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SANDIA NATIONAL LABORATORIES
WASTE ISOLATION PILOT PLANT

Analysis Plan for Hydraulic-Test Interpretations

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1. INTRODUCTION AND OBJECTIVES

This Analysis Plan directs the interpretation of hydraulic tests performed in formations at the Waste Isolation Pilot Plant (WIPP) site. Hydraulic tests are performed in support of WIPP compliance activities to provide data needed for generation and defense of conceptual models, and for numerical modeling of groundwater flow and transport. Interpretations of the hydraulic tests will serve as input to models used for compliance decisions related to the performance of the WIPP disposal system.

The objectives of hydraulic-test interpretations are to obtain estimates of some or all of the following hydraulic properties:

- Permeability-thickness product (transmissivity) (all tests);
- Storativity (only tests with observation wells);
- Fracture-matrix storativity ratio (only tests exhibiting double-porosity responses);
- Interporosity flow coefficient (only tests exhibiting double-porosity responses);
- Anisotropy (only tests with three or more observation wells);
- Flow dimension (all tests); and/or
- Formation pore pressure (all tests).

Error/uncertainty in the estimation of these parameters will be assessed directly by the analysis code used (see Section 3).

2. APPROACH

The analytical approach to be followed is well established and has been used on the WIPP project for many years (Beauheim and Roberts, 2004, and Roberts et al., 1999, Chapter 6). The computer code to be used for analysis is nSIGHTS (n-dimensional Statistical Inverse Graphical Hydraulic Test Simulator) v. 2.41. The input to this code consists of some or all of the following:

- transient pressure data;
- transient flow-rate data;
- well radius;

- tubing string radius;
- tested thickness;
- fluid density;
- fluid thermal expansion coefficient;
- test-zone compressibility; and/or
- distance from source well.

3. SOFTWARE LIST

The computer code to be used for the analysis of hydraulic-test data is nSIGHTS v. 2.41 (qualified under NP 19-1) or later (when qualified). The use and qualification of utility codes for such things as barometric and earth-tide corrections to test data will be documented in analysis reports prepared and reviewed for those activities in accordance with NP 9-1. Commercial off-the-shelf spreadsheet programs, such as Excel 2007, and graphing programs, such as Grapher 7.0, may also be used for data manipulation and plotting, again in accordance with NP 9-1.

4. TASKS

The tasks to be performed in connection with a hydraulic-test analysis are the following:

- Assemble data on well completion and location;
- Assemble data relevant to the performance of the test;
- Assemble qualified data files to be used in interpretation;
- Manipulate data files to put in the proper input format for the analysis code(s);
- Plot data in nSIGHTS to evaluate data quality and develop preliminary model conceptualization;
- Using nSIGHTS utilities, perform any corrections that need to be made to the data prior to analysis (e.g., removal of barometric and earth-tidal effects, compensation for packer-pressure or temperature fluctuations, etc.);
- Analyze data with nSIGHTS code to provide "baseline" fit to data;

- Perform perturbation analysis, using a minimum of 500 optimizations, to define structure of fitting parameter space and provide confidence that global minimum has been found—repeat as necessary;
- Produce hardcopy plots of final simulations;
- Make copies of input files and final output files; and
- Prepare analysis package, obtain necessary reviews, and submit to records center.

The principal analysts for hydraulic tests are Richard L. Beauheim (6712), Dale Bowman (6712), and Kris Kuhlman (6712). Pre- and/or post-analysis data processing may be performed by other individuals. Analysis reports documenting the analysis process and results will be prepared, reviewed, and submitted to the WIPP Records Center by the responsible analyst at the completion of each set of related analyses.

5. SPECIAL CONSIDERATIONS

All hydraulic-test analysts must have general training in the theory of hydraulic-test analysis, and specific training in the use of nSIGHTS.

6. APPLICABLE PROCEDURES

All applicable WIPP quality-assurance procedures will be followed for these analyses. Training of personnel will be done in accordance with the requirements of NP 2-1 *Qualification and Training*. Analyses will be performed and documented in accordance with the requirements of NP 9-1 *Analyses*. All software used will meet the requirements of NP 19-1 *Software Requirements*. Data generated using procured and off-the-shelf software will be verified in accordance with the requirements of NP 9-1. The analyses will be reviewed following NP 6-1 *Document Review Process*.

7. REFERENCES

Beauheim, R.L., and R.M. Roberts. 2004. "Well-Test Analysis Techniques Developed for the Waste Isolation Pilot Plant." *Proceedings: 66th EAGE Conference and Exhibition, Paris, France, 7–10 June 2004* (Paper H005). Houten, the Netherlands: European Association of Geoscientists and Engineers. ERMS# 552034.

Roberts, R.M., R.L. Beauheim, and P.S. Domski. 1999. *Hydraulic Testing of Salado Formation Evaporites at the Waste Isolation Pilot Plant Site: Final Report.* SAND98-2537. Albuquerque, NM: Sandia National Laboratories.