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Ground Water Level Measurements in Selected Boreholes Near the Site of the Proposed Repository

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SCIENTIFIC INVESTIGATION PLAN

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SCOPE AND OBJECTIVE

Scope

This Scientific Investigation Plan (SIP) presents an independent confirmatory study supporting previously gathered information and describes a program to acquire ground water level data in specific hydrologic boreholes near the site of proposed repository. The SIP is subject to the University and Community College System of Nevada (UCCSN) Quality Assurance (QA) program requirements. Through Cooperative Agreement DE-FC28-04RW12232 with the U.S. Department of Energy (DOE), the Harry Reid Center for Environmental Studies (HRC) at the University of Nevada – Las Vegas will conduct ground water level measurements in selected boreholes near the site of the proposed repository, and compile and submit generated data to the UCCSN Technical Data Archive (TDA). Twenty-eight (28) surface-based boreholes with 33 usable monitoring ports currently comprise the network. The boreholes are located within Areas 25 and 29 of the Nevada Test Site; others are on Bureau of Land Management land west of the Nevada Test Site in Nye County, Nevada (see table).

Objective

The objective of this task is to provide ground water level measurements of known accuracy and precision using manual and electronic methods. The HRC will use field-proven protocols and established implementing procedures for all aspects of data collection, analysis, management, and reporting. The water level measurements produced by this program will yield quality-assured data that can be reliably used for a variety of purposes including: continued site characterization, refinement of the local potentiometric surface, inputs to the Death Valley Regional Flow Model and related hydrologic characterization, to fulfill permit conditions issued by the State of Nevada, to monitor seismically-induced ground water fluctuations, and to support a proposed repository licensing application.

Relationship to Previous Work

Historic Ground Water Level Trends

Ground water level investigation is a critical part of long-term environmental monitoring for the Yucca Mountain project that currently includes important physical measurements such as seismic activity and precipitation measurement. Prior to HRC involvement, 20 years of historic water level data obtained by the USGS was used to map the local potentiometric surface in support of site characterization and for inputs to regional hydrologic modeling (Ervin, 1994). A statistical evaluation of historic data suggested that ground water levels near Yucca Mountain have been remarkably stable for at least 20 years and that most variability falls within ranges expected due to earth tidal forces and atmospheric pressure (Wilson, 2000). Results of trend analysis of water levels in 22 boreholes at Yucca Mountain measured between 1986 and 1993 indicated that 19 wells showed no statistically significant changes while 3 wells west of Solitario Canyon Fault showed very small but statistically significant positive trends (USGS, 1995). In addition, significant short-term seismically-induced water level fluctuations were detected in USW H-5and USW H-6 resulting from large earthquakes that occurred in 1992 in southern California and southern Nevada (O’Brien, 1993).

