Homework 6: Well Test Analysis Using Aqtesolv
GEOS 4430 - Fall '11

Due: Nov. 29th, graded items indicated by "⇒" in left margin.

1 Introduction

This homework is intended to give you some experience in consulting-style aquifer analysis problems. The basic setting is a small aquifer (Quaternary alluvium) resting in a impermeable bedrock (Cretaceous shale) valley (Fig. 1). A small town uses the aquifer for 60% of its treated water supplies, and various small contaminant plumes are affecting the water quality. This study is aimed at designing a pump-and-treat system for a tetracholorethene (PCE) plume (Fig. 2). A *recovery well* (CH-RW-1) has been installed by your company, with the aim of removing as much of the high-PCE-concentration as possible, for treatment at the surface in an *air-stripper* (evaporator). Today's exercise is to determine the appropriate pumping rate for the recovery well, and to estimate aquifer properties from the pump test results (drawdown vs. time data).

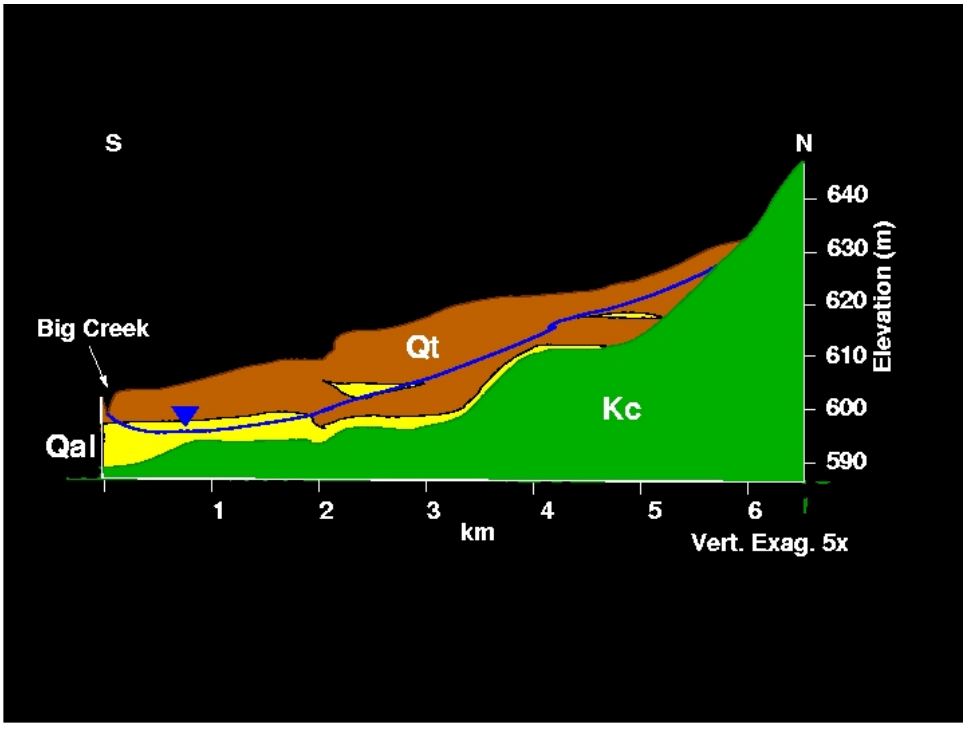

Figure 1: Cross-stream geologic section, Hays, KS. Line oriented north-south along Vine St. (bold horizontal street shown in Fig. 2). After *Latta* [1948].

