1.061 / 1.61 Transport Processes in the Environment
Fall 2008

1.061: Homework # 1[10 pt total]

Problem 1 [6 pts]
Using whatever means you desire, estimate the flow, $Q[m^3s^{-1}]$, in the Charles River. Describe the method of estimation in one page of neatly worded prose. Include all assumptions and approximations, and an estimate of uncertainty. See the attached notes for a standard method of uncertainty analysis. HINT: You will have an easier time if you go upstream where the river is narrower, *e.g.* at or beyond River Street. *After* making your estimate, look up the flow measured in Waltham at the following link http://waterdata.usgs.gov/ma/nwis/uv/? site_no=01104500&PARAmeter_cd=00065,00060.

You will be graded on the effectiveness and originality of your method and the clarity of your prose. You will not be graded on the proximity of your estimate to the reported value.

Problem 2 [2 pts]
Nitrate is a common groundwater contaminant in rural areas. Sources of nitrate include fertilizers, septic systems, and manure. Nitrate is regulated in drinking water because it causes methemoglobinemia, or "blue baby" syndrome. See, e.g. http://pmep.cce.cornell.edu/facts-slides-self/facts/nit-heef-grw85.html.
The water standard for nitrate is 10 mg/l.

Consider a small lake which receives input from a river at rate $Q_R = 0.1$ m^3s^{-1} and from a groundwater seepage at rate $Q_G = 0.005$ m^3s^{-1}. The river inflow is free of nitrate, but the groundwater contains nitrate percolated from septic tanks around the lake. The mean nitrate concentration in the groundwater is 40 mg/L. The lake volume is $10^5 m^3$.

a) Assuming the nitrate concentration has reached a steady state in the lake, what is the nitrate concentration in the lake outflow?
b) If the groundwater source could be instantly removed, approximately how long would it take for the nitrate concentration in the lake to drop to zero?

Problem 3 [2 pts] - Your roommate drops a bottle of foul smelling cologne in your small [200 m^3] room. The cologne begins to evaporate with first-order rate constant, $k = 0.03$ min^{-1}. Your roommate does not bother to clean up the spill, because he thinks it will evaporate soon enough. To dissipate the odor more quickly he opens the door and window to create a wind current of 1 m^3s^{-1}. You think that the air current is not much help in removing the odor, and you insist that you roommate should mop up the spill immediately. Who is right?