BAE 452/552

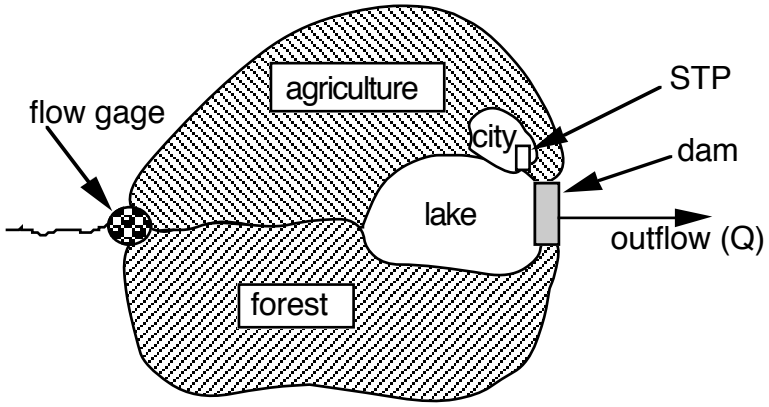
Problem set 3

1. (**BAE 452/552**) Go to the EPA websites (http://www.epa.gov/waterscience/criteria/ & http://www.epa.gov/waterscience/standards/):

a. Briefly summarize the section on 'water quality criteria' and 'water quality standards.

b. On the set http://www.epa.gov/waterscience/criteria/, click on each of the following categories listed (Aquatic life, Human Health, Biological, Nutrient, Microbial, Recreational). Select one of your choice, and briefly describe what criteria information you were able to find.

2. (**BAE452/552**) The following lake basin is considered:



Data given:

Lake geometry:

volume (V) = 6.22 x 10^8 m^3, surface area (A_S) = 7.77 x 10^7 m^2, depth (H) = 8 m

Sewage Treatment Plant (STP):

population served = 50,000; water use = 150 gcd; influent TP = 6 mg/L; plant removal = 20%; (numbers include 5% capture of CSO below)

Combined Sewers Overflow (CSO):

runoff coefficient (C) = 0.45*; service area = 6 mi^2; capture by STP = 5%; overflow TP concentration = 4 mg/L;

Storm Drains (SW):

runoff coefficient (C) = 0.27*; service area = 4 mi^2; TP concentration = 0.7 mg/L;

Upstream Gage:

annual average flow = 500 cfs; natural TP concentration = 0.02 mg/L;

Agricultural Land:

drainage area = 60 mi^2; TP loading = 0.5 lb/mi^2-day; runoff = 30% of rainfall;

Forest:

drainage area = 80 mi^2; TP loading = 0.15 lb/mi^2-day; runoff = 30% of rainfall;

PROBLEM:

The lake basin receives 30 in./yr** of rainfall. On an annual average basis: (a) estimate the total phosphorus (TP) concentration in the lake using the phosphorus loading concept (Assume v_S = 10 m/yr.), and (b) what trophic state is the lake likely to be in?

*for use in rational method (Q=CiA); **assume this annual average intensity for i (in./hr).
useful conversions:
- 1 MGD = 1.548 cfs (MGD = million gallons per day)
- 1 mi^2 = 640 acres
- 1 m^3/s = 35.4 cfs
- 1 in/yr = 0.07367 cfs/mi^2
- 1 mg/L-cfs = 5.4 lb/day

hints: for each source, calculate discharge in cfs, sum, and then convert to m^3/s; similarly, for each source calculate loading in lb/day, sum, and then convert to g/yr.

3. (**BAE552 only**): The total P mass balance for a well-mixed lake can be expressed also as:

$$V\frac{dp}{dt} = W - Qp - k_s Vp$$

where

V = Volume (m^3)
p = total phosphorus concentration (mg m^{-3})
t = time (yr)
W = total P loading rate (mg yr^{-1})
Q = outflow (m^3 yr^{-1})
k_s = a first-order settling loss rate (yr^{-1})

Assuming steady-state, show how p can be found expressed as follows:

$$p = \frac{L_p}{H(k_s + \rho)}$$