CEE 577 11 March 2014

MID-TERM EXAM

Closed book, 1 sheet of notes allowed.
Answer all 3 of the following 3 questions. Please state any additional assumptions you made, and show all work.

Important constants & conversions:

1 ha (hectare) = 10,000 m^2
1 ft = 0.3048 m

1. (30%) Loading of para-dichlorobenzene (PDCB) to Lepidoptera Lake terminated at 7PM on March 11, 2014. Prior to this, the concentration of PDCB in the lake had been at steady state. If the lake has a hydraulic residence time of 298 days and PDCB decays according to first order kinetics with a rate constant of 0.94 yr^{-1}, when will the PDCB concentration be reduced to exactly half of its current concentration?

2. (40%) Saginaw Bay is in the southwest quadrant of Lake Huron. It receives the flow of the Saginaw River, which has a high chloride concentration of 63.1 g m^{-3} and a discharge of 7 x 10^9 m^3 yr^{-1}. There is no reverse flow from the lake to the bay.

	Saginaw Bay	**Lake Huron**
Chloride Conc.	17.8 g m^{-3}	5.4 g m^{-3}
Volume	8 x 10^9 m^3	3,507 x 10^9 m^3
Depth	5.81 m	60.3 m
Surface Area	1,377 x 10^6 m^2	58,160 x 10^6 m^2
Outflow	7 x 10^9 m^3 yr^{-1}	161 x 10^9 m^3 yr^{-1}

   a. Write the mass balance equation and determine the bulk turbulent diffusion coefficient, E' (m^3 yr^{-1}) and the turbulent diffusion coefficient, E (m^2 yr^{-1}). Assume the mixing length is approximately 10 km. Assume that the interface cross-sectional area between the bay and the lake is 170,000 m^2.

   b. Write the mass balance equations and calculate the steady state concentration in Saginaw Bay and Lake Huron of a non-conservative parameter with a first order decay rate of 0.0014 day^{-1}. Assume that the concentration of the parameter in Saginaw River is 10 g m^{-3} ; this is the only direct loading to the system. Show your mass balance equations. **Express answer in ug/L.**

3. (30%) On a separate sheet of paper, answer any six (6) of the following questions.

A. Calculate the % loss of CBOD as water moves 2 kilometers downstream in a river flowing at 0.01 m/s. Assume the CBOD deoxygenation rate is 0.12 d^{-1}, and the CBOD settling rate is 0.10 d^{-1}.

B. Describe the steps involved in a wasteload allocation process

C. What is the concentration of dioxane in a lake 1 year after Acme Chemical Company (ACC) initiates operation on its shore. The lake has an area of 100,000 m^2, an average depth of 1 m, and an outflow of 1000 m^3/day. Dioxane decays at a 1st order rate of 0.5 yr^{-1}, and assume ACC discharged 11 kg/yr to the lake on the day it opened and this discharge increased linearly to 14.65 kg/yr by the end of year 1. Assume there was no dioxane in the lake before ACC started operation.

D. Describe what happens when a wastewater with ammonia is discharged into a flowing river. Be specific on the chemical changes and microbial ecology.

E. Is it common to add an inhibitor to the BOD test? Why or why not?

F. Explain the difference between CBOD and NBOD.

G. Explain the difference between mechanistic modeling and stochastic modeling

H. Explain the difference between ambient and effluent standards