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

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

Re: SALT

Dear Jeff:

We have enclosed a copy of our reviews of two documents. These documents are entitled "Analytical Study of the Ogallala Aquifer in Deaf Smith County, Texas" and "Interpretation of Pressure-Depth Data from Confined Underpressured Aquifers Exemplified by the Deep-Basin Brine Aquifer, Palo Duro Basin, Texas." Please call if you have any questions concerning our reviews.

Sincerely,

Jeff Brown

WMGT DOCUMENT REVIEW SHEET

FILE #:

DOCUMENT: Interpretation of Pressure-Depth Data from Confined Underpressured Aquifers Exemplified By the Deep-Basin Brine Aquifer, Palo Duro Basin, Texas: Orr, E.D. and Kreitler, C.W., April 1985, Water Resources Research, vol. 21, no. 4.

REVIEWER: Williams & Associates, Inc.

DATE REVIEW COMPLETED: November 1985

BRIEF SUMMARY OF DOCUMENT: DATE APPROVED:

The report under review describes the work conducted by the Texas Bureau of Economic Geology. The report under review describes the investigations of underpressured aquifers in the Palo Duro Basin.

Downhole pressure data are plotted and evaluated with respect to hydrogeologic setting, which includes surface topography, structural dip of the aquifer, and potentiometric surface. The report defines the key terms.

Hydrostatic refers to a pressure-depth gradient which can be represented by a fresh water pressure-depth gradient of 0.433 psi/ft. The hydrostatic gradient varies as the density of the water varies. The existence of hydrostatic gradient implies boundary conditions which cause either no flow or only horizontal flow in a ground water flow system.

Underpressured conditions refer to a sequence of hydrostratigraphic units wherein pressures at depth are less than those that would be expected in a hydrostatically pressured aquifer in the same region: the pressure-depth trend is shifted away from the hydrostatic pressure vs. depth curves toward lower pressures by an amount that can be attributed to topographic effects. These effects occur because the land surface is the datum for the depth measurements. The possibility that vertical flow may occur is indicated by pressure-depth gradients that are greater than or less than the hydrostatic gradient.

Depressured refers to values of pressure or hydraulic head which may result from production of oil or gas in the vicinity. Under depressured conditions the pressures are

lower than hydrostatic due to outside influences other than natural influences.

The report under review discusses the quality and nature of the data base. There are 466 drill stem test (DST) measurements from 276 petroleum exploration wells in the Palo Duro Basin. The data were obtained from Petroleum Information Services. The data were grouped into three classes (A, B, or C). Category A contains the highest quality data for which both initial and final shut-in pressures were available; these pressures are within 10 percent of each other. Category B contains tests in which the initial and shut-in pressures differ by more than 10 percent. Category C designates those data which did not include initial or final shut-in pressures. Data obtained from counties along the Matador Arch were eliminated. These data were eliminated due to the production of oil and gas from the units of interest. Production is assumed to yield depressured data in this area.

The data were compiled in a figure which designates areas of downward, "parallel", and upward flow in the "deep basin brine aquifer." Only the northeastern corner of the county had data available for interpretation in the report under review. This designation is based on the pressure depth relationships as noted above. Deaf Smith County includes both downward flow and "parallel" flow in the "deep basin brine aquifer."

The report under review reaches several conclusions. The report under review concludes that poor data can distort the pressure depth plots. Surface topography, structural dip of the aquifer, and potentiometric surface may distort the pressure-depth plots also. Calculating pressure-depth data for theoretical flow conditions permits a more accurate interpretation of the hydraulic gradient and the potential for vertical flow. The authors of the report conclude that the potential for vertical flow varies across the Palo Duro Basin.

SIGNIFICANCE TO NRC WASTE MANAGEMENT PROGRAM:

This document is significant due to its importance with respect to the direction of ground water flow in the Palo Duro Basin and specifically the Deaf Smith County Salt Repository Project Site. The data indicate that the site may be an area of parallel (horizontal) or downward flow in the deep basin brine aquifer. It should be noted that the report under review states (p. 543) that "local permeability variations may cause vertical deflections of ground water." The direction of groundwater movement is important to the Waste Management Program because it is required for determination of ground water movement rates toward the accessible environment.