Wells Comprising the Yucca Mountain Ground Water Level Monitoring Network

YMP Borehole Name	Physiographic Location	Approximate Depth to Water (feet)	Current Measurement Method	Aquifer
UE-29 a1	Upper Forty Mile Wash	91	Hand Held Tape	Alluvium
UE-29 a2	Upper Forty Mile Wash	97	Hand Held Tape	Alluvium
UE-29 UZN 91	Upper Forty Mile Wash	58	Hand Held Tape	Alluvium
USW WT-1	Upper Busted Butte Wash	1545	Powered Electric Tape	Volcanic Flow System
USW WT-2	Tributary to Drill Hole Wash	1873	Transducer	Volcanic Flow System
UE-25 WT-3	South End Fran Ridge	985	Powered Electric Tape	Volcanic Flow System
UE-25 WT-4	Lower Prow Ridge	1440	Powered Electric Tape	Volcanic Flow System
UE-25 WT-6	Upper Yucca Wash	919	Powered Electric Tape	Volcanic Flow System
USW WT-7	Solitario Canyon	1380	Powered Electric Tape	Volcanic Flow System
USW WT-10	Crater Flat	1140	Transducer	Volcanic Flow System
UE-25 WT-12	West Side Busted Butte	1135	Powered Electric Tape	Volcanic Flow System
UE-25 WT-13	Crater Flat	996	Transducer	Volcanic Flow System
UE-25 WT-14	Mouth of Drill Hole Wash – North End of Fran Ridge	1135	Powered Electric Tape	Volcanic Flow System
UE-25 WT-15	Lower 40-Mile Wash	1160	Powered Electric Tape	Volcanic Flow System
UE-25 WT-16	Upper Yucca Wash	1550	Transducer	Volcanic Flow System
UE-25 WT-17	Busted Butte Wash	1295	Powered Electric Tape	Volcanic Flow System
UE-25 c2	C-Well Complex	1319	Powered Electric Tape	Volcanic Flow System
USW G-2 (Tube 2)	Prow Ridge	1751	Powered Electric Tape	Volcanic Flow System
USW H-1 (Tubes 2,4)	Upper Drill Hole Wash	1698 - 1879	Powered Electric Tape	Volcanic Flow System
USW H-3 (Upper & Lower Intervals)	YM Crest	2467	Powered Electric Tape	Volcanic Flow System
USW H-4 (Lower Interval)	Tributary to Drill Hole Wash	1700	Transducer	Volcanic Flow System
USW H-5 (Upper & Lower Intervals)	YM Crest	2307	PET (upper) Transducer (lower)	Volcanic Flow System
USW H-6 (Upper & Lower Intervals)	Solitario Canyon	1726	Powered Electric Tape (lower) Transducer (upper)	Volcanic Flow System
USW VH-1	Crater Flat	603	Powered Electric Tape	Volcanic Flow System
UE-25 J-11	Jackass Flats	1042	Powered Electric Tape	Volcanic Flow System
UE-25 J-12	Jackass Flats	745	Powered Electric Tape	Volcanic Flow System
UE-25 J-13	Jackass Flats	930	Powered Electric Tape	Volcanic Flow System
UE-25 p1	Near C-Well Complex	1185	Transducer	Carbonate Aquifer
USW SD-1 ST1	YM Crest	2510	Powered Electric Tape	Volcanic Flow System

* Boreholes USW H-1, Tubes 1 & 3, and USW WT-24 are no longer measured due to downhole obstructions and are not listed

Recent Ground Water Level Trends

More recently, analysis of HRC-acquired quarterly ground water level data collected during 2002 using manual techniques from 18 boreholes in the volcanic flow system aquifer (USW WT-1, UE125 WT-3, UE-25 WT-4, UE-25 WT-6, USW WT-7, USW WT-10, UE-25 WT-12, UE-25 WT-14, UE-25 WT-15, UE-25 WT-17, USW WT-24, UE-25 c2, USW G-2, UE-25 J-11, UE-25 J-12, UE-25 J-13, USW VH-1, and USW SD6 ST-1). This analysis appears to support the general concept of highly stable ground water levels in deep wells in the Upper and Lower Volcanic Flow System near Yucca Mountain developed by the previous twenty years of measurements. Water levels in the only manually-measured borehole penetrating the carbonate aquifer (UE-25 p1) also exhibited very small variability, as did the 3 manually-measured wells in shallow coarse alluvium in Upper Forty Mile Canyon (UE-29 a1, UE-29 a2, and UE-29 UZN 91. Water levels in 3 wells electronically measured (USW WT-2, UE-25 WT-13, and USW H-5) exhibited similar low variability (Page, 2003).

