# 12.102 Problem Set #3
Water – Our most valuable resource

Part I

Read chapter 8 in MWM.

1) The diagram below shows a cross-section through a new dam on the Colorado River. On the one hand, this project has helped the local communities to the east because there are now artesian wells pouring out of the hillside. Unfortunately, a recent surge in state-sponsored recreation in the new reservoir has dumped 10^4 gallons of gasoline and tequila into the water. Assume the contaminants spill and homogenize instantaneously. Here is the question: who gets to sue first, person #1 or person #2? (20 pts) *hint: you will want to use a version of Darcy's law to solve this, but keep in mind that there are many different versions of this equation...*

Rock Type		Permeability (m/day)
Granite		10^{-6}
Conglomerate		10
Shale		10^{-5}
Siltstone		2
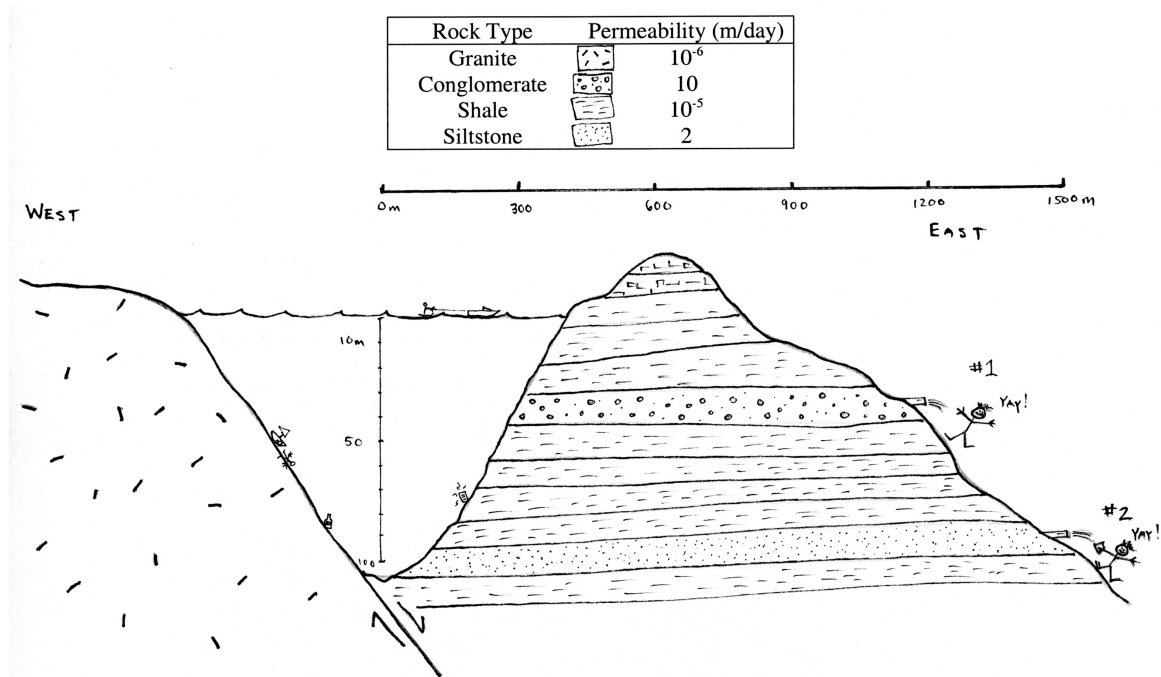
2) What other impacts (beneficial or detrimental) might the dam have on the surrounding environment? (10 pts)

Part II

You are a hydrogeological engineer, and you work for a very important U.S. city. This particular city is growing at a rapid rate, and needs a new water supply to support its rising population. The water rights for the flowing water (rivers, reservoirs) in a nearby river are all divvied up. Therefore, it is your job to find a new groundwater supply. Attached is a map with the following features: the geology of the region, an outline of a drainage basin (i.e. a topographically enclosed area containing a network of rivers - every drop of water that falls in a basin, theoretically leaves the same basin), and the location of your city. Read the supplemental material from Dallmeyer before doing these problems, as they will aid you in drawing a geologic cross-section from the map.

1) It is first important to understand the geology of the area in three dimensions in order to figure out how the groundwater will behave. Draw a schematic geological cross-section from A to A' (the line indicated on your map) including the proper rock units and other geological features (proper dips on sedimentary rock layers, and faults). Make sure your cross section is roughly to scale and has proper labeling - accuracy and legibility are both important. You may assume topography for your cross section based on the direction of the river. Also note that the problem from part I is an example of a geologic cross-section with a lot of vertical exaggeration (this means that the vertical scale is different than the horizontal scale; it is *way* easier to draw them without vertical exaggeration). (20 pts)

2) Now, draw on your map and your cross-section where you would plan to put a well to access abundant groundwater (ie, an aquifer), and explain in a few sentences why this may be a good place. (10 pts)

