Sidney's Big Book of Water and Wastewater Math

INDIGO WATER GROUP

Unit Conversions to Know by Heart

1 inch = 2.54 centimeters
1 meter = 3.28 feet
1 mile = 5280 feet

1 acre = 43,560 ft^2
1 m^2 = 10.76 ft^2

1 gallon = 3.785 liters
1 ft^3 = 7.48 gallons
1 m^3 = 35.31 ft^3

1 ft water = 0.433 psi

1 gallon = 8.34 lbs when specific gravity is 1.0
1 kg = 2.2 lbs

1% = 10,000 mg/L
1 mg/L = 1 ppm
1 μg/L = 1 ppb

1 day = 1440 minutes
1 hp = 0.746 kW

1 gram = 15.43 grains
1 grain per gallon = 17.1 mg/L

Water Formulas

pounds per day = (concentration in mg/L)*(flow rate in mgd)*(8.34)

chlorine dose = demand + residual

$$\text{velocity} = \frac{\text{flow}}{\text{area}} \qquad V = \frac{Q}{A}$$

$$\text{flow rate} = \frac{\text{volume}}{\text{time}} \qquad Q = \frac{V}{t}$$

$$\text{overflow rate} = \frac{\text{flow rate}}{\text{area}}$$

$$\text{weir loading rate} = \frac{\text{flow rate}}{\text{feet of weir}}$$

(concentration 1)*(volume 1) = (concentration 2)*(volume 2) $\qquad C_1V_1 = C_2V_2$

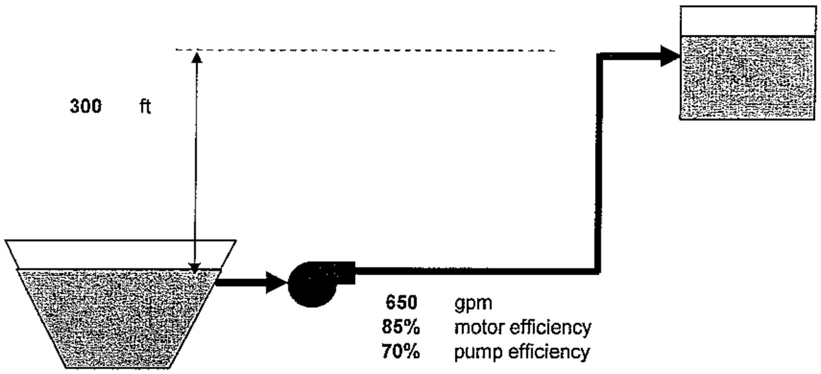
(conc. 1)*(volume 1) + (conc. 2)*(volume 2) = (conc. 3)*(volume 3)

$$C_1V_1 + C_2V_2 = C_3V_3$$

$$\text{horsepower} = \frac{(\text{flow in gpm})*(\text{lift in feet})}{3960}$$

Pumps

Numbers in **RED** can be changed. Numbers in **BLUE** are calculated by the spreadsheet.



Water Horsepower = {(GPM x Pump head)/ 3,956}	**49.3**	hp	Run Time	**12**	hours per day
				5	days per week
Brake Horsepower = Water Horsepower / % Pump Efficiency	**70.4**	hp			
			Electricty Cost		
Electrical or Motor Horsepower = Brake Horsepower / % Motor E	**82.8**	hp		**0.09**	$/kwh

** Sometimes, this is called the wire to water horsepower.

Problem One:

> Water is being pumped from a reservoir uphill 300 to a storage tank. Calculate the Brake Horsepower if the pump rate is 650 gpm.

Answer: 70.4 hp

Problem Two:

> A 25 horsepower pump is used to dewater a lake. If the pump runs for 12 hours a day for 5 days a week, how much will it cost to run the pump per week? Assume energy costs of 0.09 dollars per kilowatt hour.

Answer: $100.71

25 hp	**0.746** kw	**0.09** $	**12** hours	**5** days	**$100.71**
	1 hp	1 kw*h	1 day	1 week	week

** Set it up this way because you need 25 horsepower per hour to run this pump.

25 ~~hp~~	**0.746** ~~kw~~	**0.09** $	**12** ~~hours~~	**5** ~~days~~	**$100.71**
	1 ~~hp~~	1 ~~kw*h~~	1 ~~day~~	1 week	week

Problem Three:

> Calculate the water horsepower required for a pump to raise water 300 feet at a rate of 650 gallons per minute. If the pump runs for 12 hours a day for 5 days a week, how much will it cost to run the pump for one year? Assume energy costs of 0.09 dollars per kilowatt hour.

