553985

Sandia National Laboratories
Waste Isolation Pilot Plant

Test Plan TP 03-01

Test Plan for Testing of Wells at the WIPP Site

Task 1.4.2.3

Revision 3

Effective Date: 07/13/10

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1. ABBREVIATIONS, ACRONYMS, AND INITIALISMS

A	ampere
APV	access port valve
ASME	American Society of Mechanical Engineers
CBFO	(U.S. DOE) Carlsbad Field Office
CMR	Central Monitoring Room
DAS	data-acquisition system
DC	direct current
DOE	(U.S.) Department of Energy
DST	drill-stem test
EPA	(U.S.) Environmental Protection Agency
ES&H	environmental safety and health
FY	fiscal year
gal	gallons
GET	General Employee Training
gpm	gallons per minute
GWMP	Groundwater Monitoring Program
HA	hazard analysis
HMI	Human Machine Interface
HP	horsepower
I.D.	inside diameter
JHA	job hazard analysis
mA	milliamp
mps	megabits per second
MOC	WIPP Site Managing and Operating Contractor
NMOSE	New Mexico Office of the State Engineer
n	flow dimension
NP	(SNL WIPP) Nuclear Waste Management (QA) Procedure
OLE	Object Linking and Embedding
OPC	OLE for Process Control
PHS	primary hazard screening
PI	Principal Investigator
PID	Proportional, Integral, and Derivative
PIP	production injection packer
psia	pounds per square inch absolute
psig	pounds per square inch gauge
QA	quality assurance
QAPD	Quality Assurance Program Document
RTD	resistance temperature detector
RTU	remote terminal unit
S	storativity
SN	Scientific Notebook
SNL	Sandia National Laboratories
SNS	Scientific Notebook Supplement

SP	(SNL WIPP) Activity/Project Specific Procedure
SSW	Shallow Subsurface Water
SMN	SSW Monitoring Network
T	transmissivity
TP	(SNL) test plan
VAC	volt alternating current
VDC	volt direct current
VFD	variable frequency drive
WRES	Washington Regulatory and Environmental Services
WIPP	(U.S. DOE) Waste Isolation Pilot Plant
WMN	WIPP Monitoring Network
WTL	(SNL) Well-Testing Lead

2. REVISION HISTORY

Revision 2 of this test plan (TP) removed the requirement for documenting safety briefings in the scientific notebook. Site safety briefing forms are maintained as separate health and safety documents and are non-QA records. This revision also included a specific requirement for duplicate tests at each pneumatic slug test location. The second test will be performed at a pressure differential of either one-half or twice that used for the initial test. The final revision to this TP was to change the mechanical totalizing flow meter data from a QA record to a non-QA record. Experience from several tests has shown that the mechanical totalizing flow meters do not agree with the more accurate inductive flow meters. Calibration of the mechanical flow meters will be performed on an as-needed basis with pre- and post-test checks.

Revision 3 of this test plan removed many of the areas where an instrument or gage was called out specifically by brand. For example we no longer identify mini-Trolls as the down-hole pressure transducer as we may use several models of Troll gages. Secondly, the scope of the TP was expanded to include work in the Shallow Subsurface Water program. This revision also modified the requirement that specified the use of a mechanical flow meter. The use of a mechanical flowmeter, such as the Carlon flowmeter, is optional when performing any of the testing covered in this TP. This revision also removed section 4.5, Ground Water Sampling and Control which detailed the steps related to water quality sample collection. The TP now refers the reader to the applicable SP(s) and NP(s) covering this work.

The purpose and content of any future changes and/or revisions will be documented and appear in this section of revised editions. Changes to this TP, other than those defined as editorial changes per SNL WIPP quality assurance (QA) procedure NP 20-1, *Test Plans*, shall be reviewed and approved by the same organization that performed the original review and approval. All TP revisions will have at least the same distribution as the original document.

3. PURPOSE AND SCOPE

The Waste Isolation Pilot Plant (WIPP) is a U.S. Department of Energy (DOE) facility designed for the safe disposal of transuranic wastes resulting from U.S. defense programs. In order to demonstrate compliance with U.S. Environmental Protection Agency (EPA), 1993) and (EPA, 1996), models of groundwater flow around the WIPP are needed. These models must:

- demonstrate an understanding of the hydrologic systems within which WIPP exists,
- identify the flowpaths that radionuclides released from the WIPP repository through inadvertent human intrusion would most likely take.
- simulate groundwater flow and radionuclide transport along the important flow paths in the event that human intrusion of the repository occurs.

Development of these models requires data from wells completed to all units within the hydrologic system. Testing of these wells creates data which can be used for either model development or model calibration\verification. The data acquired includes, but are not limited to:

- hydraulic parameters, e.g., flow dimension (n), storativity (S), and transmissivity (T), inferred from well tests used to define parameter distributions within the models;
- transient head responses from observation wells during long-term pumping tests that can be used during model calibration to infer hydraulic properties in areas where no wells may exist;
- direct measurements of the rates and directions of groundwater flow through wells that can be used in model verification;
- fluid specific gravities (or densities) used in calculation of hydraulic head gradients; and
- water-quality analyses that may be useful in inferring flow directions and fluid sources.

Additionally, the data generated from testing can be used by the DOE in support of operating permits supplied by the regulatory agencies for WIPP. This includes the discharge permit (DP) issued by the State of New Mexico, which requires the monitoring of anthropogenically derived water found perched at the Santa Rosa-Dewey Lake contact below the WIPP facility (NMED, 2010).

This TP describes the methods that will be used to obtain the data needed for hydrologic modeling at the WIPP.

4. EXPERIMENTAL PROCESS RATIONALE AND DESCRIPTION

The overall strategy and scope of well testing and/or water quality sampling in WIPP wells is defined by the Sandia Principal Investigator (PI). Either the PI or the Sandia Well-Test Lead (WTL) designated by the PI may make decisions about specific types of tests to be conducted, test parameters (e.g., pumping rates, observation wells to be monitored), durations of tests, tool placements, instrumentation, sampling criteria, etc., and authorize deviations from the procedures outlined in this TP.

Wells that constitute the WIPP groundwater monitoring network are completed to the Santa Rosa-Dewey Lake Formation, the Culebra and Magenta Dolomite Members of the Rustler Formation, and the Bell Canyon Formation (Figures 4-1 and 4-2). Though many of these wells have been tested in 2010, there are still a few in need of testing, re-testing, and/or sampling for water quality parameters. The PI, in consultation with the WTL, will decide upon which wells need to be tested or sampled for water quality on a fiscal year (FY) basis.

System	Series	Group	Formation	Member	Approximate Thickness* (m)	(ft)
Recent	Recent		Surficial Deposits		3	10
Quaternary	Pleistocene		Mescalero Caliche		10	30
			Gatuña			
Triassic		Dockum	Undivided		3	10
Permian	Ochoan		Dewey Lake Redbeds		150	500
			Rustler	Forty-niner	18	60
				Magenta	7	24
				Tamarisk	26	85
				Culebra Dolomite	7	24
				Los Medaños	37	120
			Salado		600	2000
			Castile		400	1300
	Guadalupian	Delaware Mountain	Bell Canyon		310	1000
			Cherry Canyon		335	1100
			Brushy Canyon		550	1800

* At center of WIPP site.