In addition to quarterly monitoring measurements, there is considerable interest in continuous monitoring of ground water levels near the site of the proposed repository as a method to record seismically-induced changes. As part of work performed during the preceding cooperative agreement under this new seismic monitoring initiative, HRC successfully instrumented 7 boreholes with downhole instruments capable of measuring fluctuations in the 0.1 to 0.01-foot range at sampling rates as fast as one measurement per second. Small, short-term fluctuations induced by earthquakes nearly 5000 kilometers from Yucca Mountain have been detected. This continuous monitoring system can also provide a record of ground water level fluctuations caused by other natural phenomena such as earth tide forces, atmospheric pressure changes, and by non-natural events such as well pumping.

APPROACH

Data Collection Methodology

Ground water level measurements will be obtained using two methods, manual and electronic. Manual methods will involve the use of three types of graduated tapes: A Powered Electric Tape (PET), a Reference Steel Tape (RST), and a hand-held steel tape. The PET will be used for routine measurements at approximately 29 boreholes, the hand-held steel tape for measurements in 3 shallow wells emplaced in alluvial materials, and the RST will be used as a calibration standard for the PET in 6 wells. Electronic digital pressure transducers have been installed in 7 wells with plans to install 1 – 2 additional instruments per year on the network. Boreholes proposed for instrumentation will be selected in consultation with DOE and other interested organizations.

Site Access, Remote Access, and Training

Field activities related to this task take place in the Yucca Mountain site access and remote access control zones. Compliance with government site access and remote access procedures is required at all times. UCCSN personnel designated for field work on this task will have experience with remote access operations and data collection, environmental, safety, and health compliance requirements/standards, and surface-based borehole safety/security. The UCCSN training and experience requirements for this task have been developed in accordance with QAP-2.1, "Qualifications, Indoctrination, and Training of Personnel" and are described in the task-specific Training Matrix and position descriptions.

Data Management

Tape-measured ground water level data will be manually recorded in the field using standardized depth-to-water measurement forms, and then entered into spreadsheets in the office using Microsoft Excel 2002™. Data will be reduced and compiled using calculations embedded in spreadsheets (cell calculations) that account for a number of variables affecting water level measurements including borehole deviation data and calibration data for the instrument in use for the measurement.

Electronically-measured water level data will be stored in a user-programmable, on-board microprocessor located in the downhole pressure transducer. Data will be transmitted to surface in a vendor-supplied format and collected at the surface with a laptop computer or hand-held personal data assistant. In the laboratory, the data will be exported to Microsoft Excel 2002™ for further processing, display, analysis, and reporting. All collected data will stored and backed up daily on a secure, password-protected server.

SCHEDULE

For boreholes where manual techniques are utilized, ground water level measurements will be made quarterly. For boreholes where electronic measurement techniques are utilized, ground water level measurements will be made continuously (according to a pre-programmed measurement rate, usually hourly or daily), and the results collected quarterly in coordination with manually-acquired measurements. Requests for measurements made at boreholes other than those designated in the periodic network (see table above) or at other than the quarterly schedule must be made by the DOE Technical Task Representative or a designate. Reduced data acquired using both techniques will be submitted to TDA annually. Reports, other than reduced data submissions, will not normally be required or submitted, with the exception of final technical reports at task close-out.

A comprehensive set of implementing procedures governing all aspects of data management was developed at the outset of the previous ground water level measurement task. These procedures will be used for the current task and will be reviewed and revised as necessary for compliance with applicable technical and quality assurance requirements.

INTERFACE CONTROLS

Task execution relies upon the following external and internal organizational elements:

External Interfaces:	Yucca Mountain Cooperative Agreement Technical Contact:	TBD
	DOE Institutional Affairs Specialist:	TBD
	DOE Technical Task Representative:	Drew Coleman
	Bechtel-SAIC, LLC Test Coordination Office Contact:	Mark Esp
	U.S. Geological Survey Liaison:	Glenn Locke

Internal Interfaces:	PI:	Klaus Stetzenbach
	Co-PI and Project Director:	H. Scott Page
	Investigator:	Jim Cizdziel
	Investigator:	Amanda Brandt
	Quality Control:	Ingrid Wengatz

Task coordination at the federal government level will take place with the DOE Technical Task Representative. The Bechtel-SAIC, LLC Test Coordination Office (BSC TCO) Contact will manage routine borehole access requests, borehole safety, security, and physical modification requirements, and the HRC tracer/fluid/materials reports that are submitted quarterly. At specific boreholes where a permanent HRC transducer installation precludes independent U.S. Geological Survey (USGS) access, HRC measurements will be reported to the USGS upon request from the USGS Data Contact. This requirement has recently applied to the following boreholes: UE-25 WT-13, and UE-25 p1.

