CE 5364 Groundwater Transport Phenomena
Exercise Set 3

Exercises

1. Figure 1 depicts the general area where the *Spill-O-Rama* industrial manufacturing plant operates, among other things *Spill-O-Rama* manufactures titanium knee replacements, using proprietary techniques. The golf course is about 5000 meters west of the plant boundary. The golf course opened about 1980, around the same time as the plant began operations.

   Figure 2 is a detail map of the plant itself showing the locations of monitoring wells (MW) and a pumping well (PW).

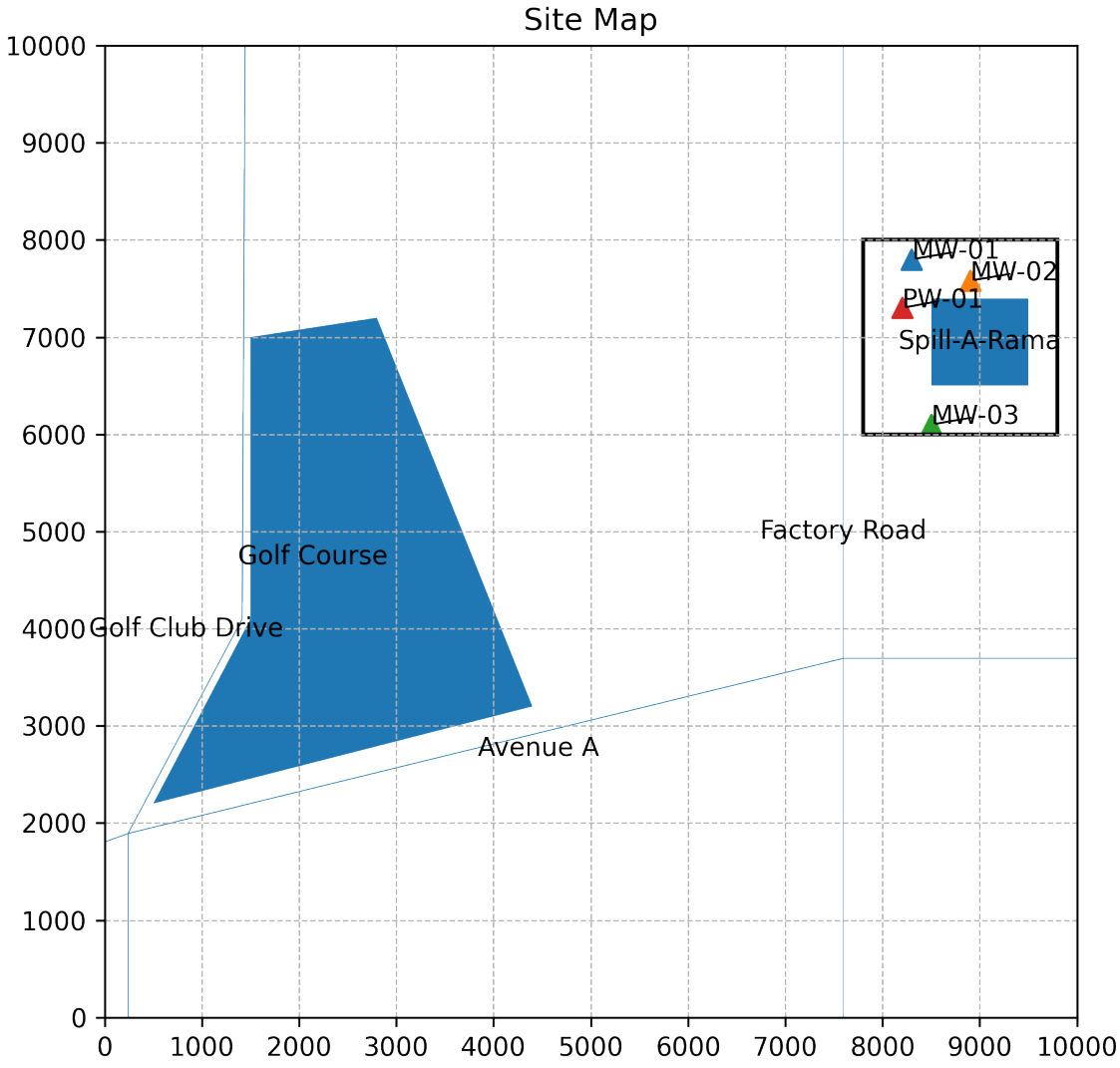

Figure 1: Overview map of the Spill-O-Rama plant and adjacent areas

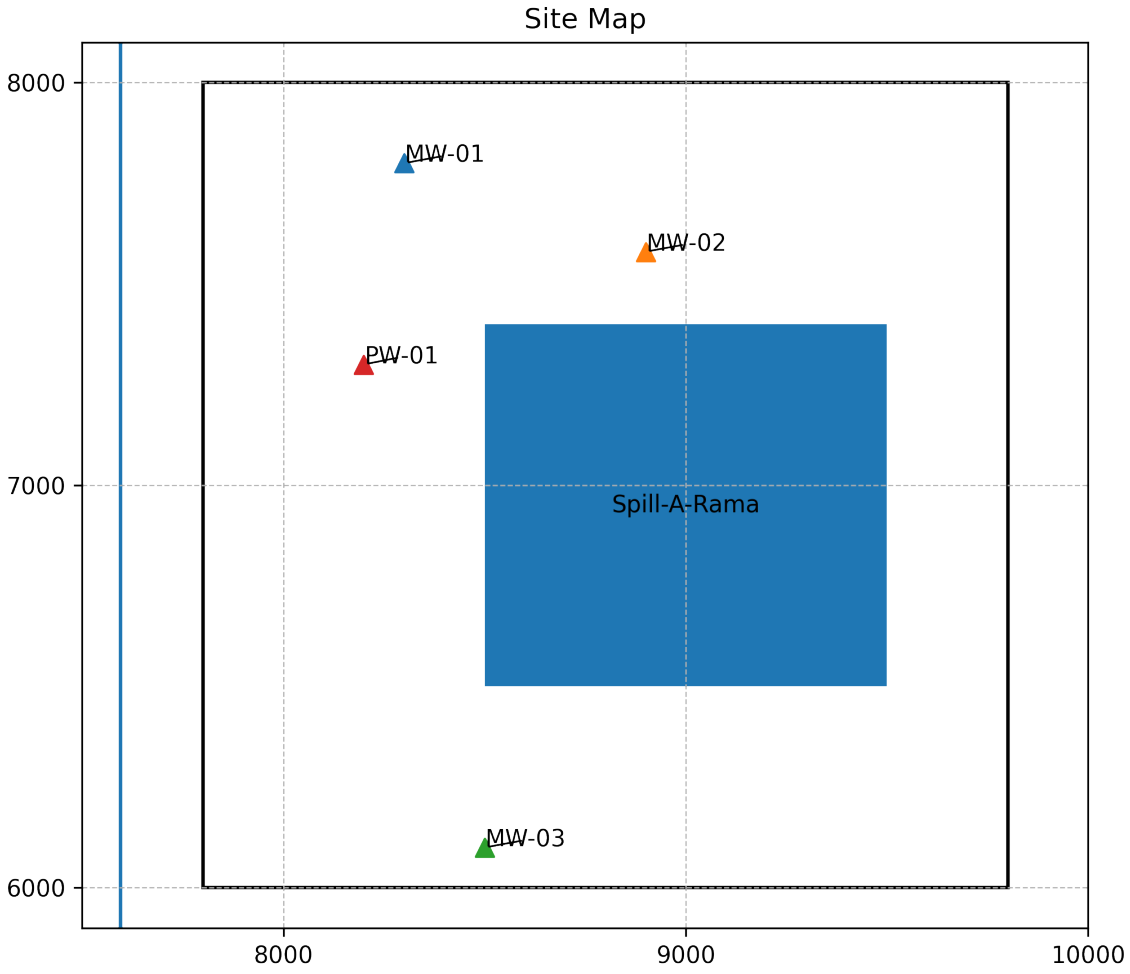

Figure 2: Detail map of the Spill-O-Rama

Figure 3 are interpreted borehole logs made by the driller when the monitoring wells were installed.

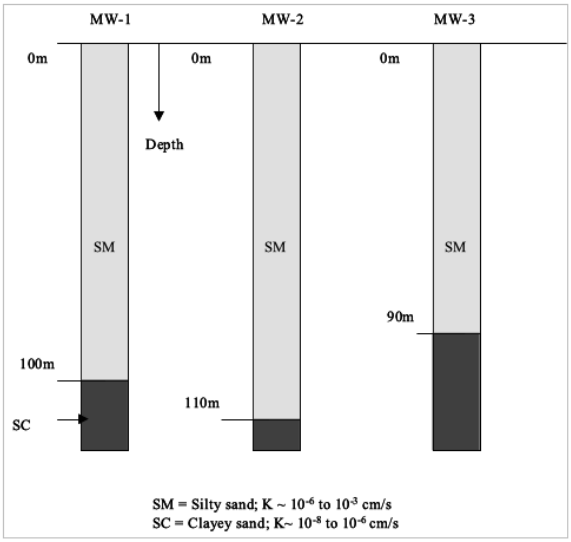

Figure 3: MW1, MW2, and MW3 drilling logs

The pumping well was installed (PW-1) to provide process and cooling water for the plant. During development of the well a pumping test was conducted and the data from that test are tabulated below.

Table 1: Drawdown-Time for 100 gpm pumping at PW1

Time (min)	MW-1 (m)	MW-2 (m)	MW-3 (m)
1.0	0.0	0.0	0.0
