OXY USA Inc.
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January 10, 2000

Mr. Mark Ashley, Hearing Examiner
New Mexico Oil Conservation Division
P. O. Box 6429
Santa Fe, NM 87505

Re: **Case 12265, Application of OXY USA Inc. for Salt Water Disposal, Government AB Lease, Well No. 9, Old Millman Ranch (Bone Springs) Associated Pool, Eddy County, NM.**

Dear Mark:

Per your request I have investigated Oklahoma's approach to "Area of Review" calculations and the Matthews & Russell pressure buildup equations contained in a technical report obtained from the Texas Railroad Commission. The attached graph illustrates the results of my calculations, and shows the pressure increase resulting from realistic injection rates to be less than 1000 psi. at the two problem wells. Following is a discussion of the method I used to apply this analysis to our proposed injection into the Government AB-9 well.

The Matthews & Russell equation for pressure buildup resulting from a constant injection rate is the same equation used by Oklahoma in their "Radius of Endangerment" calculations for injection well applications, so my analysis of our situation mirrors Oklahoma's approach. Prior to using a particular equation for a given situation, I like to examine the underlying assumptions of such calculations to get a handle of the quality of the results. The critical assumptions are detailed in the technical report from the Texas Railroad Commission. The equations assume that the reservoir is already filled with a fluid of small compressibility when injection begins. When the first barrel is injected, the pressure effects are then transmitted immediately throughout the reservoir. That will not be the case when we start injecting into the Government AB #9 wellbore because production has depleted the drainage area of this well and allowed the pore space to become partially filled with gas, a highly compressible fluid. When the injected fluid fills up this gas saturated pore space (i.e., fillup is achieved), then this assumption will be more valid. Until then, higher injection rates and/or lower surface pressures are to be expected.

As I understand it, these calculations are used to identify the appropriate size of the AOR (Area of Review) when the OCC considers UIC applications for injection or disposal wells. Their maximum size of the AOR is ¼ mile, considerable less than New Mexico's standard ½ mile. It appears that the purpose of this calculation is to identify existing or plugged wells with usable-quality water zones (i.e., "problem wells") in direct communication with the proposed injection zone. As you know, such is not the case for our application to inject into the Government AB-9 wellbore. In our case, all wells within ½ mile radius have the fresh water protected behind 2 strings of pipe cemented to surface. Interestingly, the OCC does provide, although reluctantly, an option for an operator to monitor the pressure behind the deepest casing set in the well when problem wells are found within the Radius of Endangerment. Although we have no wells with exposed usable-quality water zones within our ½ mile AOR, that approach is similar to our proposed monitoring program for the two wellbores of concern.

Using the Matthews & Russell equation I calculated the height of the fluid column during injection operations following the "Radius of Endangerment" calculations described in the Oklahoma Corporation Commission's guide entitled *1997 Operator's Guide to Filing UIC Applications and Reports*. The results

are shown graphically on the attached plot. The locations of our two "problem" wells are shown on the X-axis of the graph. I started out with two assumptions for permeability, 1.0 millidarcies and 0.5 millidarcies, and created three lines for each showing the fluid column after 1 year, 2 years and 5 years of injection. These are labeled Case 1 and Case 2. It became obvious that the surface pressures required to inject 1000 BPD of water through rock with these low permeabilities was too great (in excess of 7000 psi.), and far exceeded anticipated limits. By reducing the radius to near-wellbore, we can approximate the surface injection pressure required to cause the calculated pressure increases at the greater distances. This calculated surface injection pressure also gives us a reality check on the ability to actually inject at the assumed rate, given the reservoir parameters used in the calculations. I estimated that a normal maximum injection pressure for our AB-9 well would be 0.2 psi/ft X depth, or 1260 psi. The hydrostatic pressure of a column of injection fluid is .494 psi/ft X 6300 feet, or 3112 psi. To be conservative as possible, let us assume that the maximum injection pressure on the AB-9 was increased to 2000 psi due to step-rate testing. So the total injection pressure at the perfs would be 2000 psi + 3112 psi, or 5112 psi. Converting to feet by dividing by .494 psi/ft (to compare to our ZOE calculations), we have a maximum height of 10356 feet. See Case 3. Since this is considerably lower than previously-calculated values, it tells us that it will be impossible to sustain injection rates as high as 1000 BPD after reservoir fill-up occurs (and maybe even before), so our ROE calculations @ 1000 BPD are unrealistically high. Working backward with a maximum injection pressure of 5112 psi allows us to estimate the injection rate. This near-wellbore pressure equates to an injection rate of 241 BPD (@0.5 md, t=5yrs) or 463 BPD (@1.0 md, t=5yrs). At 1000 feet from the wellbore, the pressure differential has declined to 718 psi (for the 241 BPD case) and 901 psi (for the 463 BPD case). I feel that Case 3 more accurately depicts our situation once reservoir fillup has occurred. In fact, we hope that's the case. It is entirely possible, as I testified in the hearing, that we would be unable to pump even a couple hundred barrels per day into the Government AB-9 once reservoir voidage has been replaced.

