**6.4.3**

From Table 6.1: $A = by = 3(1.7) = 5.1\ m^2$; and

$P = b + 2y = 3 + 2(1.7m) = 6.4$ m.

From Manning's eqn: $Q = (1/n)(A)^{5/3}(P)^{-2/3}(S)^{1/2}$

$15 = (1/0.022)(5.1)^{5/3}(6.4)^{-2/3}(S)^{1/2}$; $\mathbf{S = 0.00567}$

From Eq'n 6.14: $y_c = [(Q^2/(gb^2)]^{1/3}$

$\mathbf{y_c} = [(15^2/(9.81 \cdot 3^2)]^{1/3} = \mathbf{1.37\ m}$

from Eq'n 6.12: $N_f = V/(gD)^{1/2} = (Q/A)/(gD)^{1/2}$

$\mathbf{N_f} = (15/5.1)/(9.81 \cdot 1.7)^{1/2} = \mathbf{0.720}$

$N_f < 1$, therefore flow is **subcritical**.

**6.4.6**

From Table 6.1: $A = (\pi/8)d_o^2 = (\pi/8)(2.25)^2 = 1.99\ ft^2$

$P = (\pi/2)d_o = (\pi/2)(2.25) = 3.53$ ft; $R_h = A/P = 0.564$ ft;

From the Manning eq'n: $V = (1.49/n)(R_h)^{2/3}(S)^{1/2}$

$V = (1.49/0.024)(0.564)^{2/3}(0.005)^{1/2} = 3.00$ ft/s

$\mathbf{E} = V^2/(2g) + y = (3.00)^2/(2 \cdot 32.2) + 1.13 = \mathbf{1.27\ ft}$;

$N_f = V/(gD)^{1/2}$; $D = A/T = 1.99/2.25 = 0.884$;

$N_f = (3.00)/(32.2 \cdot 0.884)^{1/2} = 0.562$ **(<1, subcritical)**

**6.4.7**

$N_f = V/(gD)^{1/2}$;  From Table 6.1: $A = (b + my)y$

$A = [10ft + 1(8.3ft)](8.3ft) = 152\ ft^2$;

$T = b + 2my = 10ft + 2(1)(8.3ft) = 26.6\ ft$

$V = Q/A = 3.16\ ft/s$;  $D = A/T = 152/26.6 = 5.71\ ft$

$\mathbf{N_f} = V/(gD)^{1/2} = 3.16/(32.2\cdot 5.71)^{1/2} = \mathbf{0.233}$ **(subcritical)**

$\mathbf{E} = V^2/2g + y = (3.16)^2/(2\cdot 32.2) + 8.3 = \mathbf{8.46\ ft}$

For critical depth using Figure 6.9a:

$(Qm^{3/2})/(g^{1/2}b^{5/2}) = [(480)1^{3/2})/(32.2^{1/2}10^{5/2}) = 0.267$;

From Fig 6.9a, $my_c/b = (1)y_c/10 = 0.36$; $\mathbf{y_c = 3.60\ ft}$

Alternatively use Eq'n 6.13; $Q^2/g = A^3/T$;

This equation yields: $\mathbf{y_c = 3.65\ ft}$

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**6.4.**8

Using Internet freeware (open channel calculators):

**$y_n$ = 6.92 ft   and   $y_c$ = 3.90 ft**

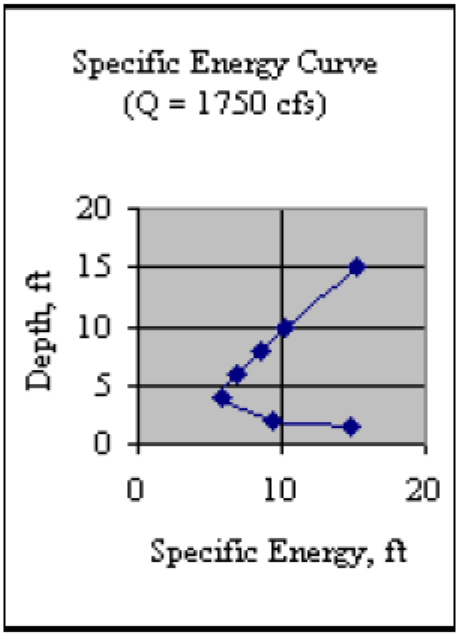
To determine a specific energy curve:

$E = Q^2/(2gA^2) + y = (1750)^2/[2g\{(40)(y)\}^2] + y$

Substituting different y's on either side of $y_c$= 3.90 ft

Q = 1750 cfs
b = 40.0 ft

| y (ft) | E (ft) |
|---|---|
| 1.5 | 14.7 |
| 2.0 | 9.4 |
| 3.9 | 5.9 |
| 6.0 | 6.8 |
| 8.0 | 8.5 |
| 10.0 | 10.3 |
| 15.0 | 15.1 |



**6.4.10**

Using Internet freeware (open channel calculators):

At the entrance to the transition, when b = 12 ft:

$y_i$ = **5.88 ft**; $V_i$ = 7.09 ft/sec; and at the transition exit,

when b = 6 ft: $y_e$ = **13.4 ft**; $V_e$ = 6.23 ft/sec

Based on an energy balance: $H_i = H_e + h_L$ or

$V_i^2/2g + y_i + z_i = V_e^2/2g + y_e + z_e + h_L$; letting $z_e = 0$

$(7.09)^2/2g + 5.88 \text{ ft} + z_i = (6.23)^2/2g + 13.4 \text{ ft} + 0 + 1.5 \text{ ft}$

$z_i$ = **8.84 ft** (the channel bottom height at the inlet)

The table below provides the transition properties.

$H = H_i - h_L$; (losses uniformly distributed in transition)

E = specific energy = H - z, and y is found from

$E = V^2/2g + y = Q^2/[2g\{(b)(y)\}^2] + y$

| Section | Width, b (ft) | z (ft) | H (ft) | E (ft) | y (ft) |
|---|---|---|---|---|---|
| Inlet | 12.0 | 8.84 | 15.50 | 6.66 | 5.88 |
| 25 | 10.5 | 6.63 | 15.13 | 8.50 | 7.94 |
| 50 | 9.0 | 4.42 | 14.75 | 10.33 | 9.80 |
| 75 | 7.5 | 2.21 | 14.38 | 12.17 | 11.70 |
| Exit | 6.0 | 0.00 | 14.00 | 14.00 | 13.40 |