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Figure 4-1. Stratigraphic units at the WIPP Site

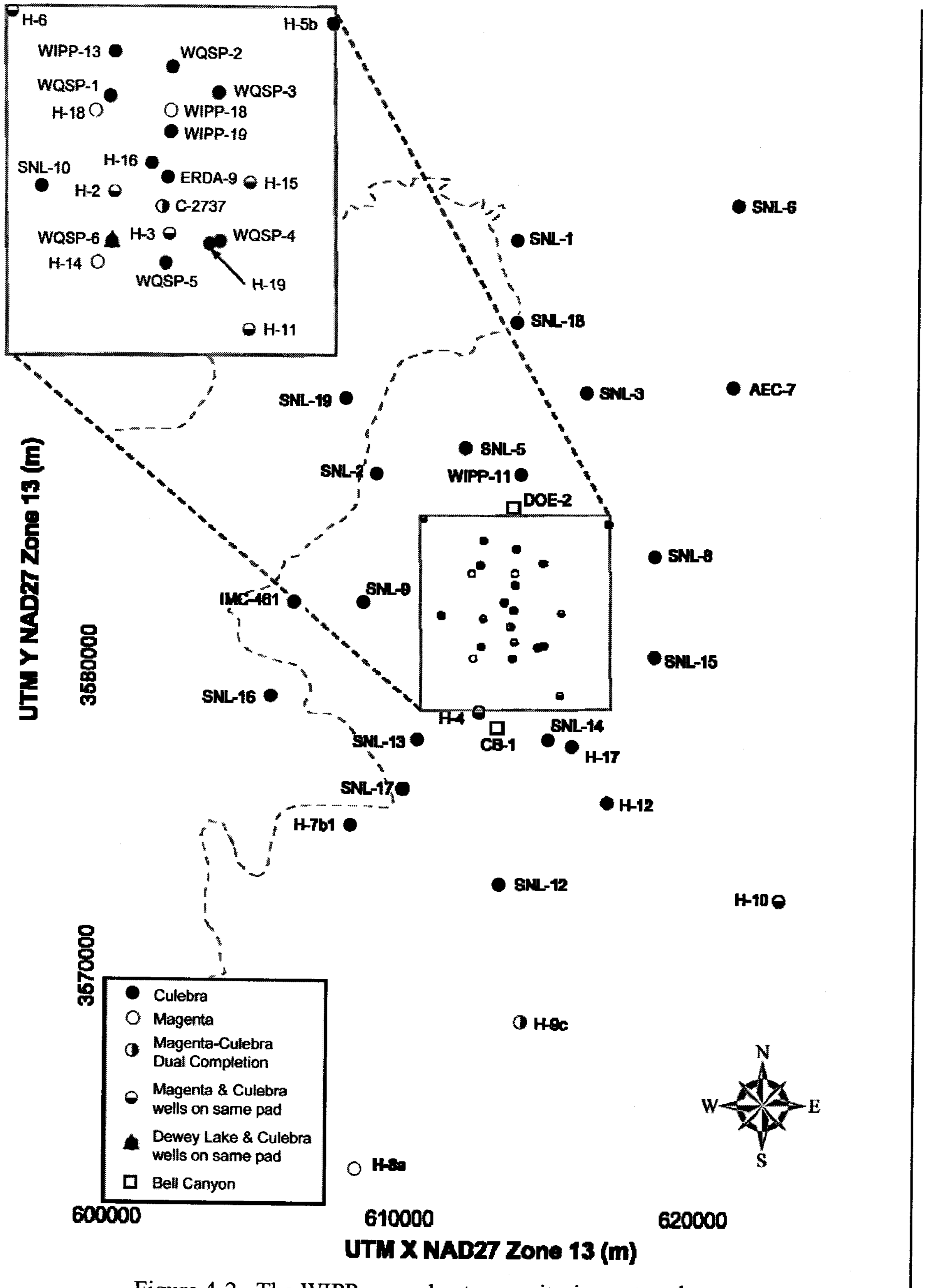

Figure 4-2. The WIPP groundwater monitoring network

4.1 Testing Activities

In each well to be tested, the following activities will occur:

1. The SNL WTL or PI will evaluate the data from previous testing or from the well-development pumping performed by Washington Regulatory and Environmental Services (WRES) in order to design a hydraulic test(s) to meet the objectives for both the location and interval being tested. When the WTL/PI has determined the type and duration of the hydraulic test(s) that will be run in an individual well, an appropriate test tool will be installed in the well. The type and configuration of test tools will vary from well to well based on the following:

- the type of test to be performed, e.g., slug or drill-stem test (DST), single-well pumping test, multipad pumping test;
- the objectives of the hydraulic testing (formation(s) or parameters of interest); and
- the well configuration (single-interval completion or dual-interval completion).

Due to the inherent variability in test-tool configurations that will be necessary to complete hydraulic testing in all wells successfully, no standard configuration is provided in this TP. Each test-tool configuration will be documented in the scientific notebook and will be submitted as part of the final records package. The placement of the test tool within the borehole will be determined by the WTL/PI. After the well has recovered from the tool-emplacement activities, an appropriate hydraulic test(s) will be performed in accordance with the procedures given in Subsection 4.3.

2. Regardless of the type of hydraulic test(s) conducted, the WTL/PI will evaluate all of the data collected on a real-time basis in order to ensure that the objectives of the test are being met prior to the termination of the test as well as to ensure that the tests are conducted with the maximum efficiency possible. The reader is referred to Subsections 4.3.2, 4.4.1, and 4.4.4 for additional information regarding the real-time data analysis associated with the various types of hydraulic tests.

3. All test equipment will be removed from the well, and the well will be configured for long-term monitoring.

This will complete SNL well testing activities in the well. WRES will also incorporate the well into its Groundwater Monitoring Program (GWMP; WTS, 2003) and, if deemed necessary, SNL will incorporate the well into its long-term monitoring program (described in TP 06-01, *Monitoring Water Levels in WIPP Wells*).

4.2 Measuring and Test Equipment

Equipment needed for the hydraulic testing and data-collection activities will consist of equipment at the land surface and downhole equipment to be installed in the wells. Equipment will consist of either "off-the-shelf" items ordered directly from qualified suppliers or standard equipment provided by qualified service companies. No specially designed equipment is anticipated. All equipment used will follow the supplier's operation and calibration specifications and will be documented as part of the QA records and controlled following NP 12-1, *Control of Measuring and Test Equipment.*

4.2.1 Surface Equipment

The surface equipment will include water-level sounders, water-quality measurement instruments, a flow measurement device, a power source, and storage tanks. A data-acquisition system (DAS) will typically be used to monitor and record test data. For a constant-rate flow test, the DAS will also control the flow rate of the pumping system. A barometer within the vicinity of the test location will be used to measure atmospheric pressure throughout the performance of a hydraulic pump test, or as determined by the WTL/PI. Equipment will be operated observing relevant SNL and WRES environmental safety and health (ES&H) procedures and protocols.

4.2.1.1 WATER-LEVEL SOUNDERS

Water levels in the wells may be measured before installing any equipment. During the test, water levels may also be measured in other monitoring wells determined by the WTL/PI. The water levels will be measured using Solinst electric water-level sounder or equivalent, according to SNL WIPP Activity/Project Specific Procedure (SP) 12-5, *Depth-to-Water Measurement Using a Solinst Brand Electric Sounder*. All measurements will be documented as part of the QA records.

