Homework 3 Solutions

14.3 The flows can be sorted and tabulated as shown below:

Rank	Flow	Probability	Recurrence Interval	Rank	Flow	Probability	Recurrence Interval
1	0.010	0.050	20.00	11	0.127	0.550	1.82
2	0.017	0.100	10.00	12	0.142	0.600	1.67
3	0.023	0.150	6.67	13	0.187	0.650	1.54
4	0.024	0.200	5.00	14	0.311	0.700	1.43
5	0.051	0.250	4.00	15	0.340	0.750	1.33
6	0.062	0.300	3.33	16	0.453	0.800	1.25
7	0.065	0.350	2.86	17	0.651	0.850	1.18
8	0.089	0.400	2.50	18	0.849	0.900	1.11
9	0.091	0.450	2.22	19	1.331	0.950	1.05
10	0.105	0.500	2.00				

When plotted on probability paper, a 7Q10 of about 0.017 cms can be estimated.

14.4 (*a*) $U^* = \sqrt{9.8(0.9)0.0002} = 0.042 \text{ mps}$

$$E_{lat} = 0.6(0.9)0.042 = 0.02268\frac{\text{m}^2}{\text{s}}$$

$$L_m = 0.4(0.9)\frac{30^2}{0.02268} = 14{,}286 \text{ m}$$

(*b*) $R = \frac{A}{P} = \frac{27}{31.8} = 0.849$

$$n = \frac{1}{U}R^{2/3}S^{1/2} = \frac{1}{0.9}0.849^{2/3}0.0002^{1/2} = 0.014$$

(*c*) Using the formula from Fischer et al. (1979)

$$E = 0.011\frac{0.9^2 30^2}{0.9(0.042)} = 212\frac{\text{m}^2}{\text{s}}$$

or the McQuivey and Keefer (1974) formula

$$E = 0.05937\frac{0.9(27)}{0.0002(30)} = 240\frac{\text{m}^2}{\text{s}}$$

14.6 For a rectangular channel

$$A_c = By \qquad P = B + 2y \qquad R_h = \frac{A_c}{P} = \frac{By}{B+2y}$$

Therefore, Manning's equation can be written as

$$Q = \frac{1}{n}\left(\frac{By}{B+2y}\right)^{2/3} S^{1/2}$$

The values can be substituted and the equation re-expressed as a roots problem

$$f(y) = 0 = \frac{1}{0.025}\left(\frac{30y}{30+2y}\right)^{2/3}(0.0005)^{1/2} - 20$$

This equation can be solved for y = 8.996 m, which can be used to compute

$$A_c = By = 30(8.996) = 270\ \text{m}^2$$

$$U = \frac{Q}{A_c} = \frac{20}{270} = 0.074\frac{\text{m}}{\text{s}}$$

16.4 For this system, the steady-state water balance would be

$$Q_{\text{inflow}} + Q_{\text{prec}} + Q_{\text{ground}} = Q_{\text{evap}} + Q_{\text{out}}$$

The known terms are

$$Q_{\text{in}} = 1000 \qquad Q_{\text{prec}} = 0.001\frac{\text{m}}{\text{d}}(1\times 10^5\ \text{m}^2) = 100$$

$$Q_{\text{out}} = 1000 \qquad Q_{\text{evap}} = 0.0025\frac{\text{m}}{\text{d}}(1\times 10^5\ \text{m}^2)0.7 = 175$$

which can be employed to estimate the groundwater inflow as

$$Q_{\text{ground}} = 3000 + 175 - 1000 - 100 = 2075\frac{\text{m}^3}{\text{d}}$$

16.5 Using the formulas from Lec. 16 (16.12 through 16.15), the evaporation flow can be estimated as

$$L_e = 597.3 - 0.57(30) = 580.2$$

$$f(U_w) = 19.0 + 0.95(1)^2 = 19.95$$

$$e_s = 4.596e^{\frac{17.27(30)}{237.3+30}} = 31.927$$

$$e_a = 4.596e^{\frac{17.27(25)}{237.3+25}} = 23.836$$

$$Q_e = \frac{19.95(31.927 - 23.836)}{580.2(1)100} 1 \times 10^5 = 278 \frac{\text{m}^3}{\text{d}}$$

17.4 A steady-state mass balance for a diffusing/reacting substance in a sediment with negligible burial can be written as

$$0 = D\frac{d^2c}{dz^2} - kc$$

which can be integrated with the boundary conditions

$$c(0) = c_0$$
$$c(\infty) = 0$$

to yield

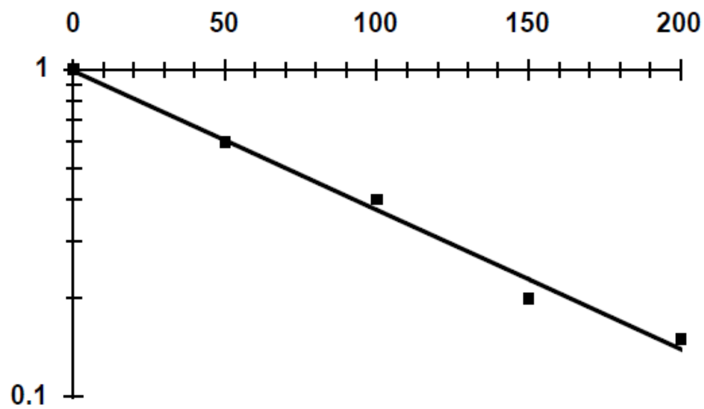
$$c = c_0 e^{-\sqrt{k/D}z}$$

Therefore, if the model holds, a semi-log plot of c/c_0 versus depth should yield a straight line with a slope of $-\sqrt{k/D}$. Such a plot, which is shown below, yields a slope estimate of –0.00979. The reaction rate is

$$k = \frac{0.693}{28} = 0.02476 \text{ yr}^{-1}$$

and the diffusion coefficient can then be estimated as

$$D = \frac{0.02476}{0.00979^2} \frac{\text{cm}^2}{\text{yr}} \cdot \frac{\text{yr}}{86400 \text{ s} \cdot 365 \text{ d}} = 8.19 \times 10^{-6} \frac{\text{cm}^2}{\text{s}}$$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