PROBLEMS, DEFICIENCIES OR LIMITATIONS OF REPORT:

The title of the document probably is inappropriate. It appears that the term "Deep Basin Brine Aquifer" is ambiguous and inconsistent. Aquifer usually refers to a rock unit with no implication pertaining to water quality. We presume the term as used herein proposes to lump all the units below the top of the Wolfcamp Series into one aquifer.

We have minor comments with respect to the report under review. The Class B category for pressure-depth data appears to us to be a wide-open category. We do not object to the A, B, C classification but the B category requires only that initial and final pressure measurements have been made. Apparently the values do not need to reflect any degree of accuracy or precision. This comment applies to the C category data also.

The report under review states that the pumping test values from "four hydrostratigraphic wells drilled by Stone and Webster Engineering Corporation for DOE" can be used to compare with data from other nearby DSTs. Information about the DOE wells was not included in the report under review. The report under review does not compare the data used in the report to the "so-called high quality" data. It would be useful to see such a comparison. The data in the report under review were not compared to other sources of data.

SUGGESTED FOLLOW-UP ACTIVITIES:

We suggest that Texas Bureau of Economic Geology be contacted to obtain the comparison of the "high quality" data from the DOE test wells as compared to the DST data used in the report under review.

WMGT DOCUMENT REVIEW SHEET

FILE #:

TEXAS WATER DEVELOPMENT BOARD REPORT #: 213

DOCUMENT: Analytical Study of the Ogallala Aquifer in the Deaf Smith County, Texas: Wyatt, A.W., Bell, A.E., and Morrison, S., May 1977, Texas Water Development Board Report No. 213

REVIEWER: Williams & Associates, Inc.

DATE REVIEW COMPLETED: December 1985

BRIEF SUMMARY OF DOCUMENT: DATE APPROVED:

The report under review was prepared as part of a series of county wide studies to illustrate "to the High Plains water users that the ground-water supply is being depleted." The report is largely nontechnical and, as a result, this review contains little discussion of the usual technical topics.

The principal purpose of the report under review is to quantify the depletion of the ground water resource in the Ogallala aquifer. The report addresses the following questions (pp. 2-3).

"1. Question: How much water is in storage under any given tract of land in the county and what is expected to happen to this water in the future?"

"2. Question: What can be expected to happen to well yields if the saturated thickness diminishes as illustrated by the map."

"3. Question: With energy cost increasing, pumping lifts (pumping levels) are becoming more and more important. What are the estimates of current pumping lifts and what are they expected to be in the future?"

"4. Question: If an all-out effort is made to conserve ground-water resources, how can landowners and water users determine how they are doing compared to the projections in the study?"

The report under review presents a brief summary of the general geology of the Ogallala aquifer. "The upper part of the formation contains several hard, caliche-cemented, erosionally resistant beds called the "caprock". A wind-blown cover of fine silt, sand and soil overlies the caprock." According to the report the Ogallala aquifer overlies Triassic and Cretaceous age rocks of lower permeability. The general land surface and the pre-Ogallala topographic surface dip about 10 feet per mile to the southeast.

The Ogallala is divided into two areas separated by the Canadian River. Erosion has removed much of the Ogallala to the east of Deaf Smith County and to the west in New Mexico. Recharge to the Ogallala is dependent on local rainfall. The Southern High Plains is relatively flat and stands above adjacent areas; the Southern High Plains "is hydraulically independent of adjacent areas." Ground water derived from the Ogallala is not being replenished at a rate that precludes mining of the resource.

The coefficient of storage of the Ogallala is assumed to be an average of 15 percent over the study area. The report under review states that "the coefficient of storage is nearly equal to the specific yield ..." The 15 percent value was selected "based on past studies and the results of numerous aquifer tests published in Water Development Board Report 98 (Myers, 1969)." This value for storage coefficient was used for subsequent calculations of the volume of water in storage based on saturated thickness.

The report under review discusses the possible rates of recharge to the Ogallala. The report cites several references which give estimates of recharge of a fraction of an inch, of less than half an inch, and of 0.8 inches per year. The authors of the report state that they believe that the possibilities for recharge from precipitation may be greater than that noted by earlier investigators "due to changes in the soil and land surface that have accompanied large-scale irrigation development in the county."

