QUIZ 1
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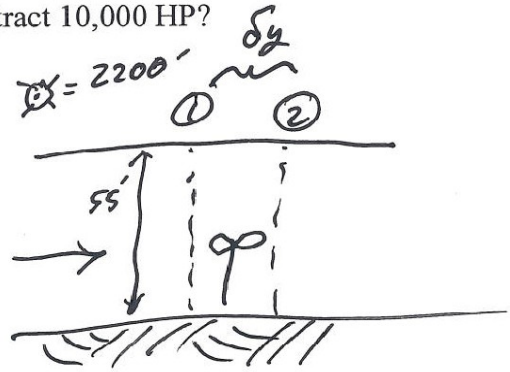
4/14

At a site on the Mississippi River, it is proposed to install run-of-the-river-turbines.

Assume that the River current at the site is 5 ft/sec, the D~ R = 55 ft and the P = 2200 ft. $\simeq b = B$ b/c very wide vs. shallow

1. What is the flow in the River? 605,000 cfs

2. What will be the impact on the water depth if the turbines extract 10,000 HP?



Select the best answer:

a) Upstream depth will increase by about 0.15ft
b) Upstream depth will decrease by about 0.15ft
c) Downstream depth will increase by about 0.15ft
d) Downstream depth will decrease by about 0.15ft
e) None of the above.

NOTE 1HP =550 ft-lbs/sec. $\times 10{,}000^{HP} \simeq 5{,}500{,}000 \frac{ft\,lb}{s}$

Show proof!

Assume: upstream velocity ≃ downstream velocity

$Q = AV$
$= 5\frac{ft}{s}(55ft)(2200ft)$
$= 605{,}000 \frac{ft^3}{s}$

$\alpha_1 = \alpha_2 = 1$
$h_{z_1} = h_{z_2}$
$h_L = \emptyset$ b/c elevation = b/t points

$N_{F_1} = \frac{5}{(32.2(55))^{0.5}} = << 1$
∴ depth is prob. more important than velocity

* Assume pt. ① & ② = same elevation

$V_1 \sim V_2 \sim 5 ft/s$

Head extracted by turbine

Energy Equ.

mechanical energy head

Rate of power out

$H_{T_1} = H_{T_2} + h_{L_{1-2}} + H_{Tb}$

$y_1 + h_{z_1} + \alpha_1 \frac{V_1^2}{2g} = y_2 + h_{z_2} + \alpha_2 \frac{V_2^2}{2g} + h_{L_{1-2}} + \frac{P'_{out}}{\gamma Q}$

$y_1 = y_2 + (h_{z_2} - h_{z_1}) + \left(\frac{\alpha_2 V_2^2}{2g} - \frac{\alpha_1 V_1^2}{2g}\right) + \frac{h_{L_{1-2}} + 5500000}{62.4(605000)}$

$y_1 - y_2 = 0.146 \sim 0.15 ft$ (upstream change)

Correct for velocity

If $V_2 = 5 ft/s$; $V_1 = \frac{V_2 A_2}{A_1} = \frac{605{,}000}{(55+0.15)(2200)}$
$= 4.99 ft/s$

$\left\{\frac{5^2}{64.4} - \frac{4.992}{64.4} = 0.002\right.$ (very little effect)