The OCC guide also states that EOR projects enjoy a distinct advantage over salt-water disposal projects because production is occurring from the same zone you are injecting into. If successful, our proposed injection into the Government AB-9 will be an EOR project that will stimulate production and increase reservoir withdrawals in the area affected by the injection. It is our intention to keep the reservoir pressure in the Bone Springs wells affected by such injection to a minimum by keeping them pumped off. If it is unsuccessful, then the reservoir pressure will not be affected much.

For completeness I have included an EXCEL spreadsheet used to generate the plot. I have also included a sheet entitled "Variables" to further explain the values used in the equation. Regarding your other request for more specifics about our proposal, I elected to use Exhibit #11 from the hearing to expand on the details. Behind that is a proposed form that we can use to record and report our observations. I know you and Lori will probably have some questions - that's why I wanted to get this to you before we sit down and discuss it. Certainly I am at your disposal to refine this analysis after we decide that it meets your needs.

Sincerely,

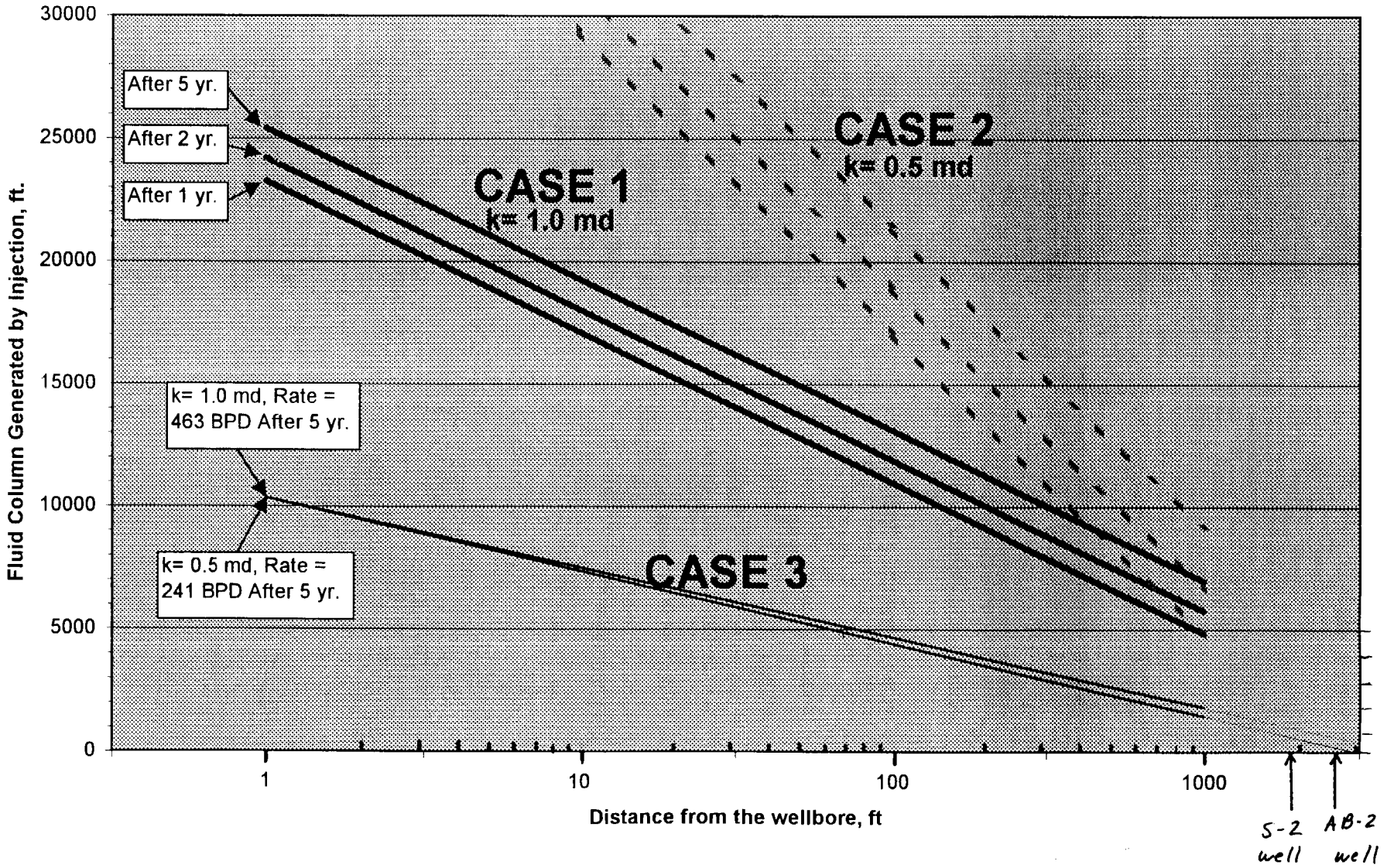
Rick

Richard E. Foppiano, P.E.
Senior Advisor - Regulatory Affairs

REF:ref

CC: Gary Womack, Joe Gibson, David Stewart (OXY, Midland) & Tom Kellahin

Radius of Endangerment Calculations



Case	1	1	1	1	1	1	1	1	1	1	1	1	3	3	3	3
Delta P, psi	9987	6955	3920	887	10444	7410	4377	1343	11047	8014	4980	1947	5112	3710	2306	901
Injection Rate, BPD	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	463	463	463	463
Viscosity, cps	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Permeability, md	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Net Pay Thickness	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2
Injection Time, days	365	365	365	365	730	730	730	730	1825	1825	1825	1825	1825	1825	1825	1825