3) As it turns out, your city is located in a semi-arid environment, and you are worried about the recharge of groundwater to your chosen aquifer. A simple way to do this is by doing a mass balance of water in your drainage area: the water that goes into your drainage area as precipitation should come out as runoff, unless it is underground. You are in luck because it is currently raining at a constant rate in your entire drainage area, and you have the ability to measure the discharge in the river leaving the system (indicated on map). Things you might want to know: it is raining at a rate of 1ml per minute per square meter, the discharge you measure in the river is 4.0 m^3/sec (this isn't all the information you need). How much water is being lost (or gained?) in your system? (15 pts)

4) Assuming this calculation is correct, will this new water supply be enough to satiate the 100,000 people moving into new housing developments in the suburbs? You can assume the aquifer is initially saturated, and that these are average American people. (10 pts)

5) Do you think the calculation in problem (3) is a robust estimate of recharge into the aquifer? If not, why not, and how else would you measure it? What are your potential sources of error? You should think about this problem and write several paragraphs. (20 pts)

N

5 Km

A

60°

T 30°

T 30°

Dam

Dam

Dam

YOUR CITY

discharge meter

T 30°

T 30°

60°

60°

RIVER

A'
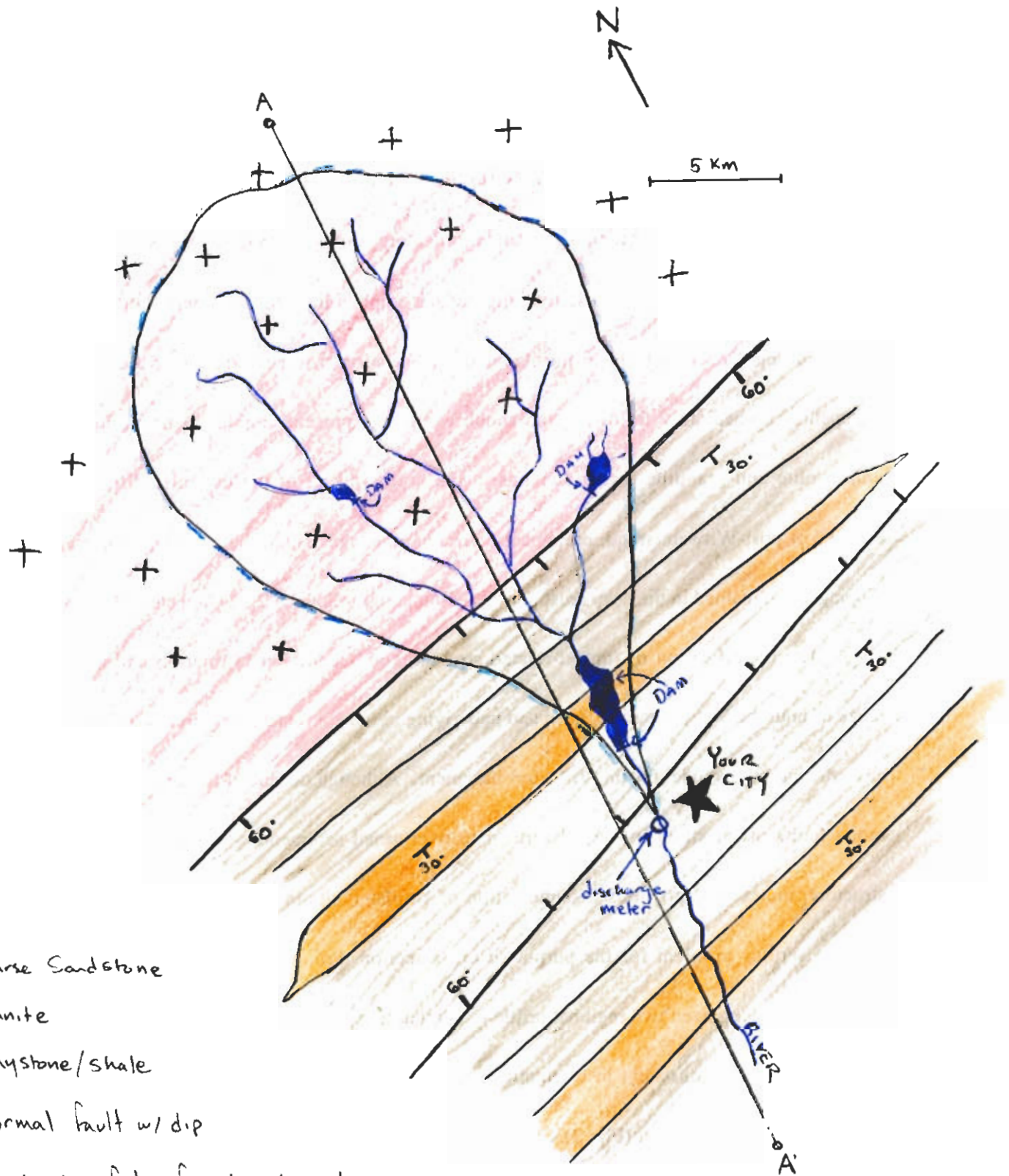
KEY

Coarse Sandstone

Granite

Claystone/shale

normal fault w/ dip
60°

30° dip + direction of dip of sedimentary layers

Outline of drainage basin

Geological contact