4.2.1.2 WATER-QUALITY MEASUREMENTS

During the pumping phases of this program, the specific conductance, temperature and pH of the produced water will be measured by the DAS or by manually read instruments and on a frequency determined by the WTL/PI. Specific gravity will be measured manually at least three times daily during pumping tests, or as directed by the WTL/PI. The same suite of measurements may also be performed on water bailed and/or swabbed from the wells prior to slug tests or DSTs. With the exception of specific gravity, these data will be considered qualitative in nature and will not be used for interpretation, but only to indicate relative changes in the quality of the fluid produced.

The specific conductance and pH will be measured with commercial off-the-shelf sensors (or equivalent) with measurement sensitivity of ± 0.025 pH and conductance sensitivity of ± 5% of full scale. Specific gravity will be measured with a laboratory-grade hydrometer. Measurements will be documented as part of the QA process.

4.2.1.3 MECHANICAL OR ELECTRICAL FLOW MEASUREMENT DEVICE

A totalizing mechanical or electrical flow meter may be used to measure the cumulative discharge during the pumping period. If necessary, the data from the totalizing flow meter can be used to calculate the average pumping rate by observing the volume of water discharged through the meter over a given time period. Totalizing-flow-meter data will be documented as non-QA records. The performance of the flow meter used will be verified consistent with the requirements identified in NP 12-1, *Control of Measuring and Test Equipment.*

As a secondary means of verifying flow meter performance, the flow rate can be estimated by determining the time required to fill a container of known volume in a specific time period; these secondary checks may be documented in the scientific notebook for the corresponding pumping activity as non-QA records.

4.2.1.4 POWER SOURCE(s)

Diesel- or gas-powered generators are typically used to generate electricity for the test equipment and pump. If a generator is used, it will be operated in accordance with the instructions provided by the manufacturer. Operation of generators is not a quality-affecting activity and, therefore, documentation of activities associated with the generators is not mandatory. It is also appropriate that all DAS and computer equipment be powered through an Uninterruptible Power Supply (UPS) which provides for the continued collection of data in the event the primary power source fails.

4.2.1.5 STORAGE TANKS

All groundwater produced from the wells during these activities will be stored in appropriate tanks at the well pad or SNL port-a-camp until such time that WRES disposes of the produced water by appropriate means. Water storage is not a quality-affecting activity and, therefore, documentation of activities associated with the storage amounts is not mandatory.

4.2.1.6 DATA-ACQUISITION SYSTEM

The DAS consists of one or more control panels and a computer system. The control panels, computer system, and all hardware components are developed using off-the-shelf items. The control panels house the programmable logic controller (PLC), data acquisition Input/Output (I/O), analyzers for pH and specific conductance, and the power supplies for most of the instrumentation. The DAS is designed around a processor supplied by Sixnet Corporation. The Sixnet DAS will be programmed using the ISaGFAF programming software supplied by Sixnet. The DAS program will be cabable of controlling the test equipment for the purposes of maintaining a fixed flow rate or water level, and the DAS will scale the raw analog signals to their engineering unit equivalents using the calibration coefficients. The engineering units for the instrumentation will be displayed on the human-machine interface (HMI) software running on the system computer. The HMI is interfaced with the primary DAS computer through an Ethernet hub or switch.

The control panels can also contain the variable frequency drive (VFD), motor starter, and circuit protection devices for the downhole pumps. Pump control includes setting the pump motor speed using a 4 to 20-mA command signal to a VFD. This generally applies to pumps that are 15 HP and less. For pumps greater than 15 HP, the control panels are not usually used and the pump is run directly from the power source and the flow is regulated using manual valves.

For very low flow applications where a steady flow regime may not be possible, such as those expected in the formations containing Shallow Subsurface Water (SSW), the controls maybe condensed into a simplified sampling pump setup without a DAS attached. The pumping test will primarily focus on collection of water quality samples using this configuration and data will be collected by downhole pressure transducers, if possible. The WTL/PI will identify the test equipment configuration that best accomplishes the objectives of collecting both water quality sample collection and testing of hydraulic properties within low flow SSW boreholes.

Flow through the hydraulic system is measured by in-line analog and digital flowmeters located near the upstream end of the hydraulic line and is controlled using the VFD to adjust power delivered to the pump in the well. Water quality (pH and specific conductance) is measured near the downstream end of the hydraulic line that is also equipped with a valve port to collect water samples for laboratory analyses, if required. A resistive temperature detector (RTD) located in the flow line between the water-quality sensors is used to measure water temperature.

The data-acquisition computer system should at a minimum have the software described in Table 4-1 installed as part of the overall system. These software products are used to configure the system hardware and to communicate between the hardware and the computer. Both ISaGRAF and Wonderware provide the capability to develop unique applications using their unique programming functions. For the SNL DAS, separate ISaGRAF and Wonderware programs were developed. These programs perform the math functions that convert raw data to engineering values and also control the pump motor speed and valve position using Proportional, Integral, and Derivative (PID) logic. The Wonderware HMI application was developed to interface with the Sixnet DAS and provide a user-friendly HMI from which the system operator could control and monitor a test.

The software and system performance is verified following the steps identified in AP-115 or AP-148. The activities described in these analysis plans are performed whenever the software or DAS hardware configuration is significantly modified. The results of the AP-115 or AP-148 activities will be documented in a data report for the system. The DAS is calibrated at a frequency determined by the WTL\PI following the process identified in SP 12-4, *Sixnet DAS Calibration*.

Table 4-1. Software Utilized in WIPP Hydrology DAS.

Software Name	Version	Function	Comment
ISaGRAF	3.47 or newer	Program Sixnet remote terminal unit (RTU) (Processor)	ISaGRAF is an IEC61131-compliant, off-the-shelf programming package used to develop a program in the RTU which converts the raw values to engineering units and controls pump speed and valve position
Sixnet I/O Tool Kit	3.0 or newer	Configure Sixnet Hardware	Sixnet I/O Tool Kit is an off-the-shelf software package that is used to configure the Sixnet hardware. This capability includes configuration of I/O channels, ports, addressing, etc.
Wonderware by Intouch	8.0, SP1 or newer	Human Machine Interface Software	Wonderware is an off-the-shelf software package that can be used to develop a custom operator interface consisting of computer screens that allow the user to view and input parameters to the program running in the Sixnet RTU.
InSQL by Intouch	8.0, SP1 or newer	Database	InSQL is an off-the-shelf database product capable of interfacing with the HMI (Wonderware) to collect and store the data being collected by the DAS
KepWare	4.100.239 or newer	OPC Data Exchange	KepWare is device-driver software used during data exchange between the Wonderware HMI software and the Sixnet using Object Linking and Embedding Process Control (OPC) client protocol.
Active Factory	8.0 or newer	Query Tool for Data extraction from InSQL	Active Factory is an add-on tool for Microsoft Excel that allows users to perform simple query functions to extract the data from the InSQL database.

4.2.1.7 FLOW-CONTROL

When constant-rate flow conditions are needed for a hydraulic pumping test, the DAS will measure the output signal from an in-line inductive flow meter and control a variable-speed pump motor to maintain a consistent flow rate throughout the testing period. The flow-rate output from the flow meter will be used as the process variable to set the control variable, specifically the speed of a variable-speed pump. The user-selected set point will be set manually at the controller or remotely via the DAS. The design control range for flow rate is variable and dependent upon the conditions encountered or anticipated.