Porosity	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Compressibility	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06
Distance from wellbore, ft.	1	10	100	1000	1	10	100	1000	1	10	100	1000	1	10	100	1000
Phi-h	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296
Injection Fluid SG	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
Injection Fluid Pressure Gradient, psi/ft	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362
Reservior Pressure, psi	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	0	0	0	0
Height of Fluid due to injection, ft	23271	17129	10980	4836	24197	18050	11906	5759	25418	19274	13128	6983	10356	7516	4672	1825

Case	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
Delta P, psi	19061	12994	6927	860	19974	13907	7840	1773	21181	15114	9047	2980	5112	3643	2180	718
Injection Rate, BPD	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	241	241	241	241
Viscosity, cps	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Permeability, md	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Net Pay Thickness	107 2	107 2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2	107.2
Injection Time, days	365	365	365	365	730	730	730	730	1825	1825	1825	1825	1825	1825	1825	1825
Porosity	0 18	0.18	0 18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Compressibility	7 50E-06	7.50E-06	7.50E-06	7.50E-06	7 50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06	7.50E-06
Distance from wellbore, ft.	1	10	100	1000	1	10	100	1000	1	10	100	1000	1	10	100	1000
Phi-h	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296	19.296
Injection Fluid SG	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
Injection Fluid Pressure Gradient, psi/ft	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362	0.49362
Reservior Pressure, psi	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	0	0	0	0
Height of Fluid due to injection, ft	41653	29363	17072	4781	43503	31212	18921	6631	45948	33657	21367	9076	10356	7380	4416	1455