Occasionally, USGS or BSC may require short-term access to boreholes within the network. The BSC TCO Contact will coordinate USGS, BSC, and HRC access requests to prevent operational conflicts. Communication and documentation between HRC and external elements will be exchanged either via telephone or e-mail, depending on the type of action involved.

IMPLEMENTING PROCEDURES AND STANDARDS

As previously described, a comprehensive set of implementing procedures governing all technical and quality aspects of the task was developed at the outset of the previous ground water level task. These procedures will be revised and additional procedures created, as necessary, for proper task execution and/or for QA compliance. The following procedures currently govern this task:

Procedure	Title
• IPLV-035, Rev.1:	"Calibrating Water Level Measurement Equipment Using the Reference Steel Tape"
• IPLV-036:	"Ground Water Level Monitoring Using a Hand-Held Steel Tape"
• IPLV-037, Rev. 1:	"Ground Water Level Monitoring Using a Powered Electric Tape"
• IPLV-038:	"Ground Water Level Monitoring Using A Digital Pressure Transducer"
• IPLV-054:	"Using the Reference Steel Tape to Acquire Data for Calibration of Ground Water Level Measurement Equipment"
• QAP-8.3:	"Borehole Protection and Access".

QAP-8.3 currently governs field operations aspects of the task but is expected be superceded in the 2nd Quarter 2004 by, "Borehole Security and Access, LP-2.28Q-BSC, Revision 0, ICN 0" (in review), developed by BSC for DOE. When finalized, it will be adopted by the HRC and become the current standard for field operations at all boreholes listed in the table on Page 4.

- Field Work Package SB-97-009, R1: “Surface-Based Borehole Instrumentation and Monitoring”,

Field Work Package SB-97-009, R1, outlines process controls utilized by the BSC TCO to manage surface-based borehole monitoring and testing and governs a number of monitoring and testing activities including water-level measurements. The primary section affecting HRC task implementation is Section 4.0, ‘Administrative (NON-Q) Instructions’.

EQUIPMENT AND INSTRUMENTATION

Manual Measurement Equipment

The PET (designated PET-1) consists of a 3000-foot, weighted electrical cable marked in hundredths-of-a foot units. The tape contains two wire conductors, one of which ends in a probe at the zero point on the electric tape. The other conductor is attached to the weight at the end of the electric tape. A battery provides power to the tape. When both the weight and the probe are in the water, an electrical circuit is completed (ground water conducts electricity allowing for an accurate depth-to-water measurement), and is sensed by circuitry in the electric tape reel at the surface. Completion of the circuit is indicated by a light and a buzzer on the instrument reel at the surface, indicating the probe has reached to the top of the water column in the well. The tape is powered by a variable speed electric motor attached to the tape reel which facilitates insertion and withdrawal of the tape from the borehole. PET-1 is calibrated annually using the Reference Steel Tape as a standard. During transit to and from Yucca Mountain, the PET will secured in a University-owned vehicle under the control of HRC personnel. When not in use, it may be stored either inside an HRC laboratory on in a University-owned vehicle. While undergoing maintenance, it will under the control of a designated hydrologic field support services vendor who maintains HRC-owned field equipment.

During the 4th Quarter of 2003, the HRC acquired a new Powered Electric Tape (designated PET-2) with configuration identical to that of PET-1. This tape will be calibrated annually and used as standby/backup equipment for routine measurement operations.