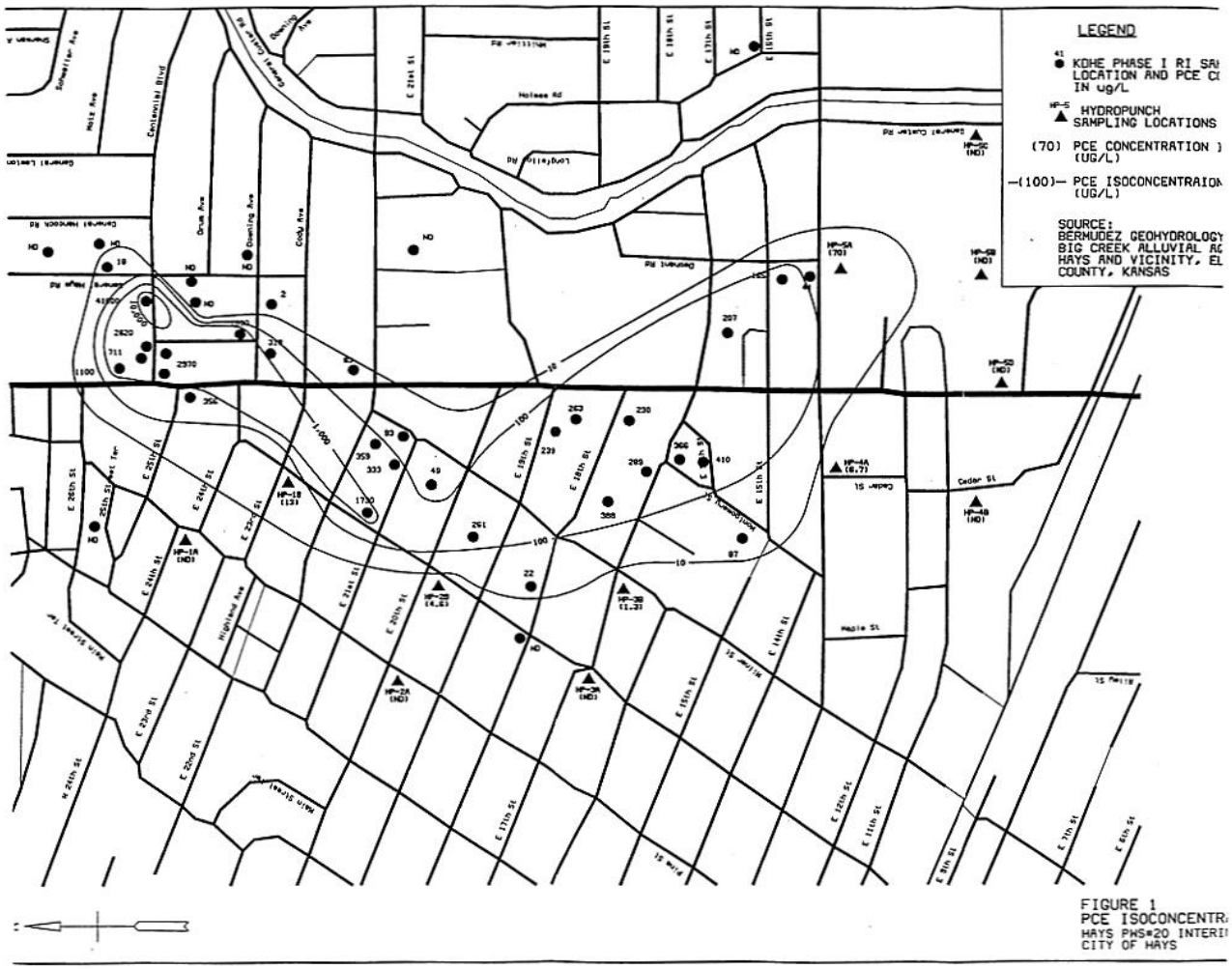

Figure 2: Map of PCE distribution. Contours show PCE concentration in ppb. EPA maximum contaminant level (MCL) for PCE in drinking water is 5 ppb. Recovery well CH-RW1 is inside the inner (10,000 ppb) contour, observation/monitoring wells not shown.

1.1 Hydrogeology

The alluvial aquifer is made up of two lithologies, a high-conductivity sand-gravel member (Qal) representing meandering stream channel fill, and a low-conductivity silt-clay member (Qt) representing overbank deposits. The lithologies are distributed somewhat randomly, although Qal is concentrated at the bottom of the alluvial fill, and toward the center of the valley (Fig. 1).

Well logs are included at the end of this lab for the two wells installed by your company: CH-RW1 located adjacent to the original PCE source (a dry-cleaners, Fig. 2), and an observation well CH-OW1 located 23 feet to the west. Use these logs to help interpret the differences between well test results. Note that the well CH-RW1 encountered approximately 45 feet of silt/clay (Qt), underlain by 15 feet of sand (Qal), and stopped in bedrock Cretaceous clay (Kc) at a depth of 59 feet (Figs. 3–4). Well CH-OW1 encountered bedrock at 58.5 feet, overlain by 3 feet of sand (Qal), with Qt silt/clay above that. Logs are unavailable for LMW-10. Assume all wells have 11 feet of saturated thickness.

The well design for both wells is similar, see Figure 5.

2 Homework Assignment

1. Use the step-drawdown test results (Fig. 6) to determine the appropriate pumping rate for a continuous PCE recovery system. What is that rate?

