

1.34 WASTE CONTAINMENT AND SITE REMEDIATION TECHNOLOGY HOMEWORK 5 – DUE APRIL 13, 2003

Question 1

Attached are maps showing a chemical company at which there has been a past release or releases of volatile organic chemicals including 1,1,1-trichloroethane (1,1,1-TCA), tetrachloroethylene (PCE), trichloroethene (TCE), and benzene, toluene, ethylbenzene and xylene (BTEX) among others.

The site is underlain, from shallow to deep, by sand and gravel, and weathered and limestone bedrock. The bedrock aquifer contains fractures and solution cavities, making it a conductive and productive aquifer. Aquifer tests indicate that the hydraulic conductivity of the aquifer is about 2×10^{-1} cm/sec.

1,1,1-TCA, TCE, and related compounds have been found in the limestone at the MW-7 well cluster in high concentrations, as well as at the MW-3 and MW-6 clusters (see Figure 1 and Table 1). These chemicals have not been found at the MW-8 well cluster. Nonetheless, there is concern that the contaminants could migrate to public water supply wells 14 and 16, which are located in Tibbets Park south of the site (see Figure 2).

You can assume that the source of the contaminants is the tank farm northeast of MW-7. (Note that north is to the left in Figure 1.) The tank farm is shaded in Figure 1 and labeled "Former Tank Containment Area." Eye witnesses report an above-ground storage tank ruptured in 1978 in the tank farm and that is a possible source of contamination as well as day-to-day operations. You can assume the subsurface extent of the source area is 50 feet wide and 50 feet thick.

- a) Determine the hydraulic gradient from the site to the supply wells based on the December 1999 water-level measurements in Figure 2. (1 points)
- b) What would be an appropriate retardation factor for these chemicals in fractured limestone bedrock with negligible organic content? (2 points)
- c) The chemical concentrations shown in Table 1 were observed in these wells in December 1997. Use the BIOCHLOR model to estimate first-order degradation coefficients for TCA and PCE degradation based on these field data. (Be realistic in the amount of time you spend in trying to fit the model to the data—start with the BIOCHLOR default values and vary coefficients around that starting point, but you can limit your time to about a half-hour in trying to get a good fit!) How well does a first-order assumption fit the field data? Provide printouts of your BIOCHLOR output. (4 points)

You can run the BIOCHLOR model on CEE net computers. The model is available as an Excel spreadsheet in the courses folders under 1.34\BIOCHLOR. Alternatively, you can download the model for free from the Air Force Center for Environmental Excellence web site and install it on your own PC. You need Microsoft Excel to run the program. A link is available on the course 1.34 web site.

- d) Based on the information provided, provide a conceptual model of contaminant fate and transport at this site. You should evaluate physical, chemical, and microbiological processes affecting the chemicals, and distinguish the near-source zone from the downgradient zone. Suggest an explanation for the BTEX constituents in MW-8C. Is there a threat to the public supply wells? (3 points)

Table 1
Observed chemical concentrations in bedrock monitoring wells – December 1997

Chemical	Concentration in well MW-7A (µg/L)	Concentration in well MW-3B (µg/L)	Concentration in well MW-6B (µg/L)	Concentration in well MW-8C (µg/L)
PCE	3,990	1,670	612	<1
TCE	13,900	1,160	36.9	<1
cis-1,2-DCE	<2000	5,180	38.8	<1
trans-1,2-DCE	<2000	<100	<1	<1
1,1-DCE	4,860	3,270	54.1	<1
vinyl chloride	<2000	<100	<1.0	<1
1,1,1-TCA	185,000	40,900	612	<1
1,1-DCA	<2000	565	8.7	<1
chloroethane	<8000	<400	<4.0	<1
benzene	<1000	<50	<0.5	1.2
toluene	<2000	130	<1	1.4
ethylbenzene	<2000	243	<1	<1
xylenes (total)	<6000	890	<3	<1
MEK	<20,000	<1000	<10	<1

