CEE 577 1 Apr 2009

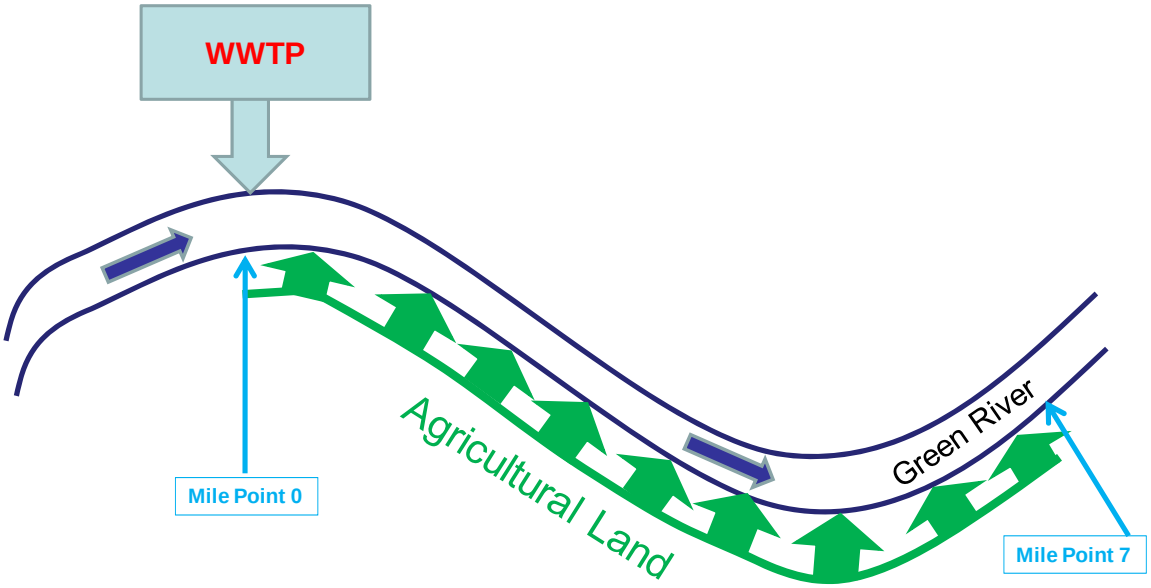
MID-TERM EXAM

Closed book, 1 sheet of notes allowed.
Answer 2 of the following 3 questions. Please state any additional assumptions you made, and show all work.

1. (50%) The Green River emerges from pristine headwaters and runs through an agricultural region. At the start of this agricultural region is a municipal wastewater discharge (from the city of Tonawanda). The BOD of the headwaters is 6 mg/L, and the dissolved oxygen is 8.2 mg/L (saturation is 10.1 mg/L for 15^{o}C). Starting at mile point zero, there is a significant non-point agricultural runoff of BOD amounting to 45 kg/mile/day. Also at mile point 0, is the Tonawanda WWTP outfall. Here a WW flow of 2 cfs is discharged with a CBOD of 100 mg/L, an ammonia-N concentration of 14 mg-N/L and a DO of 6 mg/L. Immediately past this outfall is 7 miles of agricultural land. **Calculate the dissolved oxygen concentration at the end of the agricultural land (i.e., 7 miles downstream of the Tonawanda WWTP outfall)** (T=15^{o}C). Assume the flow is constant at 40 cfs from the headwaters to the end of the non-point agricultural runoff. You may also assume an SOD downstream of the WWTP outfall of 1.5 g/m^2/d.

Additional Information:

U = 0.150 ft/sec = 2.45 miles/day	T = 15^{o}C
DO_{sat} or C_S = 10.1 mg/L (at 15^{o}C)	H = 8 ft = 2.44 m
BOD deoxygenation rate ($k_N = k_d$) = 0.8 day^{-1} (at 15^{o}C)	for k_N and k_d, θ=1.047
CBOD settling rate (k_S) = 0.080 day^{-1} (at 15^{o}C)	for reaeration, θ=1.024



2. (50%) Lake Colvin is a suburban surface water that has received inputs of monosodium methane arsenate (MSMA) for many years. Efforts to clean up the lake resulted in the termination of all known loads of this compound by the beginning of 1997. At that point, the concentration of MSMA was 0.15 µg/L. By January 1, 2002, the MSMA level in the lake had dropped to 0.08 µg/L due to decay (k =0.00015 d^{-1}) and hydraulic flushing. However, on January 1, 2002 construction of a new golf course was completed on the shore of the lake. The export coefficient for MSMA from a golf course is 200 µg/acre/d. In 2002, the golf course consisted of 9 holes and 115 acres. Two years later (January 1, 2004 they completed addition of an additional 9 holes and thereby doubled the size of the golf course. The lake outflow is 100 m^3/day.

A. Determine the volume of Lake Colvin
B. Calculate the expected MSMA concentration in Lake Colvin at the beginning of the year 2020.

3. (50%) On a separate sheet of paper, answer any five (5) of the following questions.

A. Describe the difference between mechanistic and empirical modeling
B. Discuss errors on model predictions. What is the origin of model error and what are the various types.
C. List and briefly explain the various options for controlling or reversing cultural eutrophication
D. Describe 3 different methods for determining stream velocity.
E. Explain various options for design conditions in waste load allocations
F. Describe the factors that determine re-aeration in rivers, and contrast this with the factors that determine re-aeration in lakes. In your description, relate micro-scale processes (molecules) to macro-scale (bulk water or air)