Answer: 49.3 hp

Answer: $10,327.21

49.3 hp	**0.746** kw	**0.09** $	**12** hours	**5** days	**52** weeks	**$10,327.21**
	1 hp	1 kw*h	1 day	1 week	1 year	year

Pumps and Pressure

1. A pump station is used to lift water 50 feet above the pump station to a storage tank. If the pump is 4.2 hp and has a motor efficiency of 0.9 and a pump efficiency of 0.85 , how fast can the pump station pump water into the tank?

Answer: gpm

2. The pressure gage at the bottom of a tank reads 35 psi. How many feet of water are in the tank?
Answer: feet

3. Water is being pumped from a reservoir uphill 120 to a storage tank. Calculate the Brake Horsepower if the pump rate is 1200 gpm.

Answer: hp

4. A 25 horsepower pump is used to dewater a lake. If the pump runs for 8 hours a day for 7 days a week, how much will it cost to run the pump per week? Assume energy costs of 0.07 dollars per kilowatt hour.

Answer:

5. A water tank contains 80,000 gallons of water and is 80.85 feet deep. What is the water pressure at the bottom of the tank?

Answer: psi

6. Water is being pumped from a reservoir uphill 120 to a storage tank. Calculate the Brake Horsepower if the pump rate is 600 gpm.

Answer: hp

7. A 25 horsepower pump is used to dewater a lake. If the pump runs for 5 hours a day for 5 days a week, how much will it cost to run the pump per week? Assume energy costs of 0.07 dollars per kilowatt hour.
Answer:

8. The pressure gage at the bottom of a tank reads 20 psi. How many feet of water are in the tank?

Answer: feet

9. Calculate the water horsepower required for a pump to raise water 120 feet at a rate of 600 gallons per minute. If the pump runs for 5 hours a day for 5 days a week, how much will it cost to run the pump for one year? Assume energy costs of 0.07 dollars per kilowatt hour.

Answer: hp
Answer: $

10. A water tank contains 80,000 gallons of water and is 115.5 feet deep. What is the water pressure at the bottom of the tank?

Answer: psi

11. Calculate the water horsepower required for a pump to raise water 120 feet at a rate of 600 gallons per minute. If the pump runs for 24 hours a day for 7 days a week, how much will it cost to run the pump for one year? Assume energy costs of 0.09 dollars per kilowatt hour.

Answer: hp
Answer: $

12. Water is being pumped from a reservoir uphill 50 to a storage tank. Calculate the Brake Horsepower if the pump rate is 250 gpm.

Answer: hp

13. A pump station is used to lift water 500 feet above the pump station to a storage tank. If the pump is 49.6 hp and has a motor efficiency of 0.9 and a pump efficiency of 0.85 , how fast can the pump station pump water into the tank?

Answer: gpm

14. Calculate the water horsepower required for a pump to raise water 500 feet at a rate of 300 gallons per minute. If the pump runs for 24 hours a day for 7 days a week, how much will it cost to run the pump for one year? Assume energy costs of 0.09 dollars per kilowatt hour.

Answer: hp
Answer: $

JOB ____ JOB NO. ____

SHEET NO. ____ OF ____

CALCULATED BY ____ DATE ____

CHECKED BY ____ DATE ____

SUBJECT ____

PUMPS & PRESSURE

1. $$HP = \frac{(gpm)(TDH, ft)}{(3960)(E_p)(E_m)}$$

$$4.2\ HP = \frac{(gpm)(50\ ft)}{(3960)(0.85)(0.9)}$$

$$4.2\ hp = \frac{(gpm)(50\ ft)}{3029.4}$$ ← simplify, then, cross multiply

$$(4.2\ hp)(3029.4) = (gpm)(50\ ft)$$

$$12723.48 = (gpm)(50\ ft)$$ ← divide both sides by 50 ft

$$254.5 = gpm$$

2. $$35\ psi \left| \frac{1\ ft}{0.433\ psi} \right| = 80.8\ ft$$

3. $$HP = \frac{(gpm)(HEAD, ft)}{3960}$$ ← no efficiency terms were given, so don't assume any

$$HP = \frac{(1200\ gpm)(120\ ft)}{3960}$$

$$HP = 36$$

4. $$25\ HP \left| \frac{0.745\ kw}{1\ HP} \right| \frac{\$0.07}{1\ kwh} \left| \frac{8\ hrs}{1\ day} \right| \frac{7\ days}{week} \right| = 73.01\ \frac{\$}{week}$$