2. Well-Test Analysis (what you type/enter is shown in `brown`)
   (a) Install Aqtesolv demo software from HydroSolve Inc.[1] or textbook CD-ROM, which allows printing but has few solution options. With new version you'll need a screendump facility (i.e. PrintScreen button, and paste captured image into Word or other editor)
   (b) Take Guided Tour
      i. select `Help/Pumping Test Example`
      ii. follow the instructions, beginning with select `File/New/Guided Tour`
   (c) Download input files, available as a zipfile on the class website[2]
⇒ (d) Estimate T using specific capacity ($\frac{Q}{s}$, Fig. 6 from step-drawdown test (easiest may be to use this online calculator
   (e) Using Aqtesolv
      i. run Aqtesolv
      ii. Load appropriate files (see item 2f below). This version of Aqtesolv allows only one observation well, so you'll need to

[1] `http://www.aqtesolv.com/demo.htm`

[2] `http://www.utdallas.edu/~brikowi/Teaching/Hydrogeology/Homework/hays_aqtesolv.zip`

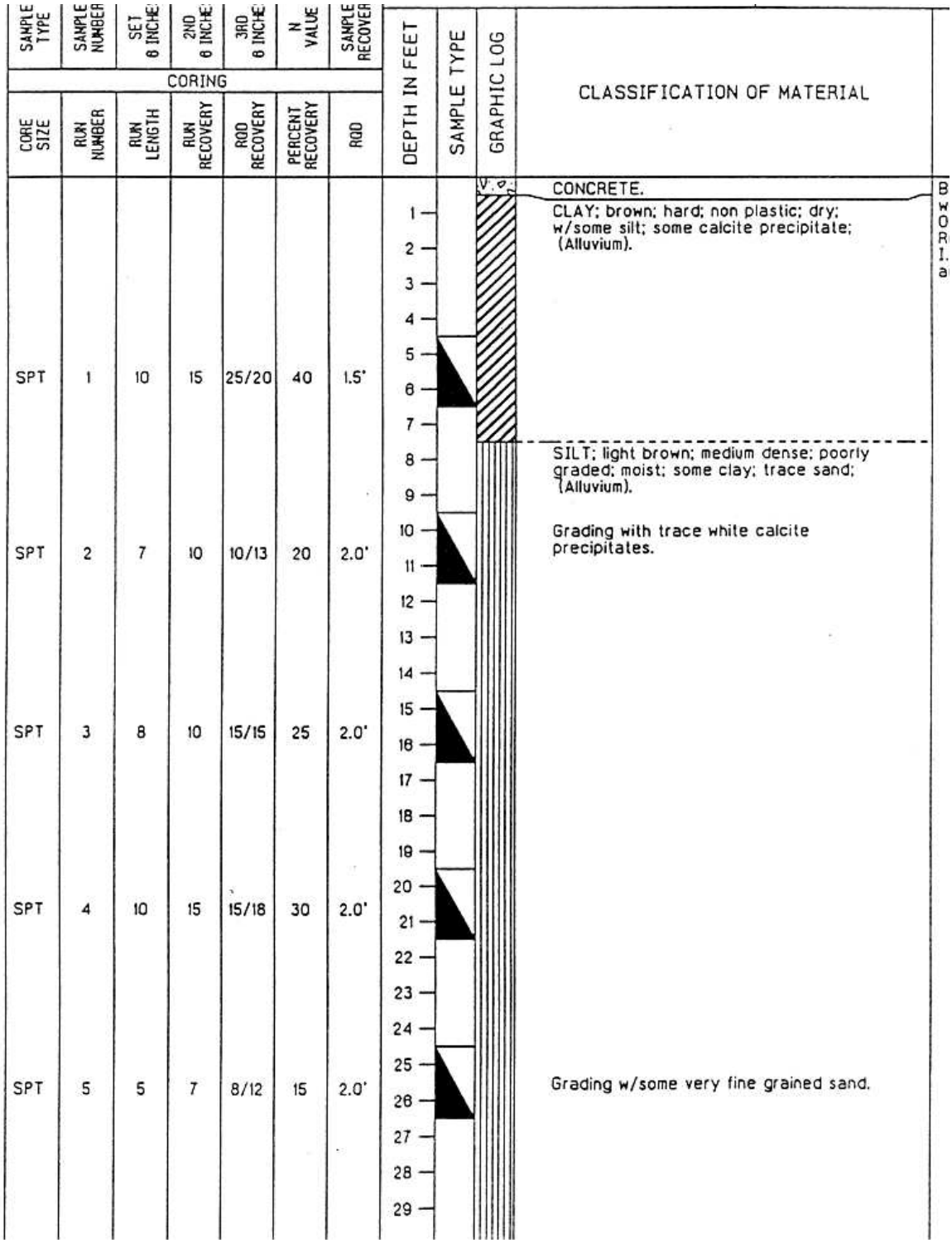

Figure 3: Upper portion of lithologic log for well CH-RW1.

