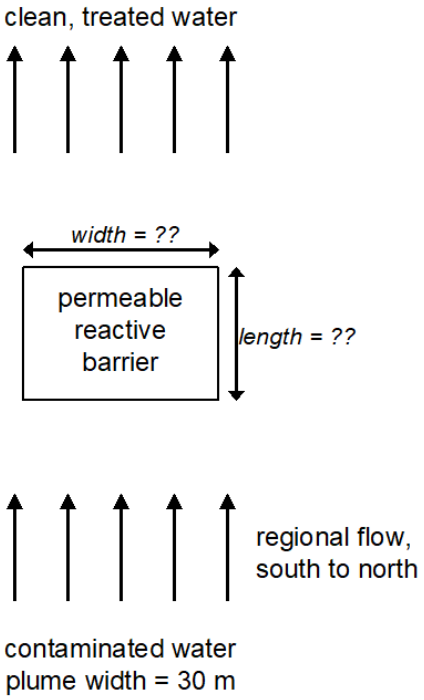
CGN 6933 Groundwater Engineering

Homework #8 Fall 2019

Due Thurs., Nov. 14, 2019 Prof. J. A. Cunningham

This assignment will be collected and graded.
Complete this assignment in a team of 2 or 3 students.

Suppose that you are a private consultant who specializes in problems of groundwater flow. You have been hired by the U.S. Environmental Protection Agency (EPA) for the following problem.



A plume of contaminated groundwater is flowing due north towards a bay. The contaminated plume is 30 m wide. The EPA has decided that the contaminated water will be treated *in situ* by the "permeable reactive barrier" (PRB) technique. Here's how it works. A geotechnical contractor will dig up part of the aquifer and replace it with highly permeable iron filings. As the contaminated water flows through the iron filings, the contaminants react with the iron and are transformed to harmless products. Your task is to specify the dimensions of the PRB. You must specify the width (i.e., the dimension perpendicular to the flow) and the length (i.e., the dimension parallel to flow) of the PRB. See the figure above.

Like most design problems, there is no unique answer to this problem. However, some designs are better than others. Your design should meet the following constraints.

(i) Your design must ensure that all the contaminated water flows through the PRB, i.e., none of the contaminated water can flow around it.

(ii) The contaminated water must spend at least 20 days traveling through the PRB, because that is how long it will take for all the contaminants to be transformed.

(iii) It is very expensive to excavate the aquifer and install the PRB, so you want your PRB to be small (but not *too* small, or else it won't meet the other criteria – you want a *little* margin of safety).

We have some information about the conditions of the site.

- The hydraulic conductivity at the site is isotropic and homogeneous. (Once you put your PRB in, the site will no longer be homogeneous.)
- The background hydraulic conductivity of the aquifer is $K = 0.6$ m/day.
- The iron filings are more permeable than that: $K = 80$ m/day.
- The porosity of the iron filings is $n = 0.4$.
- The hydraulic gradient for the regional flow is 0.005 m/m. (Note that, once you put your PRB in, the gradient will not be exactly 0.005 m/m everywhere, because your PRB will distort the regional flow.)

To support your design, you must hand in a flownet showing the streamlines and the lines of constant head. This will demonstrate that your PRB captures all the contaminated water. It also will help to verify that the contaminated water remains in the PRB for at least 20 days. You also must hand in the program that you wrote to compute and graph the flow net. (I wrote my program in Matlab, but if you prefer a different programming language, that is fine.)