5. $$80.85\ ft \left| \frac{0.433\ psi}{1\ ft} \right| = 35\ psi$$

JOB ______ JOB NO. ______

SHEET NO. ______ OF ______

CALCULATED BY ______ DATE ______

CHECKED BY ______ DATE ______

SUBJECT ______

6. $HP = \frac{(gpm)(TDH)}{3960}$

$HP = \frac{(600\,gpm)(120\,ft)}{3960}$

$HP = 18.2$

7. $25\,HP \left| \frac{0.745\,kw}{1\,HP} \right| \frac{\$0.07}{1\,kwh} \left| \frac{5\,hrs}{1\,day} \right| \frac{5\,days}{1\,week} \right| = 32.59\ \frac{\$}{wk}$

8. $20\,psi \left| \frac{1\,ft}{0.433\,psi} \right| = 46.2\ feet$

9. $HP = \frac{(gpm)(TDH, ft)}{3960}$

$HP = \frac{(600\,gpm)(120\,ft)}{3960}$

$HP = 18.18\,HP$

$18.18\,HP \left| \frac{0.745\,kw}{1\,HP} \right| \frac{\$0.07}{1\,kw \cdot h} \left| \frac{5\,hrs}{1\,day} \right| \frac{5\,days}{1\,week} \right| \ 23.70\ \frac{\$}{week}$

10. $115.5\,ft \left| \frac{0.433\,psi}{1\,ft} \right| = 50\,psi$

11. From #9, we know the pump HP is 18.18 HP

$18.18\,HP \left| \frac{0.745\,kw}{1\,HP} \right| \frac{\$0.09}{1\,kw \cdot h} \left| \frac{24\,hrs}{1\,day} \right| \frac{7\,days}{1\,week} \left| \frac{52\,weeks}{1\,year} \right| =$

$\$10648.91 / year$

Pump Problems

90. A centrifugal pump is pumping 200 gpm against a 40 ft total pumping head. The output power of the pump is approximately ______ hp.

a) 0.5
b) 2
c) 15
d) 121

91. A raw water pump with a 6" bore and a 3" stroke pumps 60 cycles/minute. What is the pumping rate in gpm?

a) 18 gpm
b) 26.75 gpm
c) 22.5 gpm
d) 14.3 gpm

92. What is the flow rate (gpm) from a pump with a discharge diameter of 6" and a velocity of 5 ft/sec?

a) 198 gpm
b) 440 gpm
c) 44 gpm
d) 338.5 gpm

93. What is the pumping rate in gpm of the following piston pump? Diameter = 10 inches, Stroke length = 6 inches, Strokes/min = 30

a) 293.6 gpm
b) 86.9 gpm
c) 45.5 gpm
d) 62.1 gpm

94. A centrifugal pump is pumping 200 gal/min against a 40-foot total pumping head. The approximate output power of is 2 HP. What will the output power be if the pumping head increased to 60 feet?

a) 1 hp
b) 2 hp
c) 3 hp
d) 8 hp

95. A single-piston reciprocating pump has a 6" diameter piston with a 6" length of stroke. It makes 16 discharge strokes/min, the pumping rate is _______ gpm.

a) 6
b) 12
c) 25
d) 47

96. A pump delivers 240,000 gallons per day at a static head of 275 feet. Calculate the pressure equivalent to this head, expressed in pounds per square inch.

a) 275 psi
b) 119 psi
c) 550 psi
d) 635 psi

97. Determine the flow capacity of a pump in gpm if the pump lowers the water in a six-foot square clear well by 8 inches in 5 minutes.

a) 57.6 gpm
b) 92.4 gpm
c) 179.5 gpm
d) 35.9 gpm
e) 430 gpm

98. What horsepower must a pump deliver to water that must be lifted 90 feet? The flow is 40 gpm.

a) '1.0 HP
b) '50 HP
c) '0.9 HP
d) '60 HP
e) '76 HP

99. If the required water horsepower of a pump is 50 HP, what must the motor horsepower be if the efficiency of the pump is 75 percent and the efficiency of the motor is 90 percent?

