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WILLIAMS & ASSOCIATES, INC.

P.O. Box 48, Viola, Idaho 83872 (208) 883-0153 (208) 875-0147

Hydrogeology • Mineral Resources • Waste Management • Geological Engineering • Mine Hydrology

April 20, 1987
Contract No. NRC-02-85-008
Fin No. D-1020
Communication No. 123

Mr. Jeff Pohle
Division of Waste Management
Mail Stop 623-SS
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: SALT

Dear Jeff:

A copy of the review of the following document is enclosed.

1. Stone and Webster Engineering Corp., September 1985, Pumping Test and Fluid Sampling Report, J. Friemel No. 1 Well (PD-9), Palo Duro Basin, Volume I. Prepared for Battelle Memorial Institute, Columbus, OH, ONWI/SUB/85/E512-05000-T31.

Please contact me if you have any questions concerning this review.

Sincerely,

Gerry Winter pl

Gerry V. Winter

GVW:sl

WM-RES
WM Record File D1020
WEA

WM Project 10, 11, 16
Docket No.
PDR ✓
LPDR ✓ (B,N,S)

Distribution:
Pohle

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WMGT DOCUMENT REVIEW SHEET

FILE #:

DOCUMENT #: ONWI/SUB/85/E512-05000-T31

DOCUMENT: Stone and Webster Engineering Corp., September 1985, Pumping Test and Fluid Sampling Report, J. Friemel No. 1 Well (PD-9), Palo Duro Basin, Volume I. Prepared for Battelle Memorial Institute, Columbus, OH, ONWI/SUB/85/E512-05000-T31.

REVIEWER: Williams & Associates, Inc., Terry Waites

DATE REVIEW COMPLETED: April 14, 1987

ABSTRACT OF REVIEW: APPROVED BY: Roy E Williams

The report under review describes pumping test and fluid sampling activities performed at the J. Friemel No. 1 well located in Deaf Smith County. The well is located approximately 35 miles west-southwest of Amarillo, Texas. The J. Friemel No. 1 well was drilled between October 1982 and March 1983. Drilling, coring, logging, and drill stem testing activities are described in a separate report. The total depth of the well is 8,283 feet below the Kelly Bushing. The deepest test zone is the Pennsylvanian Granite Wash. The shallowest test zone is the Queen/Grayburg Formation. Nine zones are being tested in the J. Friemel No. 1 well. A technique to measure vertical hydraulic conductivity was applied to the Permian Wolfcamp Group. Six of the zones are located in the Pennsylvanian System. Instrumented pumping tests occurred at all test zones. Formation fluid samples were collected from the test intervals.

The casing was perforated opposite test zones. Plugs were set above the perforations following completion of each pumping test and fluid sampling activity. The well will be plugged and abandoned in accordance with Texas Railroad Commission requirements.

The report states that a more detailed evaluation of the pumping test data will be reported in later topical reports. These topical reports will evaluate the data using numerical analysis and image well theory (p. 3).

The major difficulties discovered during the review of this document concern the nature of the single well testing techniques. The tests were conducted using a walking beam pump; the tests were all conducted as single well tests. The walking beam pump enables the contractors to produce fluids from the well at very low rates of flow. Unfortunately, this pump creates pressure fluctuations within the pumping well due to the nonconstant rate of discharge. This pumping technique creates difficulties with respect to the evaluation of drawdown data during the pumping phase of testing. Single well test techniques limit the data that are available for quantification of hydrogeologic coefficients.

BRIEF SUMMARY OF DOCUMENT:

The report describes the pumping test and fluid sampling activities performed at the J. Friemel No. 1 well. The well is located in Deaf Smith County, approximately 35 miles west-southwest of Amarillo, Texas. The J. Friemel No. 1 well was drilled between October 1982 and March 1983. A separate report was prepared describing the drilling, coring, logging, and drill stem testing activities in the well. The pumping tests, sampling, and associated activities that are described in the report under review occurred between May 31, 1983, and September 1984.

Nine zones were selected for testing. The zones ranged in depth from 8,204 feet to 1,690 feet. The nine test zones encompassed units from the Queen/Grayburg Formation down to the Pennsylvanian System Granite Wash. Five of the test zones were located in the Pennsylvanian Granite Wash. One test zone was located in the Pennsylvanian carbonate units. Another test zone was located in the Permian Wolfcamp Series. The final two test zones were located in the lower San Andres Unit 4 and the Queen/Grayburg Formation (p. 35).

The test zones were isolated by using packers. A walking beam pump jack with a diesel engine primary driver was used to pump fluid from the test zones. Two different downhole pumping systems were employed. The two pumping systems permitted using a discharge rate ranging from 0.5 to 17 gallons per minute (gpm).

A pressure and temperature monitoring system was used for each test zone. A transducer was used to measure formation pressure and temperature in the test zone; a transducer was used to measure annular fluid pressures and temperature during testing and sampling. The annular transducer was used for detecting leaks across the packer seal or through the tubing sections. The

pressure and temperature signals from the downhole transducers were connected to a portable Hewlett Packard computer system near the well head. Signals were corrected by calibration constants; the signals were then digitized and recorded on a disk (p. 38). Pressure and temperature data also were printed continuously.