4.2.1.8 BAROMETER

Barometric pressure will be monitored during all hydraulic tests using a pressure transducer or transmitter (subsection 4.2.2.5) either at the well site or another WIPP field site, such as the SNL port-a-camp. Barometric data will be recorded every 15 minutes starting on the hour, or as directed by the WTL/PI.

4.2.2 Downhole Equipment

Downhole equipment will be operated from the surface and may consist of bailing and swabbing equipment to remove fluid from the borehole(s), inflatable packers, a sliding-sleeve shut-in tool, pressure transducer, or submersible pump. The depths of all equipment installed in a well will be measured and documented relative to a known permanent datum, such as a survey marker established on the well pad. A secondary datum, such as the top of the well casing, may be used as a reference point for depths provided that the elevation of the secondary datum relative to that of the primary datum is known and documented. SNL will provide technical direction and assistance, as needed, to WRES or its contractors in installing all downhole equipment.

4.2.2.1 BAILING AND SWABBING EQUIPMENT

Bailing and swabbing equipment will be used to remove fluid from the tubing above the shut-in tool (Subsection 4.2.2.3) as needed to conduct slug tests and/or DSTs (Subsection 4.3.2.1). The bailing and swabbing equipment will consist of artificial and/or natural rubber tubing wipers (swab cups) or downhole bailers supplied and operated by the pump-truck contractor. If bailing or swabbing is not possible or ineffective, the fluid level in the tubing string may be lowered by means of air lifting, whereby a hose or pipe is used to inject compressed air below the water level in the tubing string at pressures and volumes sufficient to lift the fluid to land surface.

4.2.2.2 INFLATABLE PACKERS

Slug and drill stem testing (Subsection 4.3.2.1) may be conducted with a production-injection packer (PIP) set above the perforations or screen associated with the formation of interest on tubing or pipe. Compressed nitrogen or compressed air will be used to inflate the packers. The packers to be used will have un-inflated diameters consistent with the diameter of the casing in each well. In addition, pumping tests (Subsections 4.3.2.2 and 4.3.2.3) conducted in wells that have dual completions such as C-2737 and H-9c will require the use of PIPs to reconfigure the wellbore in such a way as to allow the pressure to be monitored in multiple formations simultaneously within the same borehole.

4.2.2.3 SLIDING-SLEEVE SHUT-IN TOOL

A sliding-sleeve shut-in tool may be used to control access to the packer-isolated zones in the wells in which slug tests or DSTs are performed. A sliding-sleeve shut-in tool consists of concentric sections of pipe with circular ports passing through the wall of the pipe. In the open position, the ports on the two sections line up, allowing fluid to pass from the tool string to the well. When one of the sections slides vertically relative to the other, the ports no longer line up (closed position), and the fluid cannot pass from the tool to the well. The shut-in tool is controlled from the surface. Gas or hydraulic pressure is applied to a piston through a control line run alongside the tool string to open or close the sleeve. Separate pistons and control lines are used to open and close the sleeve. No tubing movement or weight change to the tubing above the shut-in tool is required to operate this shut-in tool, thus minimizing tool-induced pressure disturbances in the test zone. The shut-in tool will be installed between two pup joints beneath PIPs.

4.2.2.4 MINI-PACKER SYSTEM

A miniature (~1.5-inch O.D.) inflatable packer assembly may be used to control access to the packer-isolated zones in the wells in which slug tests and/or DSTs are performed. The mini-packer assembly consists of the above-mentioned miniature inflatable packer and an associated housing along with an inflation/deflation line. The mini-packer assembly is deployed above the downhole packer as part of the tubing string (generally 2.375-inch) and positioned at a predetermined level above the top of the packer or at some level below ground surface. Upon inflation, the mini-packer system isolates the portion of the well to be tested (test zone) from the tubing string that provides access to the well head. Following the effective isolation of the test zone from the tubing string, fluid is removed from or added to the tubing string in order to create an over-pressure or under pressure condition (a slug-withdrawal or slug-injection test, respectively). Upon deflation of the mini-packer, the test zone is exposed to the over- or under-pressure condition and the resulting hydraulic response is observed and recorded. This methodology was designed to be used in wells containing a large amount of sediment.

4.2.2.5 PRESSURE SENSORS

SNL employs two types of pressure sensors to collect downhole pressure-head data. They will typically be programmable pressure-temperature transducers with onboard memory and pressure transmitters that are directly linked to a DAS, which is programmed to collect and store the data. The installation of the pressure sensors in a well is dependent upon test type and well configuration and is further discussed in Section 4.3.2

The primary data-acquisition instrument during hydraulic tests is a programmable pressure-temperature transducer, which is programmed to collect pressure-head data throughout the testing period. Pressure transducers are also used to monitor the pressure response in the nearby well(s), if any, and to collect barometric-pressure data. The operation and maintenance of the transducers currently used by SNL is described in SP 9-7, *WIPP Well Water-Level Monitoring*.

In some cases it may prove beneficial to also use pressure transmitters (e.g., Druck PTX 1830). These pressure transmitters will be monitored with the DAS (Subsection 4.2.1.6), which will record the output signal from the sensor and convert it to the desired pressure units. The pressure transmitters will be operated and maintained as described in SP 12-6 *Pressure Transducer Calibration Using the Druck DPI-610*.

4.2.2.6 SUBMERSIBLE PUMPS

In most cases, an electric submersible pump will be used for groundwater sampling and pumping tests. For pumping tests, the pump will be installed with one or more in-line check valve(s) so that the pump tubing column can be filled with water at the start of pumping to ensure immediate flow control and regulation, and to ensure that water will not drain back through the pump when the pump is turned off. Pumps will be installed on a tubing string at a depth determined by the WTL/PI. The installation depth and configuration, including pressure sensor depth, will be documented in the applicable SN.

4.3 Test Requirements and Procedures

The activities discussed in this TP have been designed so that the data collected are of the highest possible value, and are more than adequate to meet specific program objectives.

4.3.1 Test Requirements

The testing elements of the data-collection activities require specific initial and operational conditions for maximum success. Pressures in the formation and wells of interest during the test must be stabilized (changing <0.5 psi/day) before any hydraulic test is initialized, unless otherwise directed by the WTL/PI before any hydraulic test is initialized. The discharge rate during a pumping test should ideally be constant within approximately 5%, but the discharge rate evolution through time must always be well documented.

The test equipment used for the data-collection activities has to:

- provide quality data to support test objectives;
- perform according to design specifications; and
- be calibrated, as appropriate, according to standards acceptable under NP 12-1, *Control of Measuring and Test Equipment.*

4.3.2 Test Procedures

The following subsections discuss the different hydraulic test types, as well as water-quality sampling events that may be performed in WIPP wells. Each subsection also describes the general methodology for selection and execution of each type of test/event.

4.3.2.1 HYDRAULIC SLUG TESTS AND DSTs

Hydraulic slug tests and/or DSTs will generally be performed in wells incapable of sustaining a pumping rate of at least 0.25 gpm or greater. This may include wells completed to the Shallow Subsurface Water (SSW), the Magenta and some replacement Culebra wells. Hydraulic slug tests or DSTs may also be performed in some of the new wells initially in order to get a preliminary idea of the hydraulic characteristics of the formation at that location. Future testing in these wells will be designed based upon the preliminary hydraulic data.