The hand-held steel tape (designated STA-1) is a 100-foot, graduated survey tape, the first 2 feet of which are marked in hundredths-of-a foot increments. The tape is wound onto an 8-inch spool, which is deployed and retracted using a hand crank. Currently, a non-lead weight is semi-permanently attached to the tape. The tape is used by coating the lower part of the tape (approximately 1 foot) with a water-alterable material, lowering the tape so that part of the coated portion is below the expected water level in the borehole, and held in this position long enough to allow the water in the borehole to “mark” the water-alterable material on tape. STA-1 tape is not subject to operational variability due to its short length and is not calibrated. During transit to and from Yucca Mountain, STA-1 will secured in University-owned vehicles under the control of HRC personnel. It may also be temporarily stored in an HRC laboratory.

The Reference Steel Tape (RST) is a ¼-inch-by-2,800-foot, graduated tape mounted on an aluminum frame and powered by an electric motor. Since 1986 it has been the standard against which all ground water measuring equipment used on the Yucca Mountain Project is calibrated (Boucher, 1994). This tape is itself calibrated, and has traceability to National Institute of Standards and Technology through a series of other steel tapes, notably another calibrated 2,000-foot Reference Steel Tape. Mechanical stretch and thermal expansion coefficients have been applied to correct measurements made with RST to obtain true depth-to-water measurements below measurement points. Since the RST is the reference standard for all equipment calibrations, and because it is not subject to operational variability, subsequent calibration is not required beyond that originally documented in the following: "Accession NNA.19900906.0059, Calibration of the 2800-foot Reference Steel Tape", M. Boucher, USGS", August 1990". The RST will be stored inside an HRC laboratory and transported to and from Yucca Mountain in a University vehicle under the control of HRC personnel.

<u>Electronic Measurement Instrumentation</u>

The digital pressure transducer consists of a stainless steel instrument body containing an integrated silicon strain-gauge pressure sensor capable of measuring and recording temperature and pressure, depth, or drawdown; the body includes a pressure sensor, a temperature sensor, temperature-compensated real-time clock, a back-up capacitor (60 minutes) microprocessor, 1 MB on-board data-storage memory, and an internal AA battery set. The instrument is suspended inside the borehole casing beneath the water surface with either a submersible Teflon® or polyethylene cable that closes off the back of the instrument body, provides optional external power and communication signals, cable strain relief, venting, and means to anchor the probe to the wellhead. The device is programmed using a special communication cable either in the laboratory or in the field. A laptop computer and/or personal data assistant with vendor-supplied software are used to program the instrument, establish connection, and retrieve data stored on the downhole instrument. Transducers are calibrated by an independent outside service. Prior to deployment and after retrieval, transducers will be stored in the HRC in a locked office. During calibration they will be under chain-of-custody control by the HRC and the designated calibration laboratory.

SOFTWARE

Microsoft Excel 2002™ will be used to process, compile, and report manually-acquired measurements. Electronic transducer data are acquired by specialized, vendor-supplied software and firmware supplied by the hardware vendor. This software and firmware is stored on the on-board instrument microprocessor data logger. Known as 'Win-Situ 2000' (for the desktop and laptop PC) and 'Pocket-Situ' (for the personal data assistant), they are the operating system for the transducer and provide the user interface for programming, data retrieval, instrument status, and first-look data analysis. This software contains a data export module to Microsoft Excel 2002™ for detailed analysis and visualization.

PROCUREMENTS AND SUBCONTRACTS

The HRC currently utilizes the services of the Bechtel-Nevada Standards and Calibration Laboratory to calibrate and verify accuracy of electronic pressure transducers when first procured and annually thereafter.

The HRC procures electronic transducers, cables, and associated software/firmware from an outside vendor. The primary quality-affecting aspects of this procurement are the accuracy and precision of the transducers, which are verified during calibration by BN as described above.

