Geology 431, Environmental Geochemistry, Examination 1

This is a "take home" exam. You can use any notes, readings or handouts from the class but you must work on this alone. Because you have access to all these records/information, I expect the answers to be complete and very well illustrated. Make sure to include any diagrams, equations, etc. that back up your answers. A general statement will get you few if any points. Please use a word processor and graphics program (e.g., MS Word and Excel or WordPerfect and deltaGraph, etc.) for high-quality final output. You can use a spreadsheet for your calculations, just make sure to explain what you did so I can follow your equations, etc. I will not accept hand written answers. However, you can use hand drawn information on copies of figures as long as it is neat and legible. Do not consult with other students in the class or trade ideas or information regarding the questions. I expect you to prepare your answers on your own once you download and read the exam. Okay, those are the ground rules and here we go:

1. Two piles of finely ground material are found near an old smelter. Mineralogical analyses finds that both dumps contain metal sulfides. However, one dump (dump 1) has only chalcocite, covellite and arsenopyrite. The other dump (dump 2) has a mixture of metal sulfides, but is mostly pyrite. The regulators are concerned about acid mine drainage from the dumps. Which of the two dumps should they be most worried about and why? Hint: Do not add complications; use only the minerals they found. (10 points)

2. What is the common relationship between grain size distribution and metal concentration? What are the main factors/processes controlling this relationship? (10 points)

3. An old chromium coating plant is located next to a river and contaminated soil from the site is eroding into the river. Contaminated groundwater is also flowing into the river. The data below was collected to determine how much chromium was originating from the plant. Use this information to answer the following questions (30 points):
A. What is the load (in metric tons/day) of dissolved Cr in the river above and below the plant?
B. What is the load (metric tons/day) of particulate Cr in the river above and below the plant?
C. What is the concentration (in ppm) of Cr in the river sediment above and below the plant?
D. How much total Cr does the plant add each day to the river?

	Above Plant	Below Plant
TSS (mg/liter)	60	300
Dissolved Cr (µg/liter)	5	60
Total Recoverable Cr (mg/l)	0.03	1.6
Discharge (cu ft per second)	258	258

4. The following minerals and other components were found in samples of sediments collected from cores in a reservoir. Classify their geochemical environment based on Berner's (1981) classification (10 points).

Sample	Minerals	Other Components	Classification
1	siderite, vivianite, rhodochrosite	methane	
2	pyrite, makinawite, other metal sulfides	hydrogen sulfide, bicarbonate	
3	hematite, ferrihydrite, birnessite	nitrate, bicarbonate	

5. What are the limitations of applying Eh (pe) - pH diagrams to natural systems? (10 points)

6. A manufacturing plant has some waste water that has a pH of about 3. It contains high concentrations of sulfate as well as arsenate, but not much else. The plant operator wants to neutralize the solution to a pH of about 9. He says that will decrease the arsenic and sulfate concentrations to a very low value that will not affect the river in which he wants to discharge the effluent. A consultant hired by the plant CEO suggests that they should mix organic matter with the effluent and give it time to react and form sulfide before they discharge the effluent. What would happen in each of these scenarios, assuming that the system would come into equilibrium before discharge? Should the regulator that oversees the discharge be worried or not about what is in the effluent? Hint: Consider only this simple system (As and S), do not add other complications. Another consultant hired by a local environmental group suggests that the system would work better if iron hydroxide was added to the effluent before the reaction with the organics. What would that accomplish if anything? Hint: Again consider only this simple system, As, Fe and S and assume everything would come into equilibrium. This is a multi-part answer so make sure to include everything you think might happen. Make sure to include any diagrams you need to explain your answer. (40 points).