6.8.2

Channel and flow classification requires three depths: critical, normal, and actual. Normal: use the Manning eq'n (and Table 6.1), Fig 6.4, or computer software. Critical: use Eq'n 6.14 or computer software; e.g., www.eng.auburn.edu/~xzf0001/Handbook/Channels.html

y_n = 1.18 m; y_c = 1.18 m. Since $y_n = y_c$, the channel is critical. Since y/y_c and y/y_n are greater than 1.0; flow is Type 1. **Classification is C-1** (see Fig 6.12)

6.8.5

Channel and flow classification requires three depths: critical, normal, and actual. The normal depth given can be checked using the Manning equation (and Table 6.1), Fig 6.4, or computer software. Critical depth can be checked using Equation 6.14 or computer software. Both depths check: **y_n = 6.52 ft** and **y_c = 3.68 ft.** Since $y_n > y_c$, the channel is mild. Since the depth of flow (4.00 ft) is between critical and normal, it is a type-2 curve; the full **classification is M-2** (see Fig. 6.12). Therefore, the depth rises as you move upstream. The depth of flow 100 ft upstream from the location where the depth is 4.00 ft is **5.18 ft** as computed in the following energy balance.

Note: The url for one Manning calculator is: **www.eng.auburn.edu/~xzf0001/Handbook/Channels.html**

Section	y (ft)	z (ft)	A (ft^2)	V (ft/sec)	$V^2/2g$ (ft)	P (ft)	R_h (ft)	S_e	$S_{e(avg)}$	$h_L = \Delta L \cdot S_{e(avg)}$ (ft)	Total Energy (ft)
1	4.00	0.000	160.0	10.00	1.553	48.0	3.33	1.11E-02	8.04E-03	0.804	6.356
2	5.18	0.250	207.2	7.72	0.926	50.4	4.11	4.99E-03	ΔL =	100	6.356

Notes: A spreadsheet is an efficient way to solve this iterative problem. The depth at section 1 is known, and the depth at section 2 is to be found. Assume a channel bottom elevation at section 1 (in this case, we assumed 0.00 ft, MSL.) The channel elevation at section 2 can be determined with the channel slope and distance between sections. The usual equations are applied to solve for area, velocity, velocity head, wetted perimeter, and hydraulic radius. The energy grade line slope S_e is found using the Manning equation; in this case $S_e = n^2V^2/[2.22{*}R_h^{4/3}]$ (Eq'n 6.27b). Total energy is found by adding energy components (Figure 6.14). Once the spreadsheet equations are programmed, guess the depth at section 2 until total energies at sections 1 and 2 are equal. In this case, the distance step (and thus the elevation difference) is probably too great to be very accurate.

8.5.1

Principles: critical depth/flow and specific energy

Assumptions: frictionless weir

a) Start with Eq'n (6.11) using critical depth subscripts,

$V_c/[g \cdot D_c]^{1/2} = 1$; or $D_c = V_c^2/g$.

However, for rectangular channels, $D_c = y_c$ and

$V_c = Q/A = Q/(b \cdot y_c) = q/y_c$. Therefore,

$y_c = q^2/gy_c^2$ or $y_c = [q^2/g]^{1/3}$ which is Eq'n (6.14)

b) Starting with Eq'n (8.8a), we have

$q = [g(y_c)^3]^{1/2} = [g\{2/3(H_s)\}^3]^{1/2}$;

Substituting g = 9.81 in SI units yields

$q = [9.81\{2/3(H_s)\}^3]^{1/2} = 1.70\ H_s^{3/2}$

8.5.4

Apply Equation (8.7): $H = (3/2)y_c + x$;

$6.20 = (3/2)y_c + 3.60$ ft; $y_c = 1.73$ ft

Now apply Eq'n (8.8a): $q = [g(y_c)^3]^{1/2}$;

$q = [32.2(1.73)^3]^{1/2} = 12.9$ cfs per foot of width

Q = bq = (10)(12.9) = **129 cfs**

Alternatively, we could use Equation (8.8c):

$q = 3.09\ H_s^{3/2} = 3.09(6.20-3.60)^{3/2} = 13.0$ cfs per foot

Q = bq = (10)(13.0) = **130 cfs** (slight round-off error)

Weir V = Q/A = 129/[(10)(1.73)] = **7.46 ft/sec**

8.5.6

For a frictionless weir, Equation (8.8c) is written as:

$q = Q/b = 1.70\ H_s^{3/2}$; H_s is the vertical distance from the weir crest to the upstream water level (ignoring the approach velocity). Using the true energy level given:

$q = C_d\ H_s^{3/2}$; $2.00 = C_d\ (2.60 - 1.40)^{3/2}$; $\mathbf{C_d = 1.52}$

An energy balance at the weir and upstream yields:

$E_{up} = (3/2)y_c + x + h_L$; and from Equation (6.14):

$y_c = [q^2/g]^{1/3}$ $[(2.00)^2/9.81]^{1/3} = 0.742$ m, therefore

$E_{up} = 2.60$ m $= (3/2)(0.742) + 1.40 + h_L$; $\mathbf{h_L = 0.087}$ **m**

8.5.7

From Equation (8.8a); $q = [g(y_c)^3]^{1/2}$

$q = [9.81(0.30)^3]^{1/2} = 0.515$ m^3/sec-m

Q = bq = (0.515)(4) = **2.06 m^3/sec**

From Equation (8.7); $H = (3/2)y_c + x$

H = (3/2)(0.3) + 1.0 = **1.45 m**

If the upstream velocity head was not neglected, perform an energy balance (see Figure 8.7):

$H + V^2/2g = (3/2)y_c + x$; where

$V = q/H = 0.515/H$, therefore

$H + (0.515/H)^2/2g = (3/2)(0.3) + 1.0 = 1.45$;

From the resulting quadratic (or by successive substitution): **H = 1.44 m (<0.01 m change).**