The HRC receives hydrologic field support services from an outside vendor who maintains HRC-owned field equipment and provides field support for transducer installation and retrieval using the HRC-owned cable deployment trailer. These services are labor-oriented and do not involve equipment or services that are quality-affecting.

HOLD POINTS AND SAMPLES

There are no hold points or samples associated with this task.

QUALITY CONTROL – ACCURACY, PRECISION AND ERROR

<u>Manual Measurements</u>

Relative accuracy is assessed by comparing PET measurements taken from shallow, mid-level, and deep depth intervals with Reference Steel Tape measurements in the same wells (IPLV-035). Recent calibration results (August 2003) indicate that PET measurements are 99.98% as accurate as those made by the RST over the entire measured depth range of wells in the monitored network, without calibration correction factors, or within a mean error of ± 0.33 feet. With calibration factors applied, accuracy approaches 100% relative to RST. Absolute accuracy of the water level altitude in the borehole produced in accordance with the applicable procedure can not be quantified with certainty because the absolute accuracy of the altitude of the reference point and the borehole deviation associated with each specific well/borehole will not always be known exactly. Measurement precision, or the repeatability of successive measurements within a specified range, is affected by a variety of factors, but predominately by downhole conditions usually not apparent from the surface (Boucher, 1994).

As a practical matter, precision of the PET measurements may vary significantly (i.e., <0.1 to 0.01 feet) at the same well and from well-to-well. The desired measurement precision of ± 0.01 feet is usually obtained by proper field deployment of the measuring tape, but significant repeat measurement variations may occur even with good field technique. Repeat measurement precision and operator field judgment form the basis for data acceptance criteria. Illustrative examples of typical field situations involving operator judgment about precision and data acceptance is presented in IPLV-037. If the PET is properly deployed and downhole conditions do not adversely affect the tape hanging in the borehole, successive or repeat field measurements should be either equal to or within ± 0.01 feet of the first measurement, which is the smallest increment marked on the graduated tape. If downhole conditions appear to be adversely affecting measurement accuracy and/or precision leading to produced data not meeting acceptance criteria (which has occurred in certain boreholes in the network), measurement will be suspended at these locations and the BSC TCO notified in accordance with applicable procedures.

Measurement errors associated with the PET derive from operator proficiency, the degree of adherence to applicable field procedures, time between successive measurments at boreholes, environmental and downhole conditions, and other factors described in IPLV-037. For STA-1, it is generally possible to produce repeat measurements with precision of ± 0.01 foot. No relative accuracy or degree of correctness is claimed for STA-1 measurements since this piece of equipment is not subject to operational variability and it is not routinely calibrated. . Successive STA-1 measurements made in accordance with IPLV-036 that fall within ± 0.01 feet will therefore be considered accurate and acceptable. Sources of STA-1 measurement error are similar to those that apply to the PET, and are described in IPLV-036.

Electronic Measurements

The manufacturer's stated instrument accuracy rating is the basis for accuracy, precision, and data acceptance. If third party calibration confirms the stated accuracy rating is correct, then calculating instrument accuracy will be determined by multiplying the instrument measurement range (feet), by the stated accuracy rating (± 0.1% of full measurement range-feet). Accuracy will vary with instrument model (i.e., 5, 15, or 30 PSI rating), with lower PSI models having better manufacturer-stated accuracy. As with the PET, absolute accuracy of the water level altitude in the borehole measured electronically can not be known with certainty because the absolute accuracy of the altitude of the reference point and the borehole deviation associated with each specific well/borehole will not always be known exactly.