The report under review projects the depletion of the saturated thickness based on historic water level data. The data base for the report consists of measurements of the depth to water below land surface, dates for the measurements, and the depth from land surface to the base of the Ogallala aquifer. The county is divided into areas of equivalent saturated thickness based on 20 foot increments. Water-use patterns were developed by calculating the average water-level declines from 1960 to 1972; water-use patterns were used for developing an aquifer depletion schedule. Average annual water-level declines were calculated for 10 to 20 ft ranges in saturated thickness for the 1960 to 1972 period. Saturated thickness ranges from 0 to 280 ft; the

corresponding range in average annual water-level declines is 0 to 3.90 ft. A "computer program was written to calculate future saturated thickness at individual well sites." Future saturated thicknesses are projected for the period of interest using the "estimated saturated thickness" map (p. 13) for 1974 and the average annual water-level decline (1960-1972). The approximate volume of water in storage was calculated using the aforementioned map and the coefficient of storage previously noted at 15 percent.

Current pumpage was estimated by calculating the storage capacity of the dewatered section of the Ogallala aquifer as reflected in changes in the annual depth-to-water measurements. The report under review also estimates well yields based on saturated thickness. The basis for the estimated well yields was not presented. Well yields from the Ogallala aquifer in Deaf Smith County are quite variable (less than 100 gpm to over 1,000 gpm) based on the information presented in the report. Factors for natural recharge and irrigation recirculation were assumed to obtain more realistic pumpage estimates. The report under review presents water level decline maps for the aquifer for the years considered; projections in the report are made for the years 1974, 1980, 1990, 2000, 2010, and 2020. These maps were used to project pumping lifts. Several simplifying assumptions were made to enable the calculation of pumping lifts in the future. The pumping lifts calculated in the report under review are presented as a series of figures.

The projected saturated thickness at the Deaf Smith County Repository Site was approximately 100 feet in 1980 (closest projection to current time). The projected saturated thickness in the year 2020 is only 25 feet. The projected potential well yield of the Ogallala at the site in the year 1980 is over 1,000 gpm. This projected potential well yield has decreased to 100 to 250 gpm in the year 2020. Pumping lifts at the site are projected for 1980 to be approximately 300 feet. Projected pumping lifts for the year 2020 are approximately 350 feet. Projected rates of water-level decline at this site are approximately 3 feet for the year 1980. The projected rates of water-level decline decrease to 0.75 feet in the year 2020.

SIGNIFICANCE TO NRC WASTE MANAGEMENT PROGRAM:

This document is important to the waste management program for two reasons. First, well yields and available water in the Ogallala aquifer will decline significantly through the year 2020 based on the projections presented in the report. Second, the use of the Ogallala aquifer is assumed to continue at a significant rate through 2020.

PROBLEMS, DEFICIENCIES, OR LIMITATIONS OF REPORT:

The report under review makes several simplifying assumptions. Specifically, the report states (page 81) that "The amount of precipitation which fell just prior to and during the growing season was subtracted from the total water demand estimate. The difference between these values should equal that amount which would have been supplied by irrigation, which will be referred to as irrigation makeup water." We question the efficacy of using this approach. Spray irrigation is notably inefficient. Pumpage from the aquifer must be significantly greater than the crop water demand due to the high loss of moisture to evaporation and transpiration in spray irrigation techniques. The report under review proceeds to calculate "that amount which would have been supplied by irrigatiion" (pumpage) based on water level changes (declines) in the Ogallala. We also are concerned that the approach of using water level declines to calculate pumpage may be much more inaccurate than other approaches. It is not clear to us that irrigation inefficiencies and the method used to calculate pumpage are compatible. The report under review compares the volume of water pumped based on crop demand and water level declines. The volume of water pumped calculated from water-level declines is always less than the volume calculated from crop demands.

The report under review states on page 8 that "This difference was attributed to irrigation recirculation and natural recharge." We wish to point out that this difference may be due to using too low a storage coefficient (15 percent). The use of a higher storage coefficient will result in the calculation of a higher volume of water pumped.

SUGGESTED FOLLOW-UP ACTIVITY:

We do not suggest any follow-up activity.