer data files will be handled according to requirements for Data Handling in the Quality Assurance Program Plan for the Groundwater Level Monitoring Program, RRES-WQH-GWLM-QAPP.

Handling raw data

To retrieve raw electronic pressure transducer data (raw data) files from the transducer, field personnel shall perform the following steps:

Step	Action
1	Retrieve raw data files from transducer equipment in accordance with ENV-DO-201, *Pressure Transducer Installation, Removal, and Maintenance,* and ENV-WQH-SOP-064, *Westbay Pressure Transducer Installation, Removal, and Maintenance,* Transducer Data Retrieval sections.
2	Review raw data files for completeness and appropriateness. Record comments about the transducer data in the field notebook or on the Westbay® Groundwater Sampling Field Data Sheet (ENV-WQH-SOP-050, *Groundwater Sampling using Westbay System,* Attachment 3).
3	Transfer the raw data files from transducer or data logging equipment to a portable computer.
4	Create a file name that includes the well name and the date of the last data point.
5	If possible, save the raw data file to a nonvolatile removable media device for safeguarding.
6	Deliver raw data files to the GWLM Project Leader.
7	Record groundwater pressure data obtained during groundwater sampling of Westbay wells on the Westbay® Groundwater Sampling Field Data Sheet (ENV-WQH-SOP-050, *Groundwater Sampling using Westbay System,* Attachment 3)
8	Archive the field data sheets in WQH sampling record files
9	Transfer the raw data files to the common (shared) WQH server for permanent storage.

Raw Data File Handling, continued

Handling raw data, continued

The GWLM Project Leader will perform the following steps:

Step	Action
1	Insure that the raw data files are transferred to the common (shared) WQH server for permanent storage and archival.
2	Transfer the Po and Pi data to WinGT® software for calculation into water level data according to this procedure.
3	Archive processed data files on the WQH server.

Processing Transducer Data

Background

The raw electronic transducer data files are processed to obtain meaningful groundwater level data. The raw binary pressure data files are converted into useable data format using transducer manufacturer proprietary software.

In-Situ, Inc. transducers and data loggers typically create a raw data file with a 'bin' extension. Westbay® data loggers create either 'WD2' or 'WDF' raw data files.

Processing Data from In-Situ, Inc. Data Files

Compare information in the data file with information recorded during installation or removal of the transducer by field personnel by performing the following steps:

Step	Action
1	Open the data file using WinSitu® or DataManager® software programs. The data file will have a .bin filename extension.
2	Verify that the data file name represents data for the correct well. If necessary, change the data file name to reflect the well name.
3	Check that beginning and ending dates and times are in Mountain Standard Time, and that the transducer serial number and other information in the data file header correspond with field records.
4	Enter the appropriate water density into the software using the table in Temperature Corrected Water Density Values section of this document.
5	Enter the approximate latitude (36 degrees north for Los Alamos area) and approximate elevation of the water into the software to provide appropriate corrections for water density (reference Latitude and Elevation Correction Parameters for Water Density section of this document). NOTE: Transducer data may be displayed as pressure (psi), pressure head (ft), depth from surface (ft), or in elevation from mean sea level (ft msl) if the groundwater elevation is entered as the reference elevation.

Table continued on next page.

Processing Transducer Data, continued

Processing Data from In-Situ, Inc. Transducers, continued

Step	Action
6	Determine that the reference water elevation in the data file corresponds with the manual water elevation obtained when the transducer was installed. Note: If a manual water level was not obtained at the beginning of a data file, use the most recent water elevation calculated from an immediately preceding transducer data set. This method can be used if the elapsed time between the end of the prior data set and the beginning of the next transducer data set is less than 2 hours and the water level change is less than 0.1 ft.
7	Verify that the beginning pressure head recorded by the transducer corresponds with the pressure head recorded when the transducer was installed.
8	Calculate groundwater elevation using the appropriate parameters (refer to Steps 5 and 6 above) in the Data Manager® software. Compensation for atmospheric pressure is not necessary for typical In-Situ Inc. gage transducers used at LANL.
9	Transfer transducer water level data to text file or spreadsheet format for further data review and validation.