6.0	0.02	0.001	0.0
12.0	0.096	0.015	0.0
18.0	0.18	0.045	0.001
24.0	0.257	0.082	0.005
30.0	0.326	0.121	0.012
60.0	0.582	0.298	0.071
90.0	0.752	0.436	0.143
120.0	0.88	0.546	0.212
240.0	1.202	0.84	0.433
480.0	1.537	1.16	0.71

Static long-term water levels in the wells are 81.0m, 80.0m, and 85.0m for MW-1, MW-2, and MW-3, respectively.

Determine:

(a) Estimate the regional groundwater flow direction from the monitoring wells.

(b) Is the groundwater flow direction favorable for constituients to move from the golf course to the plant site

(c) Estimate the hydraulic conductivity based on the pumping test results.

(d) If the value of hydraulic conductivity from the pumping tests is comparable to the values shown on the drilling logs.

(e) Assume the golf course starts using treated wastewater to irrigate. The irrigation scheme produces a concentration in the groundwater of 10000 ppm nitrate (as nitrate). How long until nitrate is detected in the MW array?

(f) Is nitrate damage to the titanium (i.e. embrittlement) a practical concern for *Spill-O-Rama*?

(g) (Extra Credit) Assume PW1 operates at 100 gpm as specified. Construct a map of groundwater elevations for the entire study area (Golf Course and *Spill-O-Rama*).