A DST is simply a slug test that is shut-in before complete water-level recovery has occurred. The slug portion of a DST is referred to as a flow period and the shut-in portion is referred to as a build-up period. The advantages of a DST relative to a slug test are that it takes less time to complete and provides two data sets that can be analyzed instead of one. The disadvantage of a DST relative to a slug test is that the flow-period data set is less definitive than a full slug data set.

All hydraulic slug tests and DSTs will be conducted in accordance with the following TP procedures. A PIP (Subsection 4.2.2.2) will be set on tubing or pipe in the well casing above the perforations or screen with a sliding-sleeve shut-in valve or equivalent system (Subsections 4.2.2.3 through 4.2.2.5) immediately below the PIP. The PIP size will be selected so that the casing inside diameter (I.D.) is not more than twice the uninflated diameter of the PIP. The exact placement of the PIP is not critical, as long as it is within 20 ft of the uppermost perforation (slot) and its position is carefully measured. The shut-in valve will be in the open position when the test equipment is installed in the well. Once at the desired depth, the PIP will be inflated (set). After allowing the formation that is to be tested to re-equilibrate, the shut-in valve will be closed.

A pressure transducer (Subsection 4.2.2.5) will be strapped to the tubing at a depth below the stabilized formation water surface calculated to keep the transducer within its calibrated range during the test. The pressure transducer will be connected to the formation of interest using a feedthrough line passing through the PIP or other configuration as deemed appropriate. Barometric pressure will be recorded during all slug tests. The depths of all equipment in the well will be carefully measured and documented in the scientific notebook.

With the shut-in valve closed, the tubing will be bailed and/or swabbed to remove some of the water from above the formation of interest and the specific gravity of this water will be measured. The removal of water from the tubing (effectively under-pressuring the formation) is referred to as a slug-withdrawal test. The amount of water to be removed will be determined on-site by the WTL/PI, based on the following guideline: the water level will be lowered to provide a pressure no less than 5% of the maximum pressure for the transducer when the shut-in valve is opened. After bailing and/or swabbing, the water level in the tubing will be measured using a depth to water meter (Subsection 4.2.1.1). This type of test can also be accomplished by adding water to the tubing (effectively over-pressuring the formation) rather than removing water from the tubing. This is referred to as a slug-injection test, and may be performed as part of this TP if the circumstances are deemed appropriate by the WTL/PI.

The pressure in the formation of interest below the PIP will be allowed to stabilize until the rate of change is <0.5 psi/day or the WTL/PI determines the test can begin. At the direction of the WTL/PI, the shut-in tool will be opened to initiate a slug test. The WTL/PI will evaluate the test data in real time to determine if the test should be continued as a slug test or converted to a DST. Subject to the discretion of the WTL/PI, the following guidelines will be used to determine if and when a slug test will be converted to a DST:

- If 50% of the initial slug has dissipated after 3 hr, the test will remain a slug test.
- If 50% of the initial slug dissipates between 3 and 24 h, the shut-in valve will be closed and the test will be converted to a DST when 80% of the slug has dissipated.
- If 50% of the initial slug has not dissipated after 24 h, the shut-in valve will be closed and the test will be converted to a DST whenever 50% dissipation occurs.

Slug tests and DST buildup periods should ideally continue until at least 98% pressure recovery has occurred. For a slug test, the shut-in valve will then be closed and the tubing bailed and/or swabbed to create a pressure differential approximately half of that created for the first slug test. For a slug test converted to a DST at 80% slug dissipation, the tubing will also be bailed and/or swabbed to create a pressure differential approximately half of that created for the first test. No bailing and/or swabbing will be required for a test converted to a DST at 50% slug dissipation. After the pressure disturbance caused by bailing and/or swabbing has dissipated, the shut-in valve will be opened to begin a second slug test or DST. The second test will be an exact duplicate of the first test, but with half of the initial pressure differential. Testing may be terminated at any time after 98% pressure recovery has occurred or after the WTL/PI has determined that the available data are adequate for analyses.

Data-acquisition rates will be set as fast as possible at the start of each test event (slug/flow or buildup) and will then be systematically decreased throughout the test to provide a reasonably uniform distribution of data with respect to the logarithm of elapsed time. If the WTL/PI deems it appropriate to employ the use of a DAS (Subsection 4.2.1.6) to monitor slug-testing activities, all pertinent information will be documented in the scientific notebook.

During slug test and DST activities, pressure-response data will be evaluated on a real-time basis by the WTL/PI in order to determine that the objectives of the test are being met and that the test proceeds in the most efficient and effective manner. Standard straight-line and diagnostic derivative techniques described in Horne (1995) and Peres et al. (1989) may be employed to assess both the progress of the test and to determine the flow regime of the system being tested.

4.3.2.2 SINGLE-WELL PUMPING TESTS

Constant-rate pumping tests will be performed in any wells capable of sustaining a pumping rate of approximately 0.25 gpm or greater. All single-well pumping tests will be conducted in accordance with the following TP procedures. A submersible pump (Subsection 4.2.2.6) will be set in the well near the perforations or screen for the formation of interest on tubing or pipe. One or more check valve(s) will be installed above the pump to prevent water in the tubing column from draining back down through the pump when the pump is turned off. At least two pressure transducers (see Subsection 4.2.2.5) will be strapped to the tubing approximately 5-10 ft above the pump. The lengths of all tubing or pipe joints and other pieces of equipment installed in the well will be measured to the nearest 0.01 ft and documented in the scientific notebook.

In some cases, when one of the objectives of the hydraulic testing is to assess the hydraulic connection of the formation being tested with water-bearing formations above and/or below, PIPs (Subsection 4.2.2.2) will have to be installed in order to isolate the various water-bearing formations and additional pressure transducers will have to be installed in the pumping well in order to monitor the other water-bearing formations of interest associated with the particular test being conducted. Again, these decisions and associated configurations will be made on a case-by-case basis based upon prior information of the hydraulic system at that location. The rationale for all testing decisions and all testing configurations will be documented in the scientific notebook associated with the respective wells.

Prior to the initiation of the pumping test, the pump will be turned on briefly in order to perform several checks of the system. These include:

- ensuring that the submersible pump is operating properly;
- filling the tubing string with fluid to ensure that:
    - the one or more check valves above the pump are holding,
    - there is fluid filling the surface discharge lines to ensure that both the mechanical and the electronic flow meters will register flow rates immediately upon initiation of the formal pumping test; and
- ensuring that all of the electronic equipment both at the surface and downhole is operating properly.

When all of these checks and any others that the WTL/PI deems necessary have been made, the pumping will be terminated and the system will be allowed to equilibrate fully prior to the initiation of the formal pumping test.

The pump will be turned on and operated at a constant rate (determined during water-quality and/or well-development activities) to produce water from the formation of interest after it has been established that the formation of interest has re-equilibrated from the pre-test pumping. Although the primary purpose of these tests is to obtain estimates of formation transmissivity (T) and flow dimension near the pumping well, any nearby wells that may respond to the test will be monitored as well. The wells to be monitored during any pumping test will be determined by the WTL/PI on a case-by-case basis based upon prior knowledge of the hydraulic system at that location. Monitoring of these wells will be performed using pressure transducers (Subsection 4.2.2.5). In some cases, a qualitative assessment of any hydraulic connection between the formation being tested and water-bearing formations above and/or below the formation being tested will be made. Should a hydraulic connection between water-bearing formations be identified, the design and duration of the test may be modified in real-time in order to maximize the information obtained or additional testing may be scheduled at that location with modified test objectives. Pumping time may vary from 2–10 days depending on the local T of the formation of interest and/or the observed pressure response(s). Real-time analysis of the pressure data from the pumping and any monitoring wells will be used by the WTL/PI to establish the time when the pump may be turned off and the time at which recovery monitoring will be terminated. Recovery monitoring will typically continue for a period at least twice as long as the pumping duration.

