Solutions to Practice Problems No. 1

2. $Qr = 10$ m3/s
$Qw = 20$ L/s
$Cw = 200$ mg/L
$A_{xs} = 15$ m2 [but note that this is not needed until the next problem]
At steady state, change in storage = 0, so

$m'_{r,mix} = m'_{r,pure} + m'_{w}$

$(QC)_{r,mix} = (QC)_{r,pure} + (QC)_{w}$

$(10 + 0.02$ m3/s$)\ C_{r,mix} = (10$ m3/s$)(0$ mg/L$) + (20$ mg/L$)(200$ L/s$)$

$C_{r,mix} = [\ (0) + (4000$ mg/s$)]\ /(10.02$ m3/s$) = 400$ mg/m3 = **<u>0.4 mg/L = 400 ug/L</u>**

This is **8x** higher than the drinking water std.

3. Without decay the stream at steady state has a uniform concentration of 400 ug/L everywhere. With decay, the conc drops over time, hence over space downstream. First order decay occurs over time, so need to know how much time elapses from discharge to the target point 12 km downstream.

$t_{12km} = L / v = L/(Q/A) = LA/Q = (12{,}000$ m$)(15$ m2$) / (10$ m3/s$) = 18{,}000$ s $= 5$ h

$C_o = 400$ ug (the conc without decay)

$C_{12km} = C_o e^{-kt} = 400$ mg/L [exp-(0.14 h-1)(5 h)] = 400(0.5) = **<u>200 ug/L</u>**

So the conc is only half as much, although still well above the standard.

4. $A_s = 100$ hA = 10^6 m2
$d = 6$ m
$V = 6 \times 10^6$ m3

$Q_1 + Q_2 = Q_3 + Q_{evap} \pm Q_{gw}$

$Q_{evap} = v_{evap}A_s =$ (2 mm/d)(10-3 m/mm)(10^6 m2) / [(86,400 s/d)] = 0.23 m3/s

$(1.2 + 2.0)$ m3/s $= (3.0 + 0.23)$ m3/s $- Q_{gw}$

$Q_{gw} = (3.23 - 3.20)$ m3/s = **<u>0.03 m3/s = 30 L/s</u>** So a small **inflow** of groundwater.
Face velocity is $Q_{gw} / A_{sed} = Q_{gw}/A_s$ if we make the reasonable assumption that sediemnt area is very close to the surface are of a shallow lake.

$v = 0.03$ m3/s / 10^6 m2 = 3×10^{-8} m/s = 0.00001 mm/s = 0.9 mm/d

So the velocity of the water is minuscule, even by groundwater standards.

$T_{res} = V/Q^{in}_{T}$ = 6 x 10^6 m3 / (3.23 m3/s)(86,400 s/d) = **21 d** or 3 weeks

5. Work backward to get mass flow:

$m'_{r,mix} = m'_{r,pure} + m'_{w}$

$m'_{w} = (QC)_{r,mix} - (QC)_{r,pure} = (QC)_{r,mix}$ = (1200 L/s)(100 ug/L) = 120,000 ug/s = 120 mg/s = (120 mg/s)(86,400 s/d) = 10.3 mill mg/d = 10 kg/d

(I asked it in mg/d but obviously better in kg/d)

$(QC)_{r,mix} = (QC)_{r,pure} + (QC)_{w}$

$m'_{lake,out} = m'_{in}$

$Q_3 C_{lake}$ = 120 mg/s

C_{lake} = (120 mg/s)/Q_3 = (120 mg/s)/(3000 L/s) = **0.04 mg/L = 40 ug/L**

So its only 40% of the river concentration due to dilution by Stream 2