CEE 577 4 November 2015

MID-TERM EXAM

Closed book, 3 sides of a 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%) All loading of para-dichlorobenzene (PDCB) to Luna Lake terminated at 7PM on November 4, 2015. Prior to this, the concentration of PDCB in the lake had been 5.7 µg/L. Assume the lake has a hydraulic residence time of 143 days, a volume of $5x10^6$ m^3, and PDCB decays according to first order kinetics with a rate constant of 0.94 yr^{-1}. If Cecropia Corporation begins production on May 5, 2016 and discharges PDCB at a rate of 700 g/day, when will the PDCB concentration reach the standard of 10 µg/L?

2. (50%) Buckeye Creek receives runoff from more than a dozen corn farms in a small area of central Iowa. Each results in a certain dischage of organic nitrogen and contributes to the loading of Buckeye Creek. The effective drainage area of the corn farms that impacts Buckeye Creek is 20,000 ha. Assume that prior to creation of the farms, when the drainage basin was 100% pristine prairie, the organic nitrogen level in Buckeye Creek was constant at 0.25 mg/L. Now the level is substantially higher as shown in the table below.

a. Determine the total organic nitrogen concentration for each day using the standard log-log model
b. Using this information, estimate the effective export coefficient for the corn farms during this 10-day period in units of kg-organic N/ha/yr.
c. Comment on the relationship between the organic nitrogen export coefficient for this watershed and the amount of rainfall in a given year.

Day	Flow (m^3/s)	Organic Nitrogen Concentration (mg/L)
1	1.7	
2	1.8	1.1
3	2.9	
4	4.4	
5	7.6	
6	12.1	3.7
7	11.1	
8	8.3	
9	5.4	
10	3.3	

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 0.03 m/s. Assume the CBOD deoxygenation rate is 0.22 d^{-1}, and the CBOD settling rate is 0.05 d^{-1}.
   B. If a river is shown to have the following empirical relationships, $U=3.5 \cdot Q^{0.34}$, $H=2.2 \cdot Q^{0.41}$, and $B=21.4 \cdot Q^{f}$. What is the value of "f"?
   C. What is the concentration of nonylphenol in a lake 2 years after Trump Chemical Company (TCC) 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. Nonylphenol decays at a 1st order rate of 0.5 yr^{-1}, and assume TCC discharged 11 kg/yr to the lake on the day it opened and this discharge decreased linearly to 7.65 kg/yr by the end of year 1 and continued to decrease as the same rate during year 2. Assume there was no nonylphenol in the lake before TCC 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. Define 7Q10, and explain when it is used and when alternatives might be used instead
   F. Describe what the Secchi depth is and how it is measured.
   G. Explain how the dissolved oxygen level affects the rate of nitrification and the rate of CBOD deoxygenation.
   H. Explain the difference between ambient and effluent standards