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May 3, 1996

Mr. Pierce L. Chandler, Jr., P.E.
Black & Veatch
5728 LBJ Freeway, Suite 300
Dallas, TX 75240

Dear Mr. Chandler:

During our April 25, 1996 meeting a disagreement arose between Black & Veatch and the New Mexico Environment Department (NMED) regarding the conversion of soil vapor units from mg/m^3 to ppmV. Black & Veatch's position was that the TCE soil-vapor concentration from MW-17 (820 mg/m^3) was "three tenths of one percent" of the level (274 ppmV) that would be expected if equilibrium existed with the aqueous ground-water phase. Black & Veatch used these numbers to conclude that further soil-vapor investigation, and soil-vapor extraction (SVE), were not necessary.

NMED's position was that Black & Veatch had erroneously converted soil-vapor units, and that correct conversion demonstrated that additional vapor investigation was necessary. The meeting ended without the unit-conversion issue being resolved.

Black & Veatch and NMED agreed to provide each other with their calculations. Thank you for your May 1, 1996 fax acknowledging Black & Veatch's error and providing a summary data table. The purposes of this letter are to:

- provide my equations with solutions;

- describe Black & Veatch's apparent error; and

- justify the need for a nested vapor probe investigation.

NMED's Unit Conversion Calculations

At our meeting I stated that, in water, mg/L = ppm. I also stated that, in air, uL/L = ppmV. I provided the following two equations to properly convert mg/m^3 = ug/L to uL/L = ppmV.

Equation 1: $\# \dfrac{ug}{L} \times \dfrac{g}{10^6\ ug} \times \dfrac{mole}{MW\ g} \times \dfrac{V\ L}{mole} \times \dfrac{10^6\ uL}{L} = \dfrac{uL}{L} = ppmV$

Equation 2, the Ideal Gas Law: $PV = nRT$

The following constant and variables can be used for Albuquerque:

R = Ideal Gas Constant = 0.082 atm L/mole/$^{\circ}$K
n = 1 mole
T = temperature = 20 $^{\circ}$C = 293 $^{\circ}$K
P = pressure = 0.83 atm
V = volume (L) of 1 mole of gas at specified T and P
MW = molecular weight = 131.5 g/mole for TCE
\# = soil-vapor concentration = 820 mg/m^3 = 820 ug/L TCE in MW-17

The exact T and P in the soil-vapor laboratory, at the time of analysis, should be used if available. If not, reasonable assumptions can be made to "fine tune" the V calculation.

The Ideal Gas Law is used as follows to solve for V:

$$V = \frac{nRT}{P} = \frac{0.082 \times 293}{0.83} = 28.95 \text{ L}$$

Equation 1 reduces to the following solution for ppmV TCE in MW-17 soil vapor:

$$\frac{820 \times 28.95}{131.5} \frac{uL}{L} = 180.5 \text{ ppmV TCE}$$

Black & Veatch's Apparent Error

It is correct that 820 mg/m^3 = 0.82 mg/L in any medium. It is incorrect that, in soil vapor, 0.82 mg/L = 0.82 ppmV.

Black & Veatch appears to have incorrectly assumed that mg/L in air is equal to ppmV, and divided 0.82 mg/L by 274 ppmV (uL/L) as follows to arrive at 0.003.

$$\frac{0.82 \text{ mg/L}}{274 \text{ uL/L}} = 0.003 \frac{\text{mg}}{\text{uL}}$$

Percentage is a unitless ratio obtained with two numbers having the same units. The value of 0.003 would be three tenths of one percent if the numbers 0.82 and 274 had the same units. Black & Veatch's apparent miscalculation, however, results in 0.003 mg/uL, which is not a unitless percentage.

Justification for Nested Vapor Probe Investigation

Of the three wells containing 1900 ug/L or greater dissolved-phase TCE (MW-17, MW-33 and MW-61), MW-17 is the only well containing

a significant vapor phase. As NMED discussed at our April 25, 1996 meeting, this provides strong evidence that:

- the ground-water solute and soil-vapor TCE phases are not anywhere near equilibrium at the Sparton site; and

- MW-17 is near a vadose-zone source of TCE.

NMED also stated at the meeting that it uses 10 ppmV as a cleanup target to protect ground water from chlorinated-solvent soil vapor in hydrogeologic settings like the Sparton site. Black & Veatch agreed that 10 ppmV was a reasonable cleanup target.

The 180.5 ppmV TCE in MW-17, located near but not in the source area, is far above the 10 ppmV cleanup target. As discussed above, this is strong evidence that a significant amount of TCE remains in the vadose zone in and around the source area. Because of this, and because no soil vapor data were collected in the actual source area, nested vapor probes must be installed in and around the source area to define the magnitude and geometry of the vapor cloud.

It appears that our parallel vapor-concentration conversion calculations are now consistent with each other. I agree with you that, based on available data, significant soil-vapor (> 10 ppmV) has only been found in MW-17 and MW-18 both of which are near the source area. Your observation underscores the need for a nested vapor probe investigation, as discussed above.

After consultation with and concurrence from the other government parties, NMED will provide Sparton with details on vapor-probe nest locations and construction.

Thanks again for your appreciative letter. It was my pleasure to help Black & Veatch identify and solve its P-Chem error.

Sincerely,

Dennis McQuillan
Remediation Manager
Ground Water Quality Bureau

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xc   Mark E. Weidler, Environment Secretary
      Ed Kelley, Director, Water and Waste Management
      Richard Mertz, Chief Counsel
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      Ron Kern, Hazardous and Radioactive Materials Bureau
      Steve Cary, Office of the Natural Resource Trustee
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