a) 74 HP
b) 40.5 HP
c) 50 HP
d) 89 HP
e) 111 HP

100. How many kilowatt-hours per day are required by a pump with a motor horsepower of 50 horsepower when the pump operates 24 hours a day?
a) 716 kW-hr/day
b) 960 kW-hr/day
c) 894 kW-hr/day
d) 1,075 kW-hr/day
e) 1,287 kW-hr/day

Jar Testing

101. Through jar testing, you have determined that your best Alum dose is 5 mg/L. Your liquid alum has a specific gravity of 1.31 and its strength is 49.8%. Your plant flow is 700 GPM. How many mL/min will your chemical feed pump need to pump to produce this residual?
a) 84.1 mL/min
b) 200 mL/min
c) 10.1 mL/min
d) 20.3 mL/min
e) 42.0 mL/min

Miscellaneous

102. If the water rate is $5.50 for the first 500 cu ft and all water used over the minimum is billed at a rate of $0.25 per 100 cu ft, how much would a customer using 1200 cu ft be billed?
a) $5.25
b) $6.25
c) $6.75
d) $7.25

103. Calculate the percent reduction in flows achieved by an industrial water conservation program if water flows are reduced from 350 gpm to 220 gpm
a) 31%
b) 37%
c) 44%
d) 59%
e) 63%

Pump Problems

90. $HP = \frac{(Q, gpm)(Head, ft)}{(3960)(efficiency)}$

$HP = \frac{(200 gpm)(40 ft)}{3960}$

$HP = 2.0$

91. Convert all dimensions to feet. Then, find the volume pumped per stroke.

$\frac{6 \text{ inches}}{} \Big| \frac{1 \text{ foot}}{12 \text{ inches}} \Big| = 0.5 \text{ ft}$ ∴ radius = 0.25 ft

$\frac{3 \text{ inches}}{} \Big| \frac{1 \text{ foot}}{12 \text{ inches}} \Big| = 0.25 \text{ ft}$

$Volume = \pi r^2 d$

$Volume = (3.14)(0.25 \text{ ft})^2(0.25 \text{ ft})$

$Volume = 0.049 \text{ ft}^3$

$\frac{0.049 \text{ ft}^3}{\text{stroke}} \Big| \frac{60 \text{ strokes}}{1 \text{ minute}} \Big| \frac{7.48 \text{ gallons}}{1 \text{ ft}^3} \Big| = 22 \frac{\text{gallons}}{\text{min}}$

92. $Velocity = \frac{Flow}{Area}$

diameter = 0.5 ft
radius = 0.25 ft

$\frac{5 \text{ ft}}{\text{sec}} = \frac{Flow}{(\pi)(r^2)}$

$\frac{5 \text{ ft}}{\text{sec}} = \frac{Flow}{(3.14)(0.25^2)}$

$5 = \frac{Flow}{0.19625}$

$0.981 \frac{\text{ft}^3}{\text{sec}} = Flow$

92. (cont.)

$$\frac{0.981\ ft^3}{sec} \Big| \frac{7.48\ gallons}{1\ ft^3} \Big| \frac{60\ sec}{1\ min} \Big| = 440\ \frac{gallons}{min}$$

93. $\frac{10\ inches}{} \Big| \frac{1\ foot}{12\ inches} \Big| = 0.83\ ft$ $\therefore$ radius $= 0.42\ ft$

$$Volume = \pi r^2 d$$

$$V = (3.14)(0.42\ ft)^2(0.5\ ft)$$

$$V = (3.14)(0.42\ ft)(0.42\ ft)(0.5\ ft)$$

$$V = 0.2769\ ft^3/stroke$$

$$\frac{0.2769\ ft^3}{stroke} \Big| \frac{30\ strokes}{minute} \Big| \frac{7.48\ gallons}{1\ ft^3} \Big| = 62.1\ \frac{gallons}{minute}$$

94. $HP = \frac{(Q, gpm)(Head, ft)}{3960}$

$$HP = \frac{(200\ gpm)(60\ ft)}{3960}$$

$$HP = 3.03$$

95. $\text{Volume} = \pi r^2 d$

$V = (3.14)(0.25\text{ ft})^2(0.5\text{ ft})$

$V = (3.14)(0.25\text{ ft})(0.25\text{ ft})(0.5\text{ ft})$

$V = 0.098125\text{ ft}^3$

$\frac{0.098125\text{ ft}^3}{\text{stroke}} \Big| \frac{16\text{ strokes}}{\text{minute}} \Big| \frac{7.48\text{ gallons}}{1\text{ ft}^3} \Big| = 11.74\ \frac{\text{gallons}}{\text{min}}$