Based on the method of calculating electronic instrument accuracy described, the relative accuracy of a 30 PSI instrument will be ± 0.83 inches (0.069 feet) of water over its entire pressure/depth range of 69 feet (see IPLV-038). For any calibrated 30 PSI-rated instrument, all produced data that falls within a ± 34.5-foot ground water level fluctuation range within the borehole will therefore be acceptable. For example, for a well with a water level elevation of 1700.00 feet above mean sea level (MSL), any measured change between 1665.50 and 1734.50 feet above MSL would retain a relative accuracy of ± 0.83 inches. Since the average annual fluctuation of most boreholes within the periodic network is less than 2 feet, this is well within expected fluctuation ranges on the periodic network. This takes into account unusual events such as the largest seismically-induced ground water level fluctuation ever measured, which occurred in 1992 as a result of an M 7.6 earthquake near Landers, CA that caused a 3-foot change at borehole USW H-5 (Fenelon and Moreo, 2002) which persisted for several weeks.

For routine ground water level monitoring, the relative accuracy of electronic data from a 30 PSI instrument is comparable to that produced by manual techniques such as the PET: nearest 0.01 foot for PET-1 vs. approximately 0.07 foot for electronically produced data. However, electronic measurements do not require repetitive corrections to account for tape stretch variations, borehole depth or deviation from vertical, although these corrections are conceptually 'included' in electronic measurments because the PET will be used establish the reference water level altitude which will be the basis for subsequent electronic measurments. Like manual measurements, the absolute accuracy of the water level altitude in the borehole measured electronically will be uncertain because the individual absolute accuracy of the altitude of the reference point or measurement point will not always be known exactly.

Since the PET will be used to establish a reference level for subsequent electronic measurements, these measurements will theoretically contain the associated relative accuracy errors. However, any such propagated errors which will be systematic. Errors associated with manual measurements are relatively non-systematic since they are subject to more environmental, observational, mechanical, and gross data recording mishaps than electronic data.

Precision of derived data will be derived from the manufacturer's specifications. If third party calibration confirms the claimed accuracy is correct, then the manufacturer stated precision (30 PSI instrument) for successive measurements will be within 99.7% (3 standard deviations) of the stated accuracy of ± 0.83 inches (0.069 feet) of water over the entire pressure/depth range.

DATA RECORDING, REDUCTION, AND REPORTING

The water level measurements produced by this program must be qualified in order to yield data that can be reliably used as direct inputs to technical products, models, and for other scientific uses. This section describes the general data flow path from field acquisition, through processing, corrections, security and checking, storage, organization, to final submittal, that will ensure such reliability.

Manual Measurements

Manually collected data obtained from the PET and STA-1 will be recorded on field data sheets then manually entered into Microsoft Excel 2002™ spreadsheets. The spreadsheets contain simple cell calculations which adjust apparent depth-to-water measurements to corrected measurements using current calibration factors for the PET, the well/borehole deviation correction factor, the measurement point correction, and the reference point correction (see IPLV-036 and IPLV-037). These spreadsheets are then reviewed and signed-off for accuracy and completeness against the field sheets by a QA reviewer, and stored on a secure, password protected server which is backed-up daily. The data are organized by year, quarter, and borehole name. Corrected and QC'd quarterly measurements are compiled in a separate Microsoft Excel 2002™ spreadsheet and submitted annually to the UCSSN TDA in accordance with QAP-3.6, "Submittal of Data".

Electronic Measurements

Electronically-acquired data from calibrated transducers will be stored in an onboard microprocessor/data logger in accordance with pre-programmed instructions. In the field, the borehole cap will be unlocked and a laptop computer or personal data assistant (PDA) will be attached to the downhole cable surface connector beneath the cap. Communication will be established with the downhole instrument and the data retrieved and stored on the surface computer in a vendor-supplied format. The data are visually inspected in the field and a written record made of the retrieval on a field sheet. The borehole will then be re-secured. In the office, if the data are transferred from a laptop, a network connection will be established and the data moved directly from the laptop to the server. If a PDA was used, the data will be first transferred to the desktop computer, and then transferred by network connection to the secure server. Electronic data will be stored on the secure server in the vendor-supplied format for export to Microsoft Excel 2002™ for QA review using a vendor-supplied utility which ensures accuracy of the conversion. The data will be organized and stored on the secure server by year, quarter, borehole name, and data format. The spreadsheets containing the water level data will be reviewed for accuracy and completeness against the field sheet retrieval record and the vendor supplied format by a QA reviewer. QC'd electronic measurements will be transferred to separate Microsoft Excel 2002™ spreadsheets and submitted annually to the UCSSN TDA in accordance with QAP-3.6, "Submittal of Data".