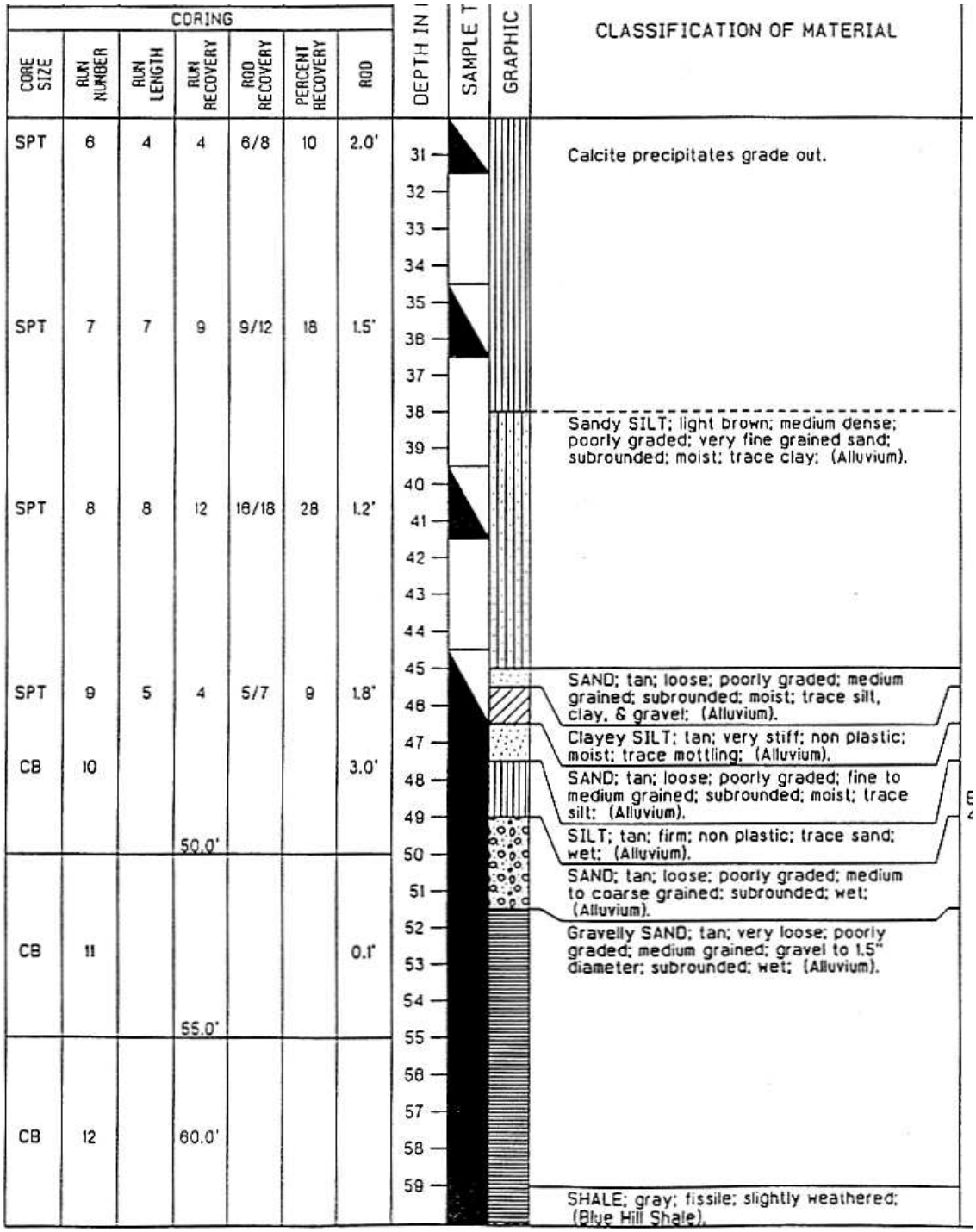

Figure 4: Lower portion of lithologic log for well CH-RW1.

