Mid-Term EXAM

Closed book, 1 sheet of notes allowed.
Answer either question #I or #II. You must also answer #III. Please state any additional assumptions you made, and show all work.

I. (50%) Hawkeye 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 Hawkeye Creek. Assume that the drainage area for Hawkeye Creek (10,000 ha) to its confluence with the Birdseye River is entirely made up of corn farms. Hawkeye creek receives a baseflow from groundwater that is 1.7 m^3/s (at the confluence), and the nitrogen concentration in this baseflow is 0.25 mg/L. On July 7 the flow in Hawkeye creek at the confluence was measured as 3.925 m^3/s. Assume the flow on this day was steady and reflective of the daily rainfall that occurred that day and the day before.

a. Determine the basin-wide average runoff coefficient ("C") based on the single flow datum measured on Hawkeye Creek near its confluence with the Birdseye River on July 7 of 3.925 m^3/s
b. Determine flows for each of the remaining 9 days using the rainfall data below and the rational formula.
c. Calculate total organic nitrogen concentration for each day using the standard log-log model
d. 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.
e. Comment on the accuracy and usefulness of this organic nitrogen export coefficient for this watershed. Consider the average rainfall for this watershed is 3.2 inches in July and 27 inches for the entire year.

Date	Avg Daily Rainfall (cm)	Organic Nitrogen Concentration (mg/L)
July 1	1.8	
July 2	3.2	4.2
July 3	0.7	
July 4	0	
July 5	1.1	
July 6	0.9	0.4
July 7	0.9	
July 8	2.1	
July 9	4.4	
July10	0.4	

II. (50%) On a separate sheet of paper, answer any five (5) 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 steady state concentration of dioxane in a lake that receives wastewater from Acme Chemical Company (ACC). 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 discharges 11 kg/yr to the lake. Assume there are no other sources of dioxane loading to the lake.

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? What does an inhibitor do and why or why not is it added?

F. Explain the difference between CBOD and NBOD.

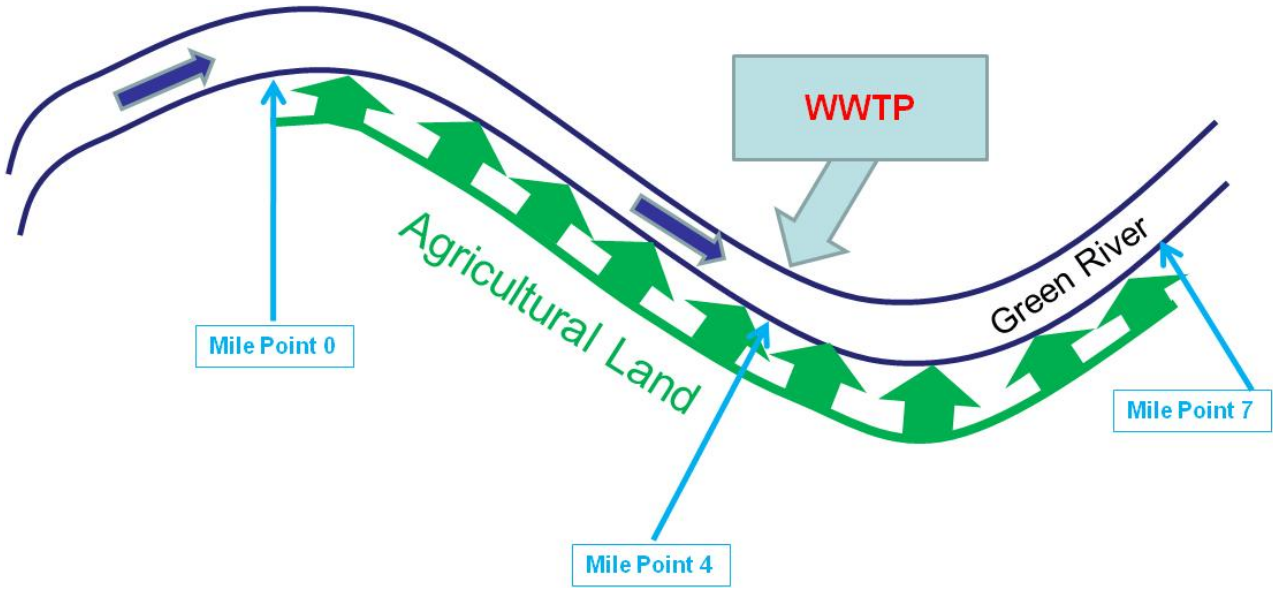
III. (50%) The Green River emerges from pristine headwaters and runs through an agricultural region. Four miles into this agricultural region is a municipal wastewater discharge (from the city of Millbury). The $CBOD_u$ of the headwaters is 2.8 mg/L, and the dissolved oxygen is 7.2 mg/L (saturation is 9.1 mg/L for 20^{o}C). Starting at mile point zero, there is a significant non-point agricultural runoff of $CBOD_u$ amounting to 45 kg/mile/day. At mile point 4 is the Millbury WWTP outfall. Here a fully nitrified WW flow of 10 cfs is discharged with a $CBOD_u$ of 30 mg/L and a DO of 4 mg/L. Immediately past this outfall is 3 more miles of agricultural land.

A) Calculate the dissolved oxygen concentration immediately above the WWTP outfall (i.e. at MP 3.999999)

B) Calculate the dissolved oxygen concentration immediately below the WWTP outfall (i.e. at MP 4.000001)

C) Calculate the dissolved oxygen concentration at the end of the agricultural land (i.e. at MP 7

Assume complete mixing across the stream in cross section. Assume also a temperature of 20^{o}C, a flow of 40 cfs from the headwaters and no incremental flow downstream except for flow from the Millbury WWTP. Many years of discharge has resulted in a very high SOD immediately downstream of the WWTP outfall of 5 g/m^2/d for the first mile (i.e., up to MP 5). After this, you can assume that it decreases to a fixed value of 0.5 g/m^2/d.



Additional Information:

U = 0.200 ft/sec = 3.27 miles/day	T = 20^oC
DO_{sat} or C_S = 9.1 mg/L (at 20^oC)	H = 4 ft = 1.22 m
BOD deoxygenation rate ($k_N = k_d$) = 0.8 day^{-1} (at 20^oC)	for k_N and k_d, θ=1.047
CBOD settling rate (k_S) = 0.080 day^{-1} (at 20^oC)	for reareation, θ=1.024

Useful conversions:

1 mile = 1609 meters
1 ha = 10,000 m^2 = 2.471 acres
1 inch = 2.54 cm