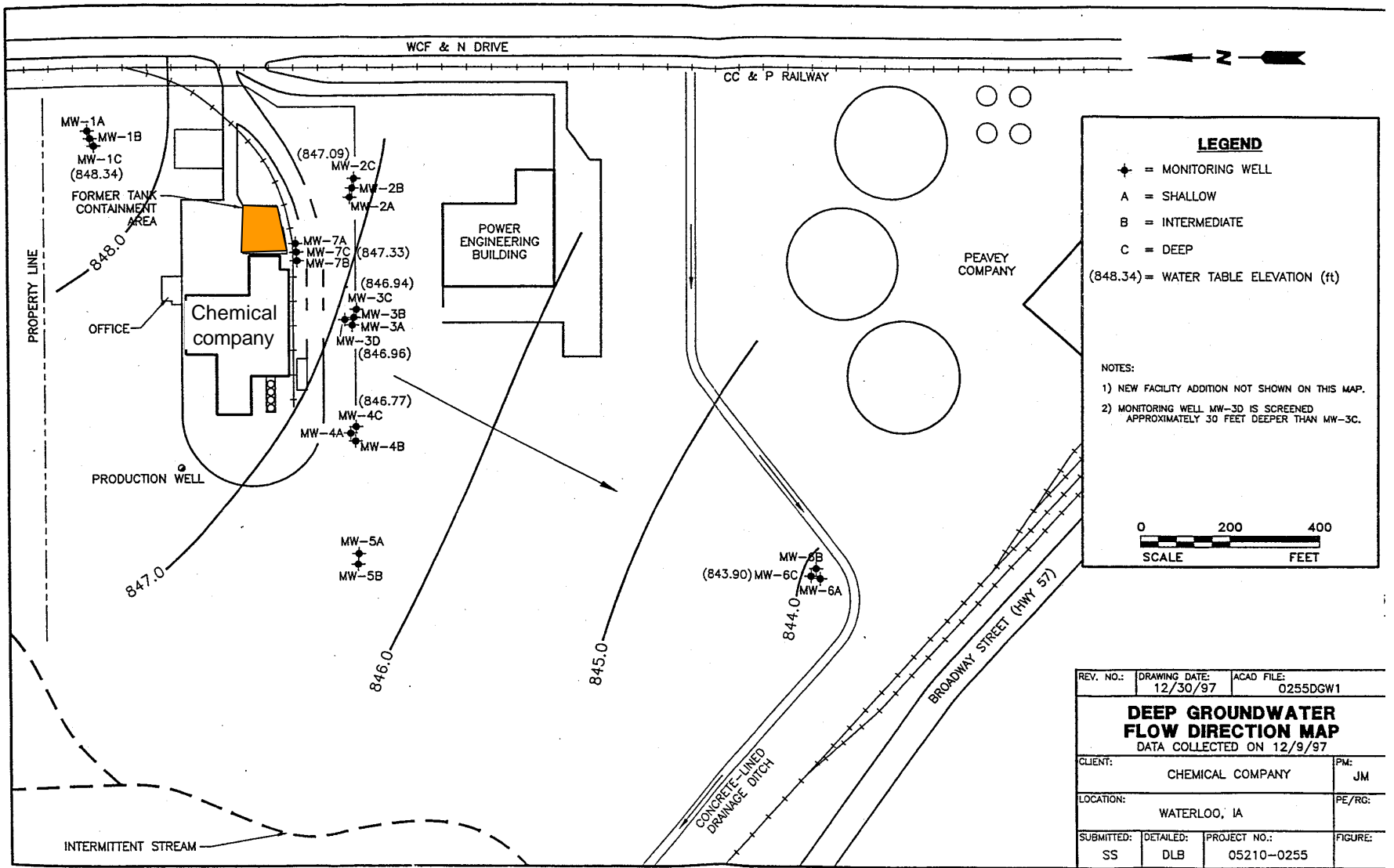


Figure 1 – Chemical company site area

