NYE COUNTY NUCLEAR WASTE REPOSITORY PROJECT OFFICE

TECHNICAL PROCEDURE

TITLE: VARIABLE SCALE PUMPING TESTS IN UNSCREENED OPEN BOREHOLES OR IN SCREENED BOREHOLES, WITH OR WITHOUT OBSERVATION WELLS	Revision: 1 Date: 02-15-02 Page: 1 of 9
PROCEDURE No.: **TP-9.5**	SUPERSEDES: **Rev. 0, 01-14-99**
APPROVAL Project Manager Date	CONCURRENCE Principal Investigator Date 2/21/02 Project Quality Assurance Officer Date 15 FEB. 2002

1.0 PURPOSE

The purpose of this procedure is to provide general instructions to NWRPO personnel to conduct aquifer testing at conventional boreholes as part of the Aquifer Testing segment of Nye County's Independent Scientific Investigations Program (ISIP). As described in the ISIP aquifer testing plan (WP-4, *Aquifer Testing Plan for Nye County's Independent Scientific Investigations Program*), it is planned to test existing and future Nye County boreholes as well as selected domestic and agricultural water supply wells in Amargosa Valley to quantify hydraulic characteristics of the boreholes and the surrounding aquifers. These test procedures cover both screened boreholes and open-hole completions. Typical tests will involve 48-hr. pump periods with the pumping well and possible observation wells on the same location instrumented. Longer tests, designed to stress the aquifer over a much larger region, may run as long as 6 months and may have several offset observation wells instrumented. The implementation of this procedure ensures that data gathered

during these pump test(s) as part of the Nye County independent scientific investigation program meet NWRPO quality assurance (QA) requirements for scientific data·

2.0 SCOPE

2.1 APPLICABILITY

This procedure applies to the NWRPO principal investigator (PI), NWRPO Scientists/Engineers, and contractors or designated personnel performing the scientific investigation tasks listed in the above section. These individuals shall be referred to herein as NWRPO personnel.

2.2 TRAINING

NWRPO personnel shall be trained before conducting work and shall document that they have read and understand this procedure. Personnel performing the tasks described in this technical procedure shall be professional geoscientists or engineers with applicable previous experience. Personnel performing field calibrations as well as data-collection tasks shall be trained in procedures specifically applicable to the equipment used.

3.0 DEFINITIONS

3.1 Aquifer – Rock or sediment which is partially or fully saturated with water and is sufficiently permeable to transmit quantities of water to wells and springs.

3.2 Aquifer Test – A test made by pumping a well for a set period of time while observing the change in hydraulic head in the aquifer. It is used to determine hydraulic characteristics of the aquifer.

3.3 Drawdown – The difference in the water level before the well was pumped and the water level at a given time after pumping commences in a pumping well.

3.4 Recovery – A the rise in the water level in an aquifer after pumping ceases in a well.

3.5 Specific Capacity - An expression of the productivity of a well, obtained by dividing the rate of discharge of water from the well by the drawdown of the water level in the well.

3.6 Storativity – Volume of water an aquifer releases or takes into storage per unit surface area of the aquifer for an applied unit change in head.

3.7 Transmissivity - A measure of the ability of an aquifer to transmit water through its saturated thickness.

4.0 RESPONSIBILITIES

4.1 The project QA Officer shall be responsible for the coordination of the internal review of this technical procedure.

4.2 The Nye County On-Site Geotechnical Representative will designate a Principal Investigator (PI) to oversee all aquifer testing activities and an on-site NWRPO Scientist/Engineer to direct aquifer test activities in the field.

4.3 The PI shall be responsible for the preparation and modification of this procedure, preparation of borehole specific testing instructions (test plans) and analysis of the test results.

4.4 The NWRPO Scientist/Engineer will carry out these instructions and supply the PI with the data for analysis and interpretation.

5.0 PROCESS

This procedure controls the activities performed by NWRPO personnel related to aquifer pump testing at designated boreholes as part of the aquifer testing phase of the ISIP. Any deviation from this procedure shall be documented in the Scientific Notebooks. The performance of the tasks specified in this procedure shall be documented in Scientific Notebooks. All documentation shall meet the requirements of QAP-3.2, “Procedures for Documentation of Scientific Investigations.”

5.1 BACKGROUND

As mentioned in Section 3.0, an aquifer pump test is a controlled field experiment to determine hydraulic characteristics of the surrounding aquifer. The standard aquifer test consists of withdrawal or pumping of water from an aquifer and monitoring the effect of that withdrawal on groundwater levels in the aquifer. The aquifer test described in this procedure will involve one pumping well with potentially one or more observation wells. The drawdown in the observation wells and the pumping well is observed and recorded as water is withdrawn from the pumping well. Recovery of water levels in both the observation wells and the pumping wells is also

monitored after withdrawal of water from the pump well has ceased. The duration of the pumping portion of the test will dictate the volume of the aquifer investigated by the test. Both cased and open (uncased) boreholes are covered under this procedure.