96. $275\text{ ft head} \Big| \frac{0.433\text{ psi}}{1\text{ ft head}} \Big| = 119\text{ psi}$

97. $Q = \frac{\text{Volume}}{\text{time}}$

$Q = \frac{24\text{ ft}^3}{5\text{ minutes}}$

$Q = 4.8\text{ ft}^3/\text{min}$

$\text{Volume} = (l)(w)(d)$

$V = (6\text{ ft})(6\text{ ft})(8\text{ inches})$

$V = (6\text{ ft})(6\text{ ft})(0.67\text{ ft})$

$V = 24\text{ ft}^3$

$\frac{4.8\text{ ft}^3}{\text{min}} \Big| \frac{7.48\text{ gallons}}{1\text{ ft}^3} \Big| = 35.9\ \frac{\text{gallons}}{\text{minute}}$

98. $HP = \frac{(Q,\text{ gpm})(\text{Head, ft})}{3960}$

$HP = \frac{(40\text{ gpm})(90\text{ ft})}{3960}$

$HP = 0.90$

99. If the motor needs to be 50 HP at 100% efficiency, then it needs be larger as efficiency decreases.

$$50\ HP = \frac{(Q)(head)}{3960}$$

$$198000 = (Q)(head)$$

$$HP = \frac{(Q)(head)}{(3960)(E_{motor})(E_{pump})}$$

$$HP = \frac{198000}{(3960)(0.90)(0.75)}$$

$$HP = 74$$

100. $\frac{50\ HP}{hour} \Big| \frac{0.745\ kWh}{1\ HP} \Big| \frac{24\ hours}{1\ day} \Big| = 894\ \frac{kW\text{-}hr}{day}$

101. ppd Alum = (mg/L)(Q, mgd)(8.34)

$\frac{700\ gallons}{minute} \Big| \frac{1\ MG}{1000000\ gal} \Big| \frac{1440\ min}{1\ day} \Big| = 1.008\ mgd$

ppd Alum = (5 mg/L)(1.008 mgd)(8.34)
ppd Alum = 42.0

ppd Alum = (mg/L)(Q, mgd)(8.34)
42.0 ppd = (49.8%)(10,000)(Q)(8.34)(1.31)
0.000007719 mgd = Q
7.72 gpd = Q

101 (cont.)

$$\frac{7.72 \text{ gallons}}{\text{day}} \left| \frac{1 \text{ day}}{1440 \text{ min}} \right| \frac{3.785 \text{ L}}{1 \text{ gallon}} \left| \frac{1000 \text{ mL}}{1 \text{ L}} \right| = 20.3 \frac{\text{mL}}{\text{min}}$$

MISC.

102. 1200 cuft
− 500 cuft ← charged \$5.50
700 cuft ← charged (7)(0.25) = \$1.75

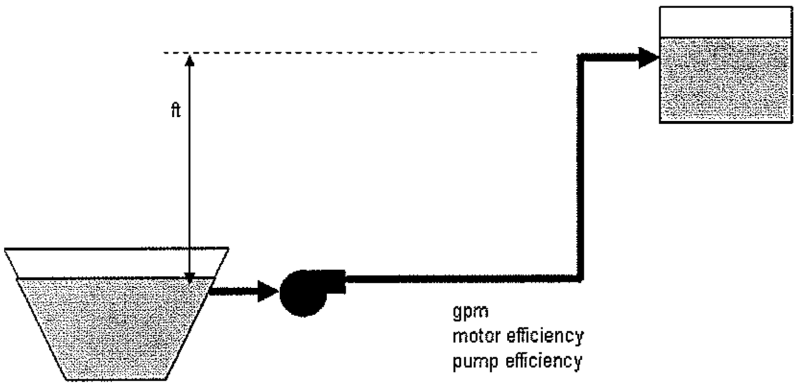
TOTAL CHARGE = \$5.50
+ \$1.75
\$7.25

103. $\% \text{ Reduction} = \left[\frac{350 \text{ gpm} - 220 \text{ gpm}}{350 \text{ gpm}} \right] * 100$

$\% \text{ Reduction} = \left[\frac{130 \text{ gpm}}{350 \text{ gpm}} \right] * 100$

% Reduction = 37

PUMPS



1. A centrifugal pump is pumping 200 gpm against a 40 