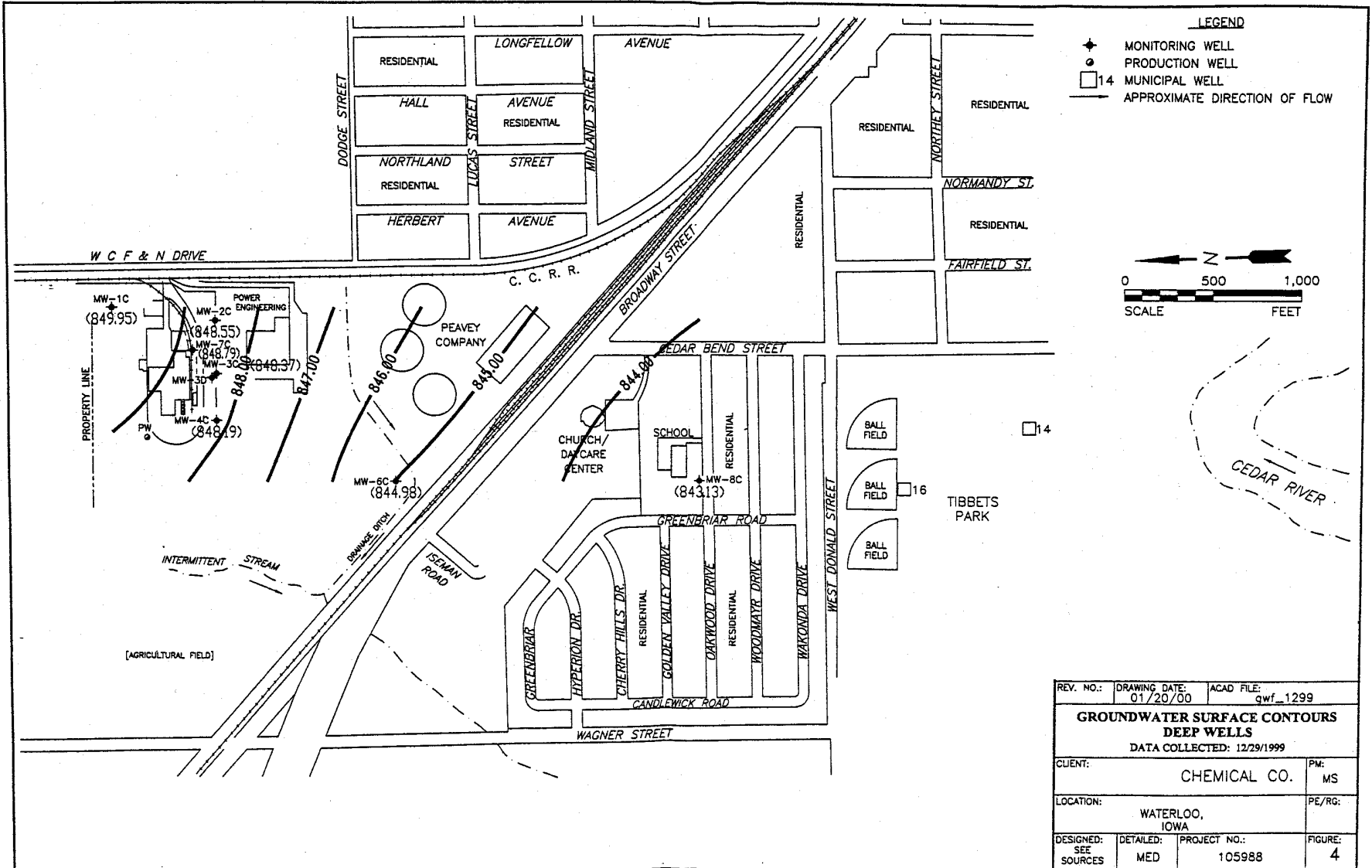


Figure 2 – Chemical company off-site area