5.2 CALIBRATION OF EQUIPMENT

Flow meters utilized during the pumping test should be checked in the field against manual measurements made by the timed-volume method (e.g. with a 55-gallon barrel and a stopwatch). If flow meter measurements are within 5% of manual measurement values, the flow meter shall be considered calibrated. If flow meter measurements do not meet these criteria, the flow meter will be considered out of calibration, and manual barrel and stopwatch methods will be used to monitor flow rates.

It is expected that pumping rates will range from as low as 20 gallons per minute (gpm) to as high as 5,000 gpm. Test rates will ultimately be determined by the formation capability and the discharge permit. Attempts should be made to maintain a steady pumping rate, although with longer aquifer tests, lasting up to 180 days, it may not be possible to maintain a consistent pumping rate for the entire length of the test.

Detailed procedures for the performance and documentation of both field and laboratory calibrations of pressure and temperature probes are contained in TP-9.2, *Instrument Calibration and Collection and Processing of Data from Boreholes*. Additional information is contained in QAP-12.1, *Procedures for Control of Measuring and Testing Equipment*. Care should be taken to document probe serial numbers and calibration status in the Scientific Notebooks. Copies of all calibration files and appropriate metadata are transmitted to the NWRPO QARC upon completion of the test.

5.3 COLLECTION AND RECORDING OF BACKGROUND DATA PRIOR TO COMMENCEMENT OF PUMPING

Prior to testing, background readings of temperature and pressure should be taken in the pumping well and any planned observation wells. Transducers will be installed in the pumping well to record temperature and pressure. The downhole transducer should be selected to optimally cover the anticipated drawdown range, typically from 0 to 250 psi. All adjacent boreholes to be used for observation wells will be completed with the pressure and temperature transducers with appropriate dataloggers. If possible, offset wells will be completed with zonal isolation equipment and multiple data collection intervals. Background pressure and temperature data shall be downloaded from the observation wells through the dedicated borehole dataloggers prior to commencement of the pump test. Procedures for downloading data are detailed in the TP-9.2. The frequency of

recording data in these observation wells will be set to respond to changes in water level as small as 0.05 ft. The pump testing will commence after ensuring that baseline water-level records in all wells are available under non-pumping conditions for a time period equal to the design pumping period or for at least 30 days, whichever is shorter. If non-pumping water level data are not available for at least that period of time, the test interpretation should include an analysis of the effect of potential unobserved trends in the data. For long term aquifer testing (greater than 30 days of pumping) simulation of the pumping will be made to obtain an estimate of the expected ranges of responses in the observation wells before the test is started.

Information concerning the boreholes involved in the testing, including the construction and location of the pumping well and observation wells, should be recorded in the field logbook (i.e. Scientific Notebook) prior to the start of the test. At this time, information concerning the specific pump to be used during the test should also be recorded. Data to be recorded includes:

- Pump data - type of pump, manufacturer, serial number, pump size and rated pumping capacity, pump setting and condition of the pump.

- Motor data - make, type and horsepower.

- Well data - well depth, screened interval, gravel-packed interval, grouted interval, casing type, length and diameter, and any other pertinent information such as distances from observation wells to test well and GPS locations of wells.

5.4 MONITORING OF PUMP AND DISCHARGE SYSTEM INSTALLATION

Monitoring of the pump installation should be performed by Nye County field personnel and depth control recorded on the *NWRPO Tubing and Casing Record*. The depth of the pump and start and stop times of the installation and any problems that arise during installation should be recorded in the Scientific Notebook. The pump test should begin only after the water level in the test well has reached its initial condition after installation of the pump.

In addition, the installation of the discharge system should be supervised or installed by Nye County field personnel. The discharged water pumped during the test should be carried through a pipeline and discharged to a natural drainage downslope of the test well. The discharge system and procedure should be in

accordance with requirements of applicable discharge permit(s). Care should also be taken to ensure that excessive erosion does not occur at the discharge point.

5.5 PUMPING OF TEST WELL

During pumping of the test well the discharge rate should be monitored on a regular basis. Flow metering devices with the capability of totalizing the volume discharged and displaying the current rate should be used at the site. Periodic timed-volume tests (stopwatch and 55 gallon barrel) should be conducted at least hourly during the first day and daily thereafter, to verify the flow meter results and provide backup in case of flow meter failure. All monitoring information should be recorded in the Scientific Notebook. Several types of aquifer tests may be conducted on the test well as part of the aquifer testing plan. Prior to design of the constant rate discharge test, a step-drawdown test may be conducted at the discretion of the PI.

