6.2.5

Table 6.1: $A = (b + my)y = [18 + 2y]y = 18y + 2y^2$

$P = b + 2y(1 + m^2)^{1/2} = 18 + 2y(1 + 2^2)^{1/2} = 18 + 4.47y$

$Q = (1.49/n)(A)(R_h)^{2/3}(S)^{1/2} = (1.49/n)(A)^{5/3}(P)^{-2/3}(S)^{1/2}$

$(A)^{5/3}(P)^{-2/3} = Q{\cdot}n/[1.49(S)^{1/2}]$; Substituting,

$(18y+2y^2)^{5/3}(18+4.47y)^{-2/3} = (300)(0.03)/[1.49(0.04)^{1/2}] = 30.2$

Successive approximation, $\mathbf{y_n = 1.33}$ **ft;** From Fig 6.4a

$nQ/[k_M(S^{1/2})(b^{8/3})] = 0.013$; $y_n/b = 0.07$; $\mathbf{y_n = 1.26}$ **ft**

6.2.7

$Q = 52\ m^3/min = 0.867\ m^3/s$; Table 6.1 can't be used.

$A = ½\,(0.8)(0.8{\cdot}m) = 0.32{\cdot}m$; where m = slope

$P = 0.8 + (0.64 + 0.64{\cdot}m^2)^{1/2} = 0.8(1 + (1 + m^2)^{1/2})$

$R_h = A/P = (0.4{\cdot}m)/(1 + (1+m^2)^{1/2})$

Apply Manning's eq'n: $Q{\cdot}n/(S)^{1/2} = (A)(R_h)^{2/3}$;

$(0.867)(0.013)/(0.0016)^{1/2} = 0.282 = (A)(R_h)^{2/3}$

$0.282 = (0.32m)[(0.4m)/(1 + (1+m^2)^{1/2})]^{2/3}$

By successive approximation or computer software:
m = 2.19 m/m

6.2.9

For a circular channel (half full), from Table 6.1:

a) $A = (1/8)(2\theta - \sin 2\theta)d_o^2 = (\pi/8)d_o^2$;

$P = \theta d_o = (\pi/2)d_o$; where $\theta = \pi/2$ (in radians)

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

$5.83 = (1/0.024)[(\pi/8)d_o^2]^{5/3}[(\pi/2)d_o]^{-2/3}(0.02)^{1/2}$

$d_o^{8/3} = 6.35$; $\mathbf{d_o = 2.00\ m}$**;** pipe size for half-full flow

b) $A = (\pi/4)d_o^2$; $P = (\pi)d_o$; Appling Manning's eq'n

$5.83 = (1/0.024)((\pi/4)d_o^2)^{5/3}(\pi d_o)^{-2/3}(0.02)^{1/2}$

$d_o^{8/3} = 3.18$; $\mathbf{d_o = 1.54\ m}$**;** pipe size for full flow

Same results with Figure 6.4b and computer software.

6.3.5

Based on Example 6.4, $m = (3)^{1/2}/3 = 0.577$

which is a slope angle of 60° (Figure 6.6)

Also, $y = b \cdot [(3)^{1/2}/2] = 0.866(b)$ or $b = 1.15y$

For a trapezoidal channel (Table 6.1),

$A = by + my^2$; Substituting for b and solving:

$150 = (1.15y)y + 0.577y^2 = 1.73y^2$; $\mathbf{y = 9.31\ ft}$**;**

And since $b = 1.15y = 1.15(7.60\ m)$; $\mathbf{b = 10.7\ ft}$

To check, determine the length of the channel sides. Since it is a half hexagon, the sides should be equal to the bottom width (see Figure 6.6).

$[(9.31ft)^2 + \{(0.577)(9.31m)\}^2]^{1/2} = 10.7$ ft (ck)

6.3.7

Based on Example 6.4 and Table 6.1:

$A = my^2$ and $P = 2y(1 + m^2)^{1/2}$

Substituting for "m" yields: $P = 2y(1 + A^2/y^4)^{1/2}$

To maximize Q for a given area, minimize P:

$$dP/dy = y(1 + A^2/y^4)^{-1/2}(-4A^2/y^5) + 2(1 + A^2/y^4)^{1/2} = 0$$

$$y(1 + A^2/y^4)^{-1/2}(2A^2/y^5) = (1 + A^2/y^4)^{1/2}$$

Now substituting for A ($A = my^2$) yields

$$y(1 + (my^2)^2/y^4)^{-1/2}(2(my^2)^2/y^5) = (1 + (my^2)^2/y^4)^{1/2}$$

$$y(1 + m^2)^{-1/2}(2m^2/y) = (1 + m^2)^{1/2}$$

$y(2m^2/y) = (1 + m^2)$; $2m^2 = (1 + m^2)$; $\mathbf{m = 1}$; $\boldsymbol{\theta = 45^\circ}$