The well was completed with a 10-3/4 inch casing string cemented to 4,695 feet. A 5-1/2 inch casing was installed to total depth. Testing was conducted through the 5-1/2 inch casing which was cemented inside the 10-3/4 inch casing for about 200 feet (p. 39). Testing above a depth of 4,695 feet was performed after removing the 5-1/2 inch casing above that depth. Testing was conducted inside the 10-3/4 inch casing above the 4,695-foot depth.

Remedial cementing was required for test zones 6 and 7. The casing was perforated and cement was pumped through the perforations into the areas where a poor cement seal was suspected.

The test zones were perforated by firing explosive shots through the casing with a retrievable hollow carrier gun. Four radial perforations per foot were shot in both the 5-1/2 inch and 10-3/4 inch casings. The test zones were developed by bailing through the tubing. Test zones were sealed using several methods using both bridge plugs and cement plugs.

Drawdown tests were conducted using a constant stroke rate on the pump. The test was continued until the pressure response approached equilibrium (p. 49). Recovery tests were initiated following termination of the drawdown test. Pressure buildup was analyzed for both test zone initial pressure and permeability.

Formation fluids were sampled for both liquid and gas phase analysis (p. 51). Samples for liquid phase analysis were taken from the discharge line between the well head and the storage tank. Samples obtained for gas analysis were collected from an in-situ sampler. The report states (p. 51) that other contractors conducted the geochemical studies; the results are reported in a separate report.

Sodium thiocyanate (Na SCN) was used as a drilling fluid tracer during drilling and coring of the well. Samples were collected from the test zones to indicate a reduction in contamination of natural formation fluids by drilling mud and other well fluids. Samples were collected during pumping tests; SCN^- concentrations were measured in the field. Samples with concentrations below 10 ppm were shipped to the University of Arizona for laboratory analysis.

A second tracer was added to the water used for testing and conditioning of the well after completing test zone 7. Sodium trifluoroacetate (TFA) was added to the water during the injection phase of the vertical well testing (p. 51). The presence of TFA in samples distinguished the injection water from formation water or water contaminated by drilling fluids. The report states that "A wellhead attachment was fabricated to obtain pressurized samples" (p. 52). This statement is somewhat misleading because the wellhead attachment is located at the top of the well where pressures are significantly different than those that are encountered in-situ. A stainless Leutert Subsurface Sampler was used via a wireline to obtain in-situ samples. Samples collected with the Leutert Subsurface Sampler obtained samples at formation pressures and temperatures. These samples were obtained primarily for gas analysis (p. 52). Formation fluids were transferred under pressure from the Leutert Subsurface Sampler to sample bottles. A portable transfer bench was used to effect the transfer.

Results of the formation pressure, permeability, and fluid temperature analyses of the test zones are attached as table 1-3 from the report under review. Detailed discussions on the tests are in Volume II which is not available at this time for review.

The Field Activity Plan and Progress Reports for activities at the J. Friemel No. 1 well are appended to this report. The progress reports are a daily log of activities at the site. The daily reports are very interesting regarding the trials and tribulations of trying to conduct a single well test at the depths and at the flow rates encountered in the Palo Duro Basin. Significant problems were encountered with the monitoring and pumping equipment. The report is also illuminating regarding the difficulties encountered in dealing with local farmers and subcontractors.

SIGNIFICANCE TO NRC WASTE MANAGEMENT PROGRAM:

This report is significant to the program because the J. Friemel No. 1 well is located very close to the proposed repository site in Deaf Smith County, Texas. The report outlines in-situ testing from the Pennsylvanian Granite Wash (deepest unit tested) up to the Queen/Grayburg Formation which is above the lower San Andres Unit 4. The lower San Andres Unit 4 is the target horizon for the repository. This report is also significant because it represents an attempt to measure vertical hydraulic conductivity using single well test techniques. Obtaining values for horizontal hydraulic conductivity and vertical hydraulic conductivity are necessary for the assessment of the suitability of the site with regard to groundwater travel time.

PROBLEMS, DEFICIENCIES OR LIMITATIONS OF REPORT:

No major problems were encountered in reviewing this report. We wish to point out the limitations of conducting single well tests. The data are limited because a separate observation well is not available for monitoring formation pressures during testing. This deficiency limits the areal extent of the values represented by the test data. In addition, the lack of an observation well prohibits the calculation of an accurate value for storage coefficient. Storage coefficient, of course, is not important to steady state flow parameters but is important if an attempt is to be made to calculate transient effects.

The walking beam pump causes erratic pressure fluctuations during the drawdown phase of the test. The fluctuating pressure drawdown is smoothed out during recovery. The low rates of discharge obtained from the well would be difficult to establish with many of the available constant rate discharge pumps. Nevertheless, we believe that an attempt should be made to use such pumps. A constant rate of discharge would increase the value of the drawdown data and reduce uncertainties regarding the calculated values of the hydrogeologic coefficients.

The report states (p. 52) that pressurized samples could be obtained from a wellhead attachment. This statement is misleading because samples obtained at the wellhead are not at in-situ pressures. We acknowledge that the samples are pressurized since they are not discharging to atmospheric pressure. These samples are removed at a pressure which is higher than atmospheric pressure, but less than the in-situ pressures.