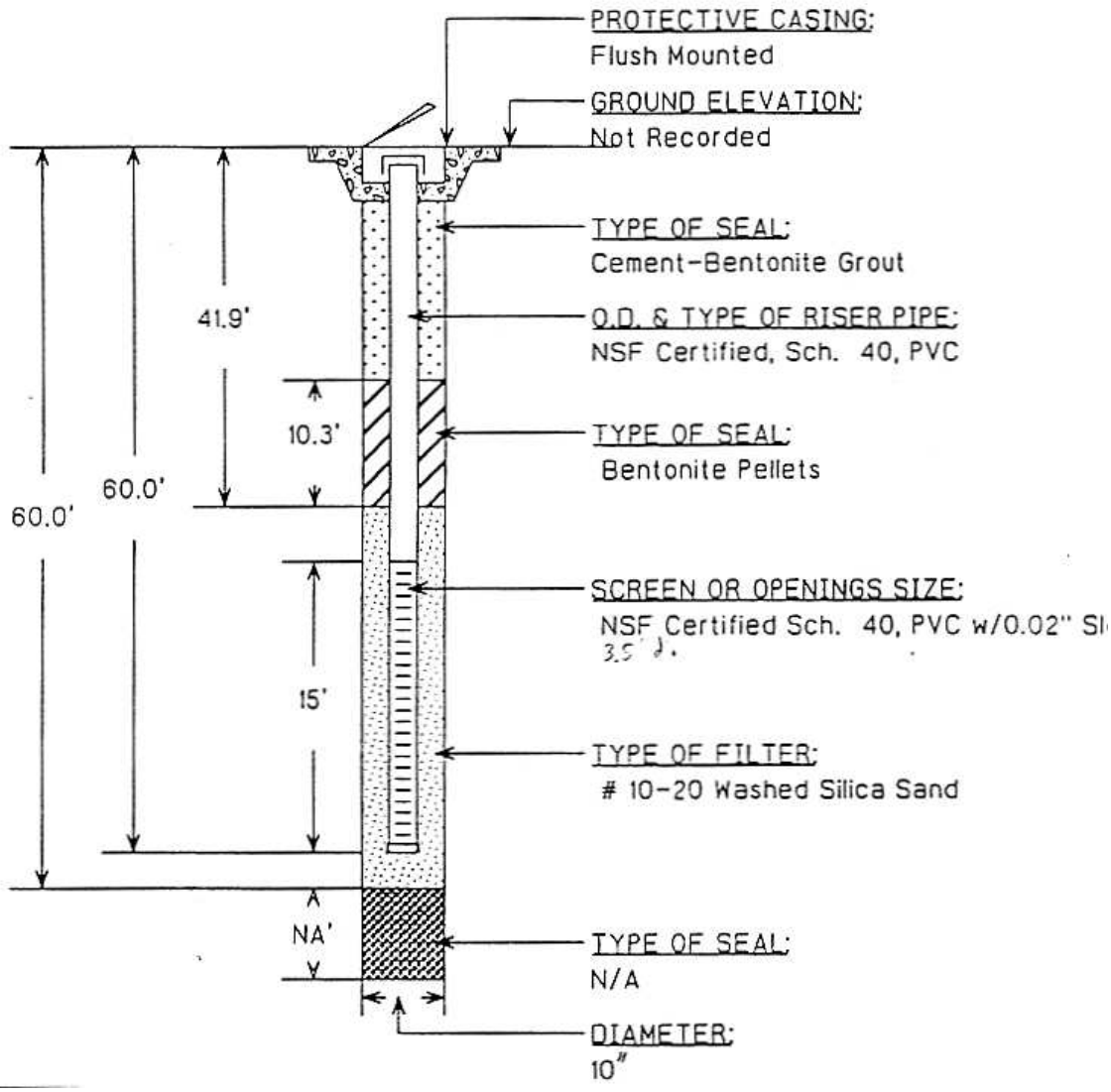

Figure 5: Design drawing for wells CH-RW1 and OW1.