The DAS (Subsection 4.2.1.6) will be used for any pumping test to record downhole pressure and flow rate in the pumping well and any other wells located on the same pad. A pressure transducer will also be used in the pumping well to provide a second set of pressure data during pumping and to serve as the primary source of data during the recovery period when the DAS is no longer on site. Barometric pressure will be collected through the use of a pressure transducer. Totalizing-measurements of well discharge (Subsection 4.2.1.3) and specific gravity measurements (Subsection 4.2.1.2) will be made during pumping as directed by the WTL/PI and documented in the scientific notebook or in the DAS data file for the test. During the recovery period, the pressure in the shut-in flow line will be measured, when possible, to verify that the check valve is not leaking.

During single-well testing activities, pressure-response data will be evaluated on a real-time basis by the WTL/PI in order to determine that the objectives of the test are being met and that the test proceeds in the most efficient and effective manner. Standard straight-line and diagnostic derivative techniques as described in Horne (1995) may be employed to assess both the progress of the test and to determine the flow regime of the system being tested.

In some cases, when one of the objectives of the hydraulic testing is to assess the hydraulic connection of the formation being tested with water-bearing formations above and/or below, PIPs (Subsection 4.2.2.2) will be installed in order to isolate the various water-bearing formations and additional pressure transducers will have to be installed in the pumping well in order to monitor the various other water-bearing formations of interest associated with the particular test being conducted. Again, these decisions and associated configurations will be made on a case-by-case basis based upon prior information of the hydraulic system at that location. The rationale for all testing decisions and all testing configurations will be documented in the scientific notebook associated with the respective wells.

4.3.2.3 MULTIPAD PUMPING TESTS

Constant-rate, multipad pumping tests are performed to obtain transient head response data from observation wells spread over an area of several square miles. They differ from the single-well pumping tests described in Subsection 4.3.2.2 primarily in terms of duration. Multipad pumping tests typically last from several weeks to over a month to allow distant observation wells time to respond.

All multipad pumping tests will be conducted in accordance with the following TP procedures. A submersible pump (Subsection 4.2.2.6) will be set in the well near the formation of interest on tubing or pipe. One or more check valves will be installed above the pump to prevent water in the tubing column from draining back down through the pump when the pump is turned off. At least two pressure transducers (Subsection 4.2.2.5) will be strapped to the tubing approximately 5-10 ft above the pump. The lengths of all tubing or pipe joints and other pieces of equipment installed in the well will be carefully measured to the nearest 0.01 ft and documented in the scientific notebook.

Prior to the initiation of the pumping test, the pump will be turned on briefly in order to perform several checks of the system. These include:

- ensuring that the submersible pump is operating properly;
- filling the tubing string with fluid to ensure that:
  - the one or more check valves above the pump are holding,
  - there is fluid filling the surface discharge lines to ensure that both the mechanical and the electronic flow meters will register flow rates immediately upon initiation of the formal pumping test; and
- ensuring that all of the electronic equipment both at the surface and downhole is operating properly.

When all of these checks and any others that the WTL deems necessary have been made, the pumping will be terminated and the pressure will be allowed to equilibrate prior to the initiation of the formal pumping test.

The pump will be turned on and operated at a constant rate (determined during water-quality sampling and/or well-development activities) to produce water from the formation of interest after it has been established that the formation of interest has re-equilibrated in the pumping well from the pretest pumping. Pressure transducers (Subsection 4.2.2.5) will be set in any monitoring wells that may show a pressure response during the pumping test. Monitoring wells for each multipad test will be determined by the WTL/PI on a case-by-case basis. Real-time analysis of the pressure data from the pumping and monitoring wells will be used by the WTL/PI to establish the time when the pump may be turned off and the time at which recovery monitoring will be terminated. The objectives of any of the multipad pumping tests will be to determine the flow geometry and the local T and storativity (S) of the formation being tested. In addition, the multipad pumping tests will provide transient pressure response data at locations in the vicinity of the WIPP Site against which the Culebra flow model can be calibrated. Also, in some cases, a qualitative assessment of any hydraulic connection between the formation being tested and water-bearing formations above and/or below the formation being tested will be made. Should a hydraulic connection between water-bearing formations be identified, the design and/or duration of the test may be modified in real time in order to maximize the information obtained, or additional testing may be scheduled at that location with modified test objectives. Pumping time may vary from 1-3 months depending on the observed pressure responses. However, under constraints imposed by the NMOSE, no multipad pumping test can produce more than a total of 3 acre-ft (977,486 gallons) of water in a calendar year, including pre-test pumping.

The DAS (Subsection 4.2.1.6) will be used for any pumping test to record downhole pressure and flow rate in the pumping well and any other wells located on the same well pad. A pressure transducer will also be used in the pumping well to provide a second set of pressure data during pumping and to serve as the primary source of data during the recovery period when the DAS is no longer on site. Barometric pressure data will be collected. Totalizing measurements of well discharge (Subsection 4.2.1.3) and specific gravity measurements (Subsection 4.2.1.2) will be made during pumping as directed by the WTL/PI and will be documented in the scientific notebook or in the DAS data file for the test. During the recovery period, the pressure in the shut-in flow line will be measured when possible to verify that the check valve is not leaking.

During multipad testing activities, pressure-response data will be evaluated on a real-time basis by the WTL/PI in order to determine that the objectives of the test are being met and that the test proceeds in the most efficient and effective manner. Standard straight-line and diagnostic derivative techniques described in Horne (1995) may be employed to assess both the progress of the test and to determine the flow regime of the system being tested.

4.3.2.4 WATER-QUALITY SAMPLING

All new wells and wells to be tested will be pumped to allow water samples representative of the completion formation to be collected. Some older wells not needing testing will also be pumped to provide groundwater samples. As discussed in Section 4, the wells will be pumped until water-quality parameters (electrical conductivity and specific gravity) are stable within approximately 5% while two wellbore volumes are pumped, or as directed by the WTL/PI. When stable conditions have been reached, water samples will be collected for laboratory analysis of major ions (Na, Mg, SO_4, Cl, K, Ca, and alkalinity), or other analyses as directed by the WTL/PI. Water-quality sampling will provide baseline information and allow inferences to be made regarding the origins and flow paths of the groundwater. Samples will be collected and controlled in accordance with NP 13-1, *Control of Samples and Standards*. The chain of custody for the samples when they are transferred to the analytical laboratory will be established using procedure SP 13-1, *Chain of Custody* and SP13-3, *Field Water Quality Measurements*.

Water samples will be collected in pretreated bottles supplied by the analytical laboratory. After collection, water samples will be chilled or refrigerated until they can be delivered to the analytical laboratory, which should occur as soon as is practical.

4.3.2.5 MODIFICATIONS TO TEST PROCEDURES

Modifications to test procedures may be required during testing activities. These modifications will be conducted at the direction of the WTL/PI and will be documented in the scientific notebook as part of the QA records as well as any supporting records and reports. Such modifications are anticipated as normal operational procedures and will not be reported as nonconformances that require corrective action.