Processing Transducer Data, continued

Processing Data from Westbay® Transducers

Compare information in the data file with information recorded during installation of the transducer on the MOSDAX Probe String Installation/Retrieval Field Form (ENV-WQH-SOP-064, *Westbay Pressure Transducer Installation, Removal, and Maintenance*, Attachment 2) by performing the following steps:

Step	Action
1	Open the data file using WinGT® or MLOG® (Convert Utility) software programs. Data file will have a .WD2 or .WDF filename extension.
2	When prompted by the software, verify that the time zone value is set to -7.00 hours with respect to Coordinated Universal Time.
3	Verify that beginning and ending dates and times, the transducer serial numbers, and other information in the data file header correspond with field data recorded on the Probe String Installation/Retrieval Field Record (ENV-WQH-SOP-064, *Westbay Pressure Transducer Installation, Removal, and Maintenance*, Attachment 2) or the field data recorded on the Westbay® Groundwater Sampling Field Data Sheet (ENV-WQH-SOP-050, *Groundwater Sampling using Westbay System*, Attachment 3).
4	Verify that correct well zone information, port name, port depth, and probe numbers coincide with those for the appropriate well, as published in the well completion report.
5	Verify that the correct ground elevation of the well (brass cap elevation) has been entered into the data file header.
6	Review the Pi and Po pressure data from the Westbay® Probe String Installation Data Form (ENV-WQH-SOP-64, *Westbay Pressure Transducer Installation, Removal, and Maintenance*, Attachment 2) or the Westbay® Groundwater Sampling Field Data Sheet (ENV-WQH-SOP-050, *Groundwater Sampling using Westbay System* ,Attachment 3) for each port and check that measured pressure data is consistent with previous measurements.

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Processing Transducer Data, continued

Processing Data from Westbay® Transducers (continued)

Step	Action
7	Determine that each probe was properly attached to the appropriate port by checking that Po values are similar to previous Po values for each port. If Po values are not similar to previous measurements, determine if measured Po values are consistent with: • Previous Pi values (if the probe did not properly connected to monitoring port) or • Atmospheric pressures at the elevation of the port (for monitoring ports above the level of the deionized water in the Westbay® casing) or • Equivalent to surface atmospheric pressure (response for probes not installed in the well).
8	Review time series of the pressure data to check for possible sensor drift with time or cyclical, spiking, or fading response that may indicate failure of the transducer or of the transducer power supply.
9	Import data file to WinGT® data file (.wgt extension file) by performing either: • Import the data file into an existing WinGT® data file (.wgt extension file) that has previously been created for that well. NOTE: Use this option only if assured that a WDF or WD2 data file is appropriate for a given well. This will save time in entering correct well information, port depths, zone intervals, etc., and allows the transducer data to be merged with pre-existing data for a specific well. **OR** • Manually enter or import Po and Pi data from groundwater sampling events (WDF or WD2 data file) into a WinGT® data file (wgt extension file) that has been created for that well

Table continued on next page.

Processing Transducer Data, continued

Processing Data from Westbay® Transducers (continued)

Step	Action
10	Select the atmospheric pressure source for use in adjusting absolute formation pressure data. The WinGT® software provides three choices for selecting atmospheric pressure data: a) The well's own atmospheric pressure measurements obtained concomitantly with the monitoring port pressure data, b) Atmospheric pressure data from another nearby well, or c) A fixed value for atmospheric pressure. NOTE: As a general guideline for calculating water levels in Westbay® wells that utilize absolute pressure measurement transducers, select the fixed value option for atmospheric pressure in the WinGT® software to adjust the absolute pressure measurements. Reference "Calculating water levels in Westbay® well", General Information for Data Processing, Review, and Validation section of this document.
11	Calculate the total head for each monitoring port using the WinGT software. NOTE: • If header file contains 0.00 for the elevation of the well, the software will calculate depth to the level of the water, based on the depth of each monitoring port. • If header file contains the appropriate ground elevation of the well in ft above mean sea level (amsl), the software will calculate total head in ft amsl for each monitoring port.
12	Transfer head data to spreadsheet file format for further review and validation.

Transducer Data Review and Validation

Policy

Groundwater level data shall be reviewed for completeness and appropriateness and validated on a routine basis as the data are collected for each well. A determination as to the acceptance or rejection of the data shall be provided by the GWLM Project Leader or designated data reviewer.

Data Quality Codes

Data Quality Codes and Data Quality Descriptions are used to identify valid and invalid data. Below are a list of Data Quality Codes and Descriptions.

Data Quality Code	Data Quality Description	Comment
I	Invalid Data	
IQ	Invalid Data with some validity question	
V	Valid Data	Null entry implies valid data
VQ	Data are considered valid with some validity question	
VR	Data are considered valid but with reduced measurement accuracy	Accuracy of measurement is less than optimal
VRVQ	Reduced measurement accuracy with validity question.	Combination of VR and VQ

Transducer Data Review and Validation, continued

Validation Reason Codes

Data Validation Reason Codes and Reason Descriptions are used to explain why data have been determined to be VQ, VR, I, or IQ. Below is a list of Data Validation Reason Codes and Descriptions.