REVIEWS AND VERIFICATIONS

The following summarizes the technical and QA reviews that will be conducted, as applicable, as part of the work sequences described previously:

1. New and/or revised IPs (technical, QA)
2. New and/or modified SIPs (technical, QA)

3. Verification of "Depth-to-Water Field Sheets for Steel and Electric Tapes" against "Corrected Depth-to-Water Measurement and Water Level Altitude Work Sheets" (technical)
4. Verification of "Field Sheet for Digital Pressure Transducer Data Extraction" against spreadsheets containing reports of electronic generated data (technical)
5. Calibration records for PET-1 and PET-2 (technical)
6. Field calibration records for electronic measurement instruments developed prior to deployment and at the time of instrument removal (technical)
7. Compiled ground water level data and Technical Reports submitted to the TDA or to the DOE Technical Data Management System (technical and QA)

RECORDS AND SUBMITTALS

The following summarizes the QA records that will be produced and managed in accordance with QAP-17.0, "Quality Assurance Records", as part of the work sequences described previously:

1. Corrected and QC'd quarterly ground water level measurements compiled in Microsoft Excel 2002™ spreadsheets and submitted annually to the UCSSN TDA. These will be acquired and managed in accordance with IPLV-037 QAP-3.4.
2. QC'd electronic ground water level measurements compiled in Microsoft Excel 2002™ spreadsheets and submitted annually to the UCSSN TDA. These will be acquired and managed in accordance with IPLV-038 and QAP-3.4.
3. Technical Reports will be prepared in accordance with QAP-3.4, "Technical Reports".
4. Other records specified as QA records in applicable IPs and QAPs.
5. Non-Q quarterly progress reports provided as a submittal but not as a QA record.

REFERENCES

Boucher, M.S. Precision and Accuracy of Manual Water-Level Measurements Taken in the Yucca Mountain Are, Nye County, Nevada. U.S. Geological Survey Water Resources Investigation Report 93-4025. 18 p.

Ervin, E.M., et al. Revised Potentiometric Surface Map, Yucca Mountain and Vicinity, Nevada. U.S. Geological Survey Water Resources Investigation Report 93-4000, 18 p.

Fenelon, J.M. and M.T. Moreo. Trend Analysis of Ground-Water Levels and Spring Discharge in the Yucca Mountain Region, Nevada and California, 1960-2000. U.S. Geological Survey Water Resources Investigation Report 02-4178.

O'Brien, G. Earthquake Induced Water Level Fluctuations at Yucca Mountain, Nevada, June 1992. U.S. Geological Survey Open File Report 93-73, 12 p.

Page, H.S. Final Technical Report: Ground Water Level Measurements in Selected Boreholes Near the Site of the Proposed Repository (2002 Data). Prepared by Harry Reid Center for Environmental Studies – UNLV for the U.S. DOE/UCCSN Cooperative Agreement Number DE-FC28-98NV12081, Task 28, Document ID TR-03-014, Rev. 0.

Wilson, C., et al. Civilian Radioactive Waste Management System Management and Operating Contractor Data Qualification Report: Water Level Altitude Data for Use on the Yucca Mountain Project. TDR-NBS-HS-000004 REV 00, August 2000, 20 p.

Implementing Procedures referenced in this SIP are located in the section, “Implementing Procedures and Standards”.