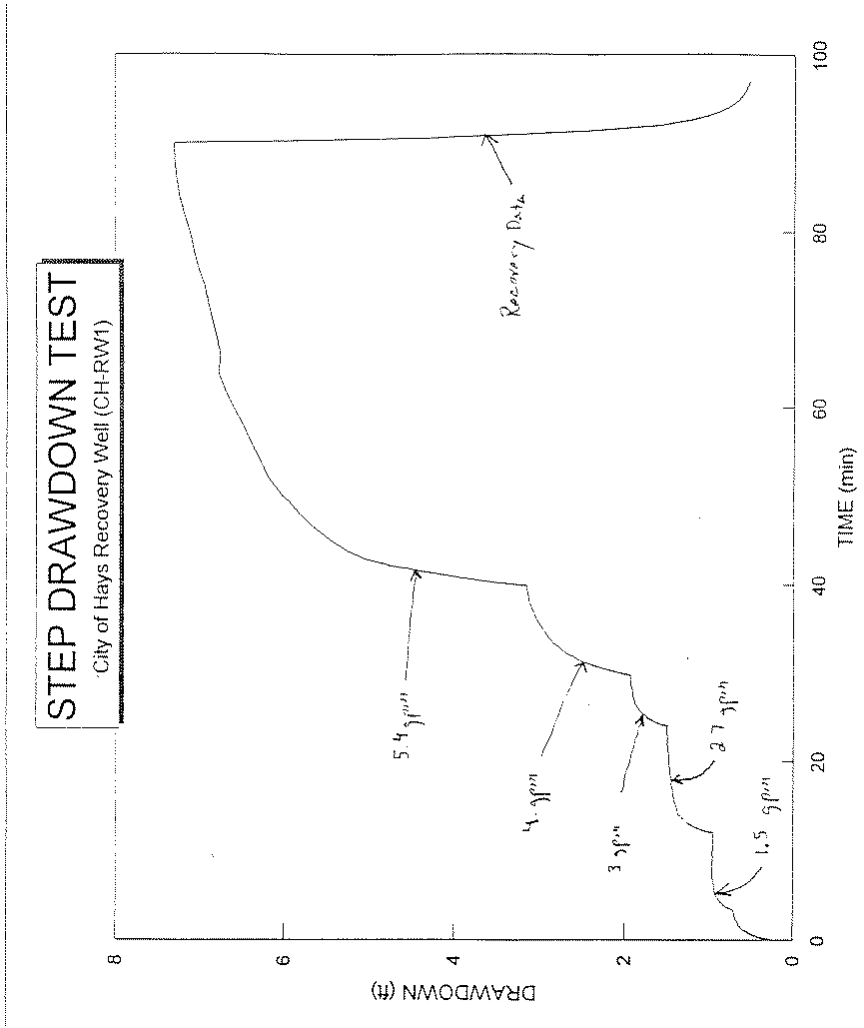

Figure 6: Results of step-drawdown test for well CH-RW-1. Pump rates are 1.5, 2.1, 3, 4 and 5.4 gallons per minute (gpm).

load the file for each of the two observation wells.

A. select `File/Open`
B. e.g. open file `lmw10.dat`, the monitoring well datafile
C. an error analysis window will open up, hopefully saying "No errors detected"
D. the window directs you to choose a solution type and solve

iii. Choosing and running the solution type:

A. select `Match/Solution`. Considering the setting of this test (see Figs. 3– 5), choose the appropriate solution method (if necessary repeat this to find the best choice).
B. for a simple forward model, select `displacement-time` in the dataset dialog
C. to obtain the optimum fit
D. manual adjustment:
   - choose `Match/Visual`
   - curve can be dragged to a new position using the cursor (put cursor over curve, left click, drag to new position)
   - shape or slope of curve can be changed by selecting `Match/Toolbox/Options/''Active Curve Types''`
   - now select any portion of the curve and drag it to a new position

iv. Note: please include plots from Aqtesolv in your solution. These can be printed by selecting `File/Print`.

(f) Analyze Well Data

⇒ i. For the following wells choose the appropriate analysis type, justify your selection, and perform your best analysis of aquifer parameters using Aqtesolv. Report your results.

A. Pumped well CH-RW-1 (input file: RW1_pump.dat)
B. Observation well CH-OW-1 (input file: OW1.dat)
C. Nearby pre-existing monitoring well LMW-10 (input file: LMW10.dat).
D. Recovery data for CH-RW-1 is included as well (file RW1_recov.dat). If the file works for you (I need to fix it a bit), try a recovery solution.

⇒ ii. What variability in aquifer parameter determinations did you see? Give some reasons why this variation occurred.

References

Latta, B. F., Ground-water supplies at Hays, Victoria, Walker, Gorham, and Russell, Kansas, with special reference to future needs, *Kansas Geol. Surv. Bull.*, *76*, 121–196, 1948.