BT	Water level is Below Transducer, data are not valid	
D	Port/Zone is dry, pressure data not valid	
DI	Data values interpolated using manual measurement values	Transducer drift prompted interpolation of data
DN	Port/Zone is nearly dry, e.g. with 0.5 ft of port	Transducer data may be unreliable
E	Equipment malfunction	
KP	Transducer water level measurement derived from known point of transducer	Water level derived from known elevation of transducer
M	Motor Arm/Shoe report inconsistent	Westbay transducers
MA	Measurement tool or method Accuracy not optimal	Accuracy of the measurement not as good as possible
MMNA	Manual water level measurement not available	
NC	Non-Conforming water level data for zone	
Pi	Pressure data is Pi not Po	Westbay transducers
RL	Manual measurement for Reference Level not documented or in question	Manual measurement not well documented
RW	Transducer removed from well, pressure data are not valid	Pressure data are atmospheric
WC	Well Construction makes pressure data questionable	Well construction may not provide reliable pressure data
WS	Water level measured in sump	Water in sump, not indicative of formation water level

Transducer Data Review and Validation, continued

Water Level Type Codes

Water level type codes describe the type of water level data that are available for data review and validation, and for population in the Water Level Database.

Water Level Type Code	WL Type Descriptions	Comment
DR	Water level derived from raw pressure data	
DI	Interpolated water level data	Data recovered from drifting transducer
DV	Single daily water level value	Daily value selected from multiple measurements
MD	Mean Daily water level	Calculated mean daily value from multiple measurements

Conducting data review and validation

Suggested steps for performing data review and validation of transducer groundwater level data are provided below; however, data review and validation personnel must review and evaluate the data for each well on an individual basis, as not all potential problems with data can be addressed in a procedure.

To conduct data review and validation, perform the following steps:

Step	Action
1	Open the spreadsheet created in Processing Transducer Data, Step 12.
2	Plot the time series of the groundwater elevation (hydrograph), and if available, the time series of the atmospheric pressure data.
3	Document the following information on the Transducer Data Review and Validation Form (Attachment 1) • Well name • Reviewer Name • Date of data review • Transducer manufacturer, serial number, and the pressure rating of the transducer • File name of the raw data file and the calculated data file • Start and end time of the transducer data • Data collection rate in minutes • Data review comments • State if data are valid or invalid • Reason for invalidating data – data quality code and validation reason code

Table continued on next page.

Transducer Data Review and Validation, continued

Data Review Procedure (continued)

Step	Action
4	Review the hydrograph to determine if a correlation exists with atmospheric pressure data. Interpret the results to determine if groundwater level data from absolute-measuring transducers require recalculation using a different selection for atmospheric pressure. • Single completion wells open to the atmosphere that use compensated transducers will typically show an inverse correlation between atmospheric pressure and water level inside the well. • For Westbay®-equipped wells using absolute transducers, if the groundwater level data were calculated using the well's real-time atmospheric pressure correction and the water level shows an inverse correlation to atmospheric pressure, the water level fluctuation may be an artifact of over-correcting a stable water level pressure response. Recalculate the groundwater level data using a fixed atmospheric pressure (refer to step 4 in the data processing section). • Compare the revised hydrograph with atmospheric pressure to evaluate any water level response to atmospheric pressure.
5	Review the hydrograph by performing the following steps; **Single completion well**

Step	Action
1	Determine if beginning and ending water levels correspond with manually measured water levels obtained before the transducer was installed and at time of retrieval of transducer data. • If the beginning transducer water level is different from the manual water level obtained at the time of transducer installation, determine the source of the difference. Some water level change could have occurred between the time of the manual measurement and the beginning of transducer measurements, especially if transducer measurements began several hours after the manual measurement or if the manual measurement is in small diameter well.

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Transducer Data Review and Validation, continued

Data Review Procedure (continued)

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>5</td><td><u>Single completion well, continued</u>
<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1 Con’t</td><td>• Check that the correct reference elevation was used during transducer installation and for water level calculations, revise and recalculate the groundwater level data if necessary.</td></tr>
<tr><td>2</td><td>Check the beginning of transducer water level data for signs of cable stretch, unkinking, or slippage. Identify suspect data.
• If the ending transducer water level does not coincide with the manual water level obtained at the end of the data series, check calculations to determine the source of the error.
• If beginning transducer water level coincides with the manual water level obtained at the time of installation, but the difference between the ending transducer water level and the manual water level obtained at the end of the data series is greater than the rated accuracy of the transducer, then transducer sensor drift may have occurred, transducer battery voltage may have declined causing erroneous measurements, or the manual measurement may contain an error. Obtain another manual measurement if possible. Consider interpolation of the transducer data to correct transducer drift if appropriate.
• If transducer water level measurements do not coincide with the manual measurements within the accuracy rating of the transducer, reject or interpolate the transducer data, and have the transducer checked and calibrated according to ENV-DO-201, Pressure Transducer Installation, Removal, and Maintenance, or ENV-WQH-SOP-064, Westbay Pressure Transducer Installation, Removal, and Maintenance.</td></tr>
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Transducer Data Review and Validation, continued