4.4 Data-Acquisition Plan

Both manually and electronically collected data will be acquired during the hydraulic testing activities. The following types of data will be recorded:

- electronically collected downhole pressure data;
- electronically and/or manually collected pumping rate and volume data from wells being pumped;
- electronically collected barometric-pressure data;
- manually collected water-level data;
- manually and electronically collected water-quality data concerning the temperature, pH, specific gravity, and specific conductance of fluid produced during pumping, bailing and/or swabbing; and
- manually collected data on equipment and instrument configurations in the wells and at the surface.

4.4.1 Scientific Notebooks

Scientific notebooks will be used in accordance with NP 20-2, *Scientific Notebooks* to document all activities and decisions made during the hydraulic-testing activities. Specific information to be recorded in the scientific notebooks includes:

- a statement of the objectives and description of work to be performed at each well, as well as a reference to this TP;
- a list, with sample signatures and initials, of all personnel authorized to enter information into the SN;
- a written account of all activities associated with each well;
- a list of all equipment used at each well, including make, model, and operating system (if applicable);
- a description of standards used for on-site instrument calibration and calibration results;
- traceable references to calibration information for instruments calibrated elsewhere;
- a sketch, showing all dimensions, of each downhole equipment configuration;
- tubing tallies and other equipment measurements;
- manually collected water-level measurements;

- manually collected water-quality data concerning the specific conductance, specific gravity, pH, and temperature of fluid produced during pumping, bailing and/or swabbing;
- entries providing the names, starting times, and completion times of all data files created with the DAS software or WinSitu, as well as tables showing the configuration information (pressure transmitter serial number, calibration coefficients, etc.) entered into the DAS to initiate each data file; and
- discussion of the information and/or observations leading to decisions to initiate, terminate, or modify activities.

All entries in the scientific notebooks will be signed or initialed and dated by the person making the entry. Continuous blocks of entries by the same individual do not all need to be initialed and dated, but the first entry on every page must always be initialed and dated. Technical and QA reviews of the applicable scientific notebook entries will be completed as required by NP 20-2, *Scientific Notebooks* or at an increased frequency as directed by the WTL/PI. When scientific notebooks are completed, the closeout process specified in NP 20-2, *Scientific Notebooks* will be followed. This process will include final PI, technical, and QA reviews. Technical reviews must be completed by an independent, technically qualified individual within three months of the completion of the scientific notebook to verify that sufficient detail has been recorded to retrace the activities and confirm the results.

Manually collected water-quality data and water-level measurements may also be recorded on specially prepared forms rather than in the scientific notebooks when that would provide a more efficient means of data collection and tracking. Any such forms will be placed in a Scientific Notebook Supplement (SNS) identified in the scientific notebook, and submitted as QA records.

4.4.2 Electronic Data Acquisition

Pressure transducers (Subsection 4.2.2.5) will be used for monitoring and testing activities. The DAS described in Subsection 4.2.1.6 will be used at locations where pumping tests are performed. Electronic data file-management systems will be documented in the scientific notebooks for these activities. These electronic data files will be submitted as QA records according to NP 17-1, *Records*.

4.4.3 Manual Data Acquisition

Manual data collection will be carried out using either scientific notebooks or forms designed specifically for each activity or data type. To minimize transcription errors and multiple documentation of the same information, the use of forms specified in the WIPP procedures is not mandatory. The WTL/PI will determine the means of documenting manually acquired data and will ensure that all quality-affecting information is documented.

4.4.4 On-Site Data Validation

During the field activities, the WTL/PI will evaluate the data as they are acquired. The data will be diagnosed for any tool failure and/or procedure-induced effect that may affect the data quality. The WTL/PI will take immediate action (if required) to make any necessary changes to the equipment configuration or the procedures to assure the data quality is consistent with the objectives of these activities. Data associated with these testing activities provided by entities other than SNL will be checked for accuracy and adequacy by the WTL/PI and documented in the scientific notebook as such. Any deficiencies will be noted. This on-site real-time data evaluation will be documented in the scientific notebook.

The WTL/PI will use real-time evaluation of the acquired data during any given activity to assure that the data are usable in a detailed interpretation, the conditions can be maintained over the planned duration of the activity, and that an activity will not be terminated before the minimum objectives can be achieved under the given time constraints. The WTL/PI may utilize some or all of the following procedures and analytical tools:

- To assure that the acquired data satisfy program plans, the WTL/PI may use the same interpretation techniques during the data-validation process as will be used in later interpretation of these data.
- The WTL/PI may use specialized plots to interpret the formation response and to identify the time domain of that response, such as the wellbore storage, transition, stabilization, or other response phase.
- The WTL/PI may use real-time analysis of the acquired data to determine the time when continuing the activity will provide no further improvement in the interpreted results within the program's time and budget constraints.
- The WTL/PI may use real-time analysis to determine whether an activity can be terminated earlier than planned, and to develop a revised schedule as appropriate.

If at any time the WTL/PI determines that an activity objective cannot be accomplished due to time constraints, problems concerning the performance of the equipment, or unsuitability of initial conditions, the WTL/PI may terminate the activity. The WTL/PI will document all real-time evaluation of data in the scientific notebook.

4.5 Quality Assurance

4.5.1 Hierarchy of Documents

Several types of documents will be used to control work performed under this TP. If inconsistencies or conflicts exist among the requirements specified in these documents, the following hierarchy (in decreasing order of authority) shall apply:

- memoranda or other written instructions used to modify or clarify the requirements of the TP (most recent instructions having precedence over previous instructions),
- this TP,
- NPs, and
- SPs.

SNL QA concurrence will be obtained and/or corrective action reports will be written for modifications to QA procedures implemented for work conducted under this TP.

4.5.2 Quality-Affecting Activities

Activities performed under this TP are quality-affecting with the following exceptions:

- water-quality measurements, not including specific gravity (see Subsection 4.2.1.2);
- operation of generators (see Subsection 4.2.1.4);
- assistance provided by the manufacturer/contractor in the installation of tools and equipment;
- support services for tasks that do not involve data collection, such as pump trucks, machining, welding, fishing services, fuel, etc.; and
- water storage and disposal.

Activities that are not quality-affecting are not subject to the requirements of the SNL QA program.

4.5.3 Quality Assurance Program Description

SNL activities are conducted in accordance with the requirements specified in the Quality Assurance Program Document (QAPD) (U.S. DOE, 2009), or subsequent revisions of this document. The requirements and guidance specified in the QAPD are based on criteria contained in American Society of Mechanical Engineers (ASME) (1989a), ASME (1989b), ASME (1989c), or U.S. EPA (1993). The requirements of U.S. DOE (2005) are passed down and implemented through the SNL WIPP QA procedures.

4.5.4 Data Integrity

Care will be taken throughout the performance of the operations for this TP to ensure the integrity of all data collected including documentation on hard copy and data recorded on electronic media. Data collected shall not be released unless and until the data are reviewed and approved by the WTL/PI.

4.5.5 Records

Records shall be maintained as described in this TP and applicable QA implementing procedures. These records may consist of bound scientific notebooks, loose-leaf pages, forms, printouts, or information stored on electronic media. The WTL/PI will ensure that the required records are maintained and are submitted to the SNL WIPP Records Center according to NP 17-1.

4.5.5.1 REQUIRED QA RECORDS

As a minimum, QA records will include:

- scientific notebooks;
- NPs and SPs used;
- calibration records for all controlled equipment;
- equipment-specification sheets or information;
- data files collected by pressure transducers and/or the DAS, with a log listing the files and defining their contents;
- all forms containing manually collected data;
- a log of all samples collected;
- copies of all permits obtained; and
- reports (e.g., gamma and perforation logs) provided by contractors.

4.5.5.2 MISCELLANEOUS NON-QA RECORDS

Additional records that are useful in documenting the history of the activities but are considered non-QA records may be maintained and submitted to the SNL WIPP Records Center. These records include:

- safety briefings
- photographs,
- as-built diagrams of equipment supplied by contractors,
- pump-truck and other equipment certifications,
- totalizing flow meter data,
- equipment manuals and specifications,
- information related to operation of generators,
- equipment manifests, and
- cost and billing information regarding contracted services.

These records do not support performance assessment or regulatory compliance and, therefore, are not quality-affecting information.

4.5.5.3 SUBMITTAL OF RECORDS

Records resulting from work conducted under this TP, including forms and data stored on electronic media, will not be submitted to the SNL QA staff for review and approval individually. Instead, the records will be assembled into a records package or packages, which will be reviewed by the WTL/PI before being submitted for QA review.

5. TRAINING

All SNL and WIPP-Site contractor personnel are required to take and pass WIPP General Employee Training (GET) followed by annual refreshers to work at the WIPP Site. All personnel that perform work on US DOE WIPP-related property must read and acknowledge receipt of the WIPP Site User's Guide (WTS, 2006). All personnel who will perform quality-affecting activities under this TP must have training in the SNL QA program (Form NP 2-1-1), must view the current QA training, and must read NP 12-1, NP 13-1, NP 20-2, and SP 13-1. They must also read the procedures outlined in this TP, the Primary Hazard Screening (PHS), and all applicable NPs and SPs, but no additional training in those procedures is required. No other special training requirements are anticipated in addition to the GET and the safety briefings described in Section 6.

Existing procedures implemented in the field cannot be expected to anticipate every possible event affecting the tests. Therefore, the WTL/PI is expected to implement appropriate measures during the conduct of the tests. These technical decisions will be documented in the scientific notebook.

6. HEALTH AND SAFETY

SNL field operations will be conducted on land controlled by WRES and the field operations team assembled for this TP will follow all WRES safety practices and policies. Operational safety for individual field operations will be addressed through an ES&H PHS (SNL2A00137-001) and a Job Safety Analysis (JSA) developed by SNL approved through the WTL/PI. If the work is within the secure area of the Managing and Operating Contractor (MOC) at WIPP, the JSA and other safety documents must be reviewed and approved by the MOC. All activities will be performed in accordance with the requirements of WP12 FP.01, WP12 IS.01, and WP12 IH.02.

All equipment will be operated in accordance with the appropriate allowable operating pressures and in accordance with the SNL ES&H pressure-safety manual. Pressure ratings for individual parts such as valves and pressure tubing will be either marked by the manufacturer with the maximum allowable operating pressure or such information will be made available in written documentation according to guidelines of the SNL Center 6700 ES&H Coordinator.

Additional and specific safety concerns and requirements to be observed by field personnel will be addressed and documented in the daily safety briefing conducted prior to any field activities. Some of these issues include:

- appropriate use of safety shoes, safety glasses, chemical goggles, hard hats, and protective gloves;
- ensuring adequate fuel is available for all field vehicles, especially those traveling to remote locations;
- proper installation and safety procedures when handling electrical submersible pumps and other electrical equipment;
- proper procedures for operation of diesel- and gas-powered generators for on-site electric power;
- proper procedures for inflation of downhole packers;
- familiarity with on- and off-site road conditions and driving regulations;
- familiarity with the locations of first-aid supplies, medical support facilities, and fire extinguishers and other safety equipment;
- familiarity with the location of lists of emergency telephone numbers and persons and offices to notify in the event of emergencies; and
- familiarity with the location of Material Safety Data Sheets.

All field personnel assigned to the field operations described in this TP will receive a safety briefing before the beginning of field operations at each well site. All work locations will maintain a mobile communication system. In case of accident, injury, or sudden illness, the WIPP Central Monitoring Room (CMR) will be notified immediately. The CMR will coordinate emergency response activities.

7. PERMITTING AND LICENSING

Permitting and licensing requirements are discussed in Subsection 8.3.

8. ROLES AND RESPONSIBILITIES

The work described in this TP will require the drilling of several new wells in the vicinity of the WIPP Site. It will also involve reconditioning several existing wells. Throughout this multiyear field program, wells will be tested, water levels monitored, and well water chemistry will be observed. SNL intends to collaborate with WRES and/or its corporate affiliates to ensure integration of program efforts, to see that this work is done in accordance with all applicable technical and regulatory standards, and that data generated are fully qualified under SNL's WIPP QA program for use in assessing the long-term performance of the repository.

8.1 SNL Responsibilities

SNL's responsibilities are:

- Identify which monitoring wells will need to be reconditioned and work with WRES to identify by what means those wells will be made ready for scientific endeavor.
- Identify which wells will need to be hydraulically tested and identify the types of tests to be performed.
- Provide water-level and water-chemistry monitoring equipment, when appropriate, for placement in new (replacement) and/or reconditioned wells.
- Provide all equipment, both downhole and surface, necessary to perform hydraulic tests in new and reconditioned wells.
- Monitor water levels and water chemistry in wells of interest to SNL, or have levels and chemistry monitored.
- Perform all hydraulic tests in wells in collaboration with WRES (Subsection 8.2).
- Analyze and interpret well tests and hydrological monitoring data acquired.
- Identify locations of new wells to be drilled and develop the technical specifications for the drilling activity.
- Process and handle core samples collected during the drilling program.

8.2 WRES Responsibilities

WRES will assume the following responsibilities in support of the activities discussed in this TP:

- Recondition (or have reconditioned) any existing wells to be tested.
- For wells to be hydraulically tested, provide (or have provided) the requisite capabilities, including (but not limited to) pump-setting trucks or pulling rigs and crews to install hydraulic testing equipment, "kill" trucks to inflate packers (when required), and

appropriately licensed, authorized, and experienced electrician(s) to wire and hook up pumps (as needed).

- Provide necessary oversight personnel at well sites to allow SNL to conduct well-testing operations on a 24-hr/day, 7-day/week basis, as needed. In turn, SNL will provide to WRES as much advance notice as possible of the need for specific operations outside normal daytime work hours.
- Dispose of any waste water or other waste materials generated during well testing and well reconditioning operations in accordance with all applicable environmental and regulatory standards (including chemical analysis of produced waste water, as appropriate).
- Facilitate compliance with the applicable WIPP Site environment, health, safety, and security requirements as they relate to program activities.
- Participate in water-level and water-chemistry monitoring and data gathering to the degree that SNL and WRES jointly determine is needed.

8.3 Responsibility for Permitting and Licensing

WRES is responsible for ensuring that WIPP-Site activities are conducted in accordance with applicable federal, state, and local regulatory requirements. WRES is responsible for all permitting and licensing requirements associated with drilling, coring, logging, reconditioning, testing, and waste disposal necessary to complete the activities outlined within this test plan. SNL will abide by all of the permitting and licensing rules and regulatory requirements as indicated by WRES. SNL is responsible for ensuring that all contracted experimental work performed by SNL contractors at the WIPP Site meets all applicable federal, state, and local regulatory requirements.

9. REFERENCES

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