DESIGN A WATER PUMPING SYSTEM

1. DO ROUGH LAYOUT
   - PIPE
   - PUMP
   - VALVES

2. DETERMINE PIPE SIZE (DISCHARGE)
   $\dot{Q} = VA$
   $A = \frac{\pi D^2}{4}$
   $V \rightarrow$ SELECT A VELOCITY. FROM NORMS.

3. DETERMINE SUCTION PIPE SIZE
   - ONE STANDARD SIZE LARGER THAN DISCHARGE

4. CALCULATE ACTUAL FLOW VELOCITIES
   - DISCHARGE $\rightarrow \dot{Q} = VA$
   - SUCTION $\rightarrow \dot{Q} = VA$

5. DETERMINE REYNOLDS NUMBER
   - DISCHARGE $\rightarrow N_R = \frac{VD}{\nu} = \frac{VD\rho}{\mu}$
   - SUCTION $\rightarrow N_R = \frac{VD\rho}{\mu}$

6. CHOOSE PIPE MATERIAL

7. DETERMINE RELATIVE ROUGHNESS,
   - DISCHARGE $\rightarrow \varepsilon/D$
   - SUCTION $\rightarrow \varepsilon/D$

8. DETERMINE FRICTION FACTOR, f
   - DISCHARGE $\rightarrow$ MOODY DIAGRAM
   - SUCTION $\rightarrow$ MOODY DIAGRAM

9. DETERMINE PIPE LENGTH
   - DISCHARGE
   - SUCTION

10. CALCULATE PIPE HEAD LOSS, h_L
    $h_L = f \frac{L}{D} \frac{V^2}{2g}$
    - DISCHARGE
    - SUCTION.

11. DETERMINE FITTING HEAD LOSS, h_L
    $h_L = \left[\Sigma K + f\Sigma\left(\frac{L}{D}\right)_E\right]\frac{V^2}{2g}$
    - DISCHARGE
    - SUCTION.

12. DETERMINE HEAD ADDED BY PUMP, h_A
    $\frac{P_1}{\gamma} + z_1 + \frac{V_1^2}{2g} + h_A - h_R - h_L = \frac{P_2}{\gamma} + z_2 + \frac{V_2^2}{2g}$

13. SELECT PUMP : $\dot{Q}$ & h_A
    - PUMP CURVES

14. CHECK SUCTION DESIGN.
    $NPSH_A > NPSH_R$
    (IF IT FAILS.. CHANGE THE DESIGN!