CE 474/574 - Unit Operations in Environmental Engineering

Design Assignment 4.
Designing a Rapid Sand Filter for the Drain, OR Public Water Supply

Great progress is being made for Drain! Once the filter units are designed, Drain will be ready to respond to the demands of LT-1 and protect the health of its citizens.

Sal Monella wants you to design a rapid sand filter that follows the principles you used for the clarifier, namely that a conservative surface loading rate be used, that the system have a *minimum* of two basins so that one is always operating even during backwashing or maintenance operations, and, that the filter system be designed for double the current water demand. (I.e., be able to handle double current flow with one basin shut down. Having 4 basins will make this easier than just 2.) Here are some design guidelines:

Professional design guidelines call for surface loading rates in the range of 100-475 m/d. Use the most conservative value of 100 m/d.

Make the system a dual-media anthracite-sand bed. The total depth of the bed is your decision as is the decision as to what depth of sand and anthracite to use. Please state clearly the values you choose and briefly explain why you decided on those values.

The type of operation you choose (*continuous flow* or *declining rate*) is also your decision, but please *state the choice and your rationale*.

Mr. Monella has secured a supply of good quality, pre-sieved Columbia River sand from a supplier in Scapoose, OR, as well as a local supplier of filter-grade anthracite. The characteristics are:

	Sand	**Anthracite**
Effective size (d_{10})	0.48	0.9
Sphericity	0.90	0.75
Porosity	0.40	0.48
Uniformity Coeff. (u)	1.5	1.5

- Calculate the initial (clean) headloss through the filter if the loading rate for you choice of the depth and the loading rate of 100 m/d.. **NOTE:** To make life easier for the grader and me, please clearly indicate the headloss *per unit depth* for each medium as well as the total headloss. That way it is easier to see if you got a good answer regardless of the sand/anthracite depth you have chose.
- Specify the surface area, lateral dimensions, and depth of the filter unit. Include in your design the estimated depth needed for backwashing, assuming a design backwash expansion of 25% of the total bed, plus extra "freeboard" depth of, say, 3 ft (~ 1 meter). Make sure you allow multiple (suggested: 4) subunits so that at least one can be backwashed and the other three can safely handle the full flow.
- Make a scale drawing of the plan and side views of the filter gallery. Indicate the dimensions and the placements of weirs, launders, etc. using the text and other supplemental graphics as a guide. Also, estimate the volume of water required for each backwash cycle and the total fraction of daily flow needed for backwash if there is 1 backwash per 24 hr and the backwash consumes an average of 3% of total product water.