Data Review Procedure (continued)

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>5</td><td><u>Multiple Completion well</u>
<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Compare the hydrograph of newly obtained data with hydrographs of previous data sets, if available, and with water levels obtained during installation and retrieval of the transducers and/or with water levels obtained during groundwater sampling.</td></tr>
<tr><td>2</td><td>Plot all data on the hydrograph and review the data for inconsistencies or irregularities</td></tr>
<tr><td>3</td><td>Note especially perched zones or water table zones that may be reported dry during sampling events. Continuous absolute pressure data from these zones may erroneously indicate a water level fluctuating in response to atmospheric pressure.
If calculated water elevation is within 0.5 ft of the elevation of the monitoring port, check if sample events have reported the zone dry; reject erroneous data and report the zone dry if appropriate.</td></tr>
<tr><td>4</td><td>Check zones where Pi is similar to Po. Ensure that the transducer properly attached to the port and was recording appropriate data</td></tr>
<tr><td>5</td><td>Evaluate Pi data of zones below the deionized water level in the Westbay® casing by calculating the water level and plotting the hydrograph of the Pi water level. Note and document any significant water level changes and investigate unusual circumstances.

If water level changes occur, check field notes of transducer installation and retrieval and groundwater sampling events to determine the source of the water level change.</td></tr>
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Transducer Data Review and Validation, continued

Data Review Procedure (continued)

Step	Action
6	Review and assess trends observed in water level data on daily, seasonal, and yearly scales. Focus on unusual spikes or cyclical trends that may indicate equipment problems. Guidance: • Rising water levels may cause over pressurization of the transducer; look for reduced sensitivity or flat data responses. • Falling or highly fluctuating water levels may drop below the level of the transducer or below the well screen or port; look for uncharacteristic water level responses and check if response is possibly the result of groundwater sampling event, nearby well pumping, etc. • Malfunctioning transducers may record normal-looking data that has no relation to water level. Review water level data for changes in character over time.
7	Reject water level data that are determined to be erroneous, atypical, or nonconformable. Several years of data may need to be obtained before a data set can be properly evaluated using these parameters. Document all primary and subsequent reviews of data on the Transducer Data Review and Validation Form (Attachment 1).
8	Validate groundwater level data that meet the criteria of the review process.
9	Document the data review and validation process on the Groundwater Level Data Review and Validation Worksheet (Attachment 1).
10	When subsequent review of water level data indicates that water level data in the WQDB require revision, document the changes made to the database on the Database Change Documentation Form (Attachment 2). Document the following items for every change made to the database: • Date and time of change • Database name and table name • Well name and port/screen name • Date and time at the start and end of water level data that is changed • Number of records changed and the unique record identifier at beginning and end of data changed • The reason for the data change and any pertinent comments about the changed data

Records Resulting From This Procedure

Records

The following records generated as a result of this procedure shall be permanently stored with ENV-WQH:

- Transducer Data Review and Validation Form (Attachment 1)
- Database Change Documentation Form (Attachment 2)
- Raw data files
- Calculated data files

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GROUNDWATER LEVEL DATA REVIEW AND VALIDATION FORM

Los Alamos National Laboratory
Water Quality and Hydrology
Transducer Data Review and Validation Form

Well Name: **Data Reviewer:**

	Transducer				Data Review						Data Validation	
Date of Review	Manu-facturer	Serial No.	Port	Sensor Range (psi)	Raw Data File Name	Calculated Data File Name	Date/Time Data Start	Date/Time Data End	Data Collection Rate (min)	Groundwater Level Data Review Comments	Data Valid? Y/N	Comment / Reason for Invalidation of Data

Los Alamos National Laboratory
Water Quality and Hydrology
Database Change Documentation Form

	Database		Data Change								
Date Time of Change	Database Name	Table Name	Well Name	Screen Port Name	Date/Time Data Change Start	Date/Time Data Change End	Number of Records Changed	Row Index Start No.	Row Index End No.	Reason for Data Change	Data Change - Comment