Variables

Injection Rate:	This is the maximum anticipated injection rate, taken from the C-108 Filing (Exhibit #5).
Viscosity:	The value of 1 cps is used because the injection fluid is water.
Permeability:	As stated in the hearing, this is a very tight reservoir. Since this is a very important number in these calculations, I reviewed the technical data offered by OXY and CHI Energy in the NMOCD Examiner hearing held on 3/2/95 (Case # 10556, Order No. R-5353-M-1) as well as internal reservoir data. Based on this, I feel that the average permeability is somewhere between 0.5 md to 1.0 md., and probably closer to the lower number in the area of the Government AB9 because of the lower porosity in that area of the reservoir.
Net Pay Thickness:	Exhibits 2 and 3 revealed that the product of porosity and new feet of pay (Phi-H) for the Government AB-9 well was 19.3. The assumptions for porosity and net pay thickness in these calculations honor that testimony.
Compressibility:	This is the total compressibility constant for water, 7.5 X 10-6
Distance from wellbore:	Self-explanatory
Injection fluid Specific Gravity:	Taken from water analysis data in the C-108 filed for the Government AB-9, exhibit 5.
Current Reservoir Pressure:	In the aforementioned NMOCD hearing on this field on 3/2/95, it was testified that the original reservoir pressure in this solution gas-drive reservoir was 2345 psi. To date, this reservoir has produced 1,147,279 BO and 25,534,873 MCFG. The oil wells in this field are all on pump and many have declined in productivity and are not far from being commercially depleted. Therefore, I used an optimistic assumption of current reservoir pressure of 1500 psi.

OXY PROPOSAL

Cease disposal into the Bone Springs pool in the Government AB-9 well when any of the following occurs:

1. Water breakthrough in any offset Bone Springs producer located within ½ mile of the well (Government AB-7, AB-8, S-3 or S-7); or

[Production volumes (oil, water gas) on these wells will be monitored by running well tests each month and gauging the tanks frequently at the AB battery and the S battery. The monthly well test data will be reported at the same time as the pressure monitoring data. When water volumes from the well test data on the AB-7, AB-8, S-3 or S-7 wells show +100 BWPD, indicating water breakthrough, injection into the AB-9 will be immediately stopped.]

2. Detection of a significant pressure increase between intermediate and production casings on the Government S-2 or the Government AB-2.

[Install 0-1000# pressure gauges before injection commences, to get baseline readings. Observe and record injection (tubing) and casing/casing annulus pressure once a week. Observe and record injection pressures and injection rate on Government AB-9 once a week. By the 15th of the month following the month in which the pressures are recorded, report all observations to the NMOCD District Office in Artesia. When the casing/casing annulus pressure has increased by at least 250# above baseline on the S-2 or the AB-2, immediately cease all injection into the AB-9.
When injection has been stopped due to any of the above conditions, OXY shall notify the NMOCD District Office in writing.]

AOR Monitoring Report

Old Millman Ranch (Bone Springs) Associated Pool
Eddy County, New Mexico
Re: Order No. _____

Well Tests:

Well Name & Number	*Test Date*	*Oil, BPD*	*Water, BPD**	*Gas, MCFPD*
Government AB 7				
Government AB 8				
Government S 3				
Government S 7				

***Note: Government AB 9 injection well must be shut-in if this value exceeds 100**

Pressure Readings:

Well Name & Number	*Date Readings Taken*	*Pressure between 5 1/2" and Intermediate Casing***
Government S 2		
Government AB 2		

****Note: Government AB 9 injection well must be shut-in if this value exceeds 250# above baseline**

Injection Well Status:

	Date Readings Taken	*Tubing Pressure, psi*	*Injection Rate, BPD*
Government AB 9			

I hereby certify that the above information is true and correct to the best of my knowledge and belief.

Signature

Printed Name

Title

Date & Telephone Number

Send to NMOCD District Office in Artesia before the 15th of the following month. Copy to Rick Foppiano in Houston.