Problem 1. Sediment Transport

A river has sediments ranging in size from 1 micron to 5 millimeters. The river is 2.5 meters deep and the vertical dispersion coefficient is 0.01 m^2/s. For which of these sediment sizes, if any, do you think it is reasonable to assume the river is well mixed (i.e. vertical concentration is uniform)? Explain and justify your answer.

Problem 2. Sediment Transport 2

You are given the following data set for a river, which is highly controlled. Its flow varies sinusoidally on a daily time scale such that its volume flow rate in m^3s^{-1} is $Q(t) = 300 + 100\sin(2\pi t)$ where time t is in days. The data on this figure can be downloaded from the course website so that you can plot it yourself. How much sediment is exported over one week? FYI - Some of your integrals may have to be evaluated by brute force (see NIntegrate on Mathematica)

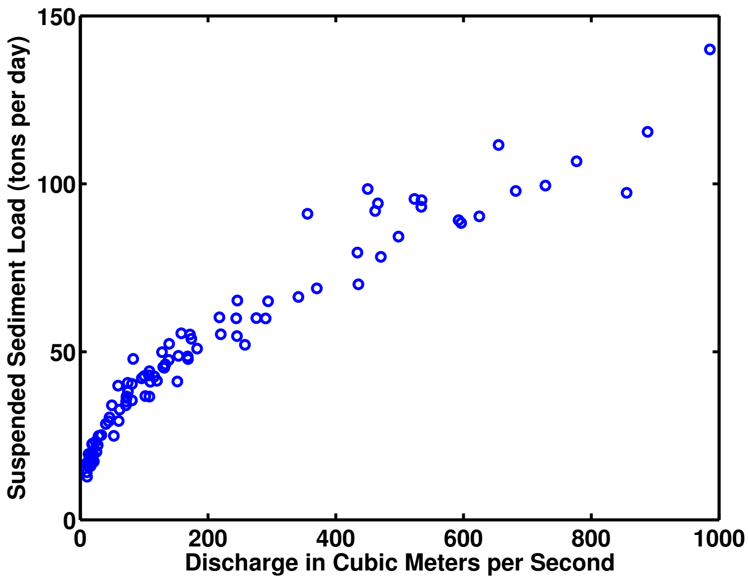

Figure 1: Sediment Load vs Volume Flow Rate

Problem 3. Air-Water Interactions

Methane has been spewing from the local cow farm for decades and it is finally being shut down. This should lead to a decrease in atmospheric methane by a factor of about 5. In one of the local lakes some horrible algae have been thriving due to this methane, but they are expected to die off once methane concentrations within the lake decrease to half their current level. The lake has a surface area of $750m^2$ and volume of $10000m^3$. If they rely on pure diffusion the gas exchange coefficient is 10^{-8} m/s. How long will it take for them to get the lake to where these algae no longer thrive? What if wind helps them with a turbulent exchange coefficient that is 10^4 times higher?