a. Then using R and the given S and n from table 14.1, I could find the flow rate through the lower channel.

b. I then divided the total flow rate by the lower channel flow rate to get the percentage of pumped water flow with respect to the lower open channel.

Calculations:

a)

$3.387\ \frac{ft^3}{s} \cdot \frac{0.0283168\ \frac{m^3}{s}}{1\ \frac{ft^3}{s}}$ $2511\ ft \cdot \frac{0.3048\ m}{1\ ft}$

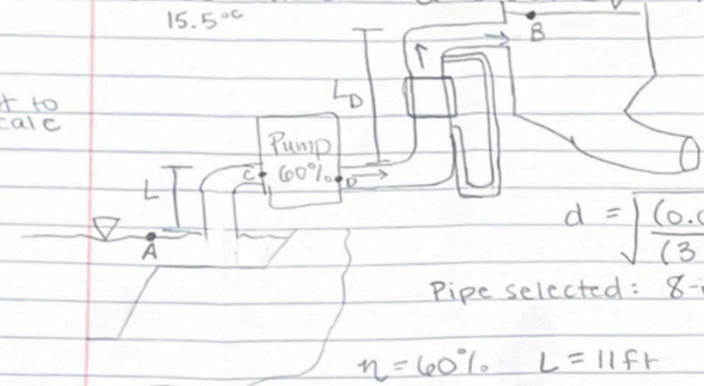
$= 0.0959\ \frac{m^3}{s}$ $= 765.35\ m$

Test 2 - fluids

a) 60°F water $Q = 3.387\ \frac{ft^3}{s}$ $V = 3\ \frac{m}{s}$

15.5°C

*not to scale



$Q = A \cdot V$

$Q = \frac{\pi}{4} d^2 \cdot V$

$\sqrt{\frac{Q4}{V\pi}} = d$

$d = \sqrt{\frac{(0.0959\ \frac{m^3}{s}) \cdot 4}{(3\ \frac{m}{s}) \cdot \pi}} = 0.202\ m \approx 202\ mm$

Pipe selected: 8-in Schedule 40 steel pipe

$\eta = 60\%$ $L = 11ft$ $L_D = 2{,}500ft$ (no turbine)

$$h_p + \overset{0}{\cancel{\frac{P_A}{\gamma}}} + \overset{0}{\cancel{\frac{V_A^2}{2g}}} + \overset{0ft}{\cancel{z_A}} = \overset{0}{\cancel{\frac{P_B}{\gamma}}} + \overset{0}{\frac{V_B^2}{2g}} + \underset{2511ft}{\overset{(L+L_D)}{z_B}} + \overset{0}{\cancel{h_t}} + h_{L_{A-B}}$$

$0 = -h_p + 2511ft + h_L$ $h_L = f\left(\frac{L}{D}\right)\left(\frac{V_B^2}{2g}\right)$

Water @60F
$2.35\ E-5\ \frac{lb\text{-}s}{ft^2}$ dynamic
$\rho = 62.4\ \frac{lb}{ft^3}$
$\rho = 999.5544\ \frac{kg}{m^3}$
$1.15\ E-3\ Pa \cdot s$

$Re = \frac{\rho v D}{\mu}$

$Re = \frac{(999.5544\ \frac{kg}{m^3})(3\ \frac{m}{s})(0.2027m)}{(1.15\ E-3\ Pa \cdot s)}$ $\frac{N}{m^2}$

$Re = 528{,}547$

$V_B = Q/A_B$

$V_B = \frac{(0.0959\ \frac{m^3}{s})}{\frac{\pi}{4}(0.2027\ m)^2}$

For steel: $\epsilon = 4.6E-5m$

$D = 202.7mm$
$0.2027m$

excel equation $f = \frac{0.25}{\left[\log\left(\frac{1}{3.7(4406.5)} + \frac{5.74}{(528{,}547)^{0.9}}\right)\right]^2}$

$f = 0.015689$

$\frac{D}{\epsilon} = \left(\frac{0.2027m}{4.6E-5m}\right)$

$\frac{D}{\epsilon} = 4406.5$

$h_L = (0.015689)\left(\frac{765.35\ m}{0.2027m}\right)\left(\frac{(3\ \frac{m}{s})^2}{2(9.81\ \frac{m}{s^2})}\right) = 27.17m$

$\frac{N \cdot m}{s} = W$

$h_p = 765.35m + 27.17m$

$h_p = 792.52m$

$Power = \frac{Q\gamma h_p}{\eta} = \frac{(0.0959\ \frac{m^3}{s})(9.81\ \frac{kN}{m^3})(792.52m)}{0.6}$

$Power = 1{,}242.6\ kW$