5.5.1 Step-Drawdown Test

The step-drawdown test is used to determine the specific capacity of the well, production volume, well efficiency and the proper sizing of pumps. Four to six pumping discharge rates (up to the maximum of the pump) should be selected. The rates should be spread over the pump's operating range in increments of roughly the same size, e.g. 250, 500, 750, and 1,000 gpm. The pump operator should commence pumping at the minimum rate and the water level changes should be monitored using the pressure transducer previously installed in the test well. Nye County on-site personnel should record the time (in hours: minutes: seconds a.m. or p.m. format), the discharge rate and the pumping level in the Scientific Notebook**.**

5.5.2 Constant Rate Discharge Test

The long-term drawdown monitoring of a well at a constant discharge rate is useful in determining the transmissivity and storativity of the surrounding aquifer. The procedure described below should be followed:

1. Measure the static water level just prior to starting the pump.

2. Begin pumping at the maximum discharge rate and continue for the specified number of days. Tests of new completions will typically run for two days. Long-term aquifer tests may run between 30 and 180 days, with the length of the test at the discretion of the PI. It is important to observe the discharge rate periodically. Site personnel should ensure that the discharge rate remains constant by adjusting the discharge valve on the pump. (Fluctuation in engine RPM will significantly affect pump discharge).

3. Drawdown in the test well and any observation wells should be monitored during pumping through use of pressure transducer(s) and appropriate datalogger(s). If observation wells are not configured with zonal isolation equipment, a single, low-pressure transducer should be installed in the open borehole. The setting depth should be selected such that the combined head due to submergence and atmospheric pressure is slightly below the maximum calibrated pressure for the pressure transducer (typically 30 psia). To supplement the pressure data, measurements of groundwater levels should be obtained as described in TP-9.9, *Measurement of Groundwater Levels*, at appropriate intervals as determined by the NWRPO personnel on site. Barometric pressure should also be monitored during long-term testing.

4. At the conclusion of the testing period, turn the pump off and begin monitoring the water level recovery. Continue monitoring until water levels have recovered back to near their initial static levels.

5.5.3 Recovery Test

At the conclusion of the step-drawdown or constant rate discharge aquifer tests, a recovery test should be performed. The recovery test is useful in evaluating wellbore efficiency and near wellbore aquifer properties. After pumping has ceased, record the time and depths to water. Monitoring should continue until the test well has recovered to near pre-pumping levels, or to a period equivalent to the pumping phase of the test. Analysis should be attempted of any brief recoveries experienced during the pumping portion of the test due to operational events. It is recognized, in this case, the recovery period will not be extended unnecessarily.

6.0 DATA ACQUSITION METHODOLOGY AND LIMITATIONS

Scientific Notebooks should be maintained and data should be collected under this technical procedure and technical procedures TP-9.2, *Instrument Calibration And Collection And Processing Of Data From Boreholes* and TP-9.9, *Measurement Of Groundwater Levels*. All data and associated metadata will be submitted to the NWRPO QARC following the conclusion of the test.

7.0 REFERENCES

All manuals related to the installation and operation of any zonal isolation equipment and instruments in boreholes are maintained at the Nye County Geotechnical Representative's office, including, but not limited to:

- The Westbay® field manual for operation of the MOSDAX® instrument assembly in boreholes.
- Calibration instructions for pressure and temperature probes.
- The zonal isolation completion report for each applicable borehole.

In addition, copies of the following Quality Assurance procedures should be maintained at the test location:

- TP-9.2, *Instrument Calibration and Collection and Processing of Data from Boreholes*
- TP- 9.9, *Measurement of Groundwater Levels*
- TP-9.5, *Variable Scale Pumping Tests in Unscreened Open Boreholes or in Screened Boreholes, with or without Observation Wells*

8.0 RECORDS

Copies of all electronic data files, calibration files, and associated metadata will be transmitted to the NWRPO QARC. The NWRPO will be responsible for maintaining the Scientific Notebooks on the individual wells as required by QAP-3.2, *Procedures for Documentation of Scientific Investigations.*

9.0 ATTACHMENTS

N/A

10.0 TEST CONDITIONS

The appropriateness of the test conditions shall be determined by the PI and field personnel.

11.0 PERSONNEL REQUIREMENTS

There are no specific personnel requirements other than those described in Section 2.2.

12.0 SPECIAL ENVIRONMENTAL TEST/STORAGE CONDITIONS

There are no special requirements for environmental test or storage conditions.

13.0 INSPECTION HOLD POINTS

There are no applicable inspection hold points.

14.0 ACCEPTABLE DETAIL AND ACCURACY LEVELS

Verification of calculations shall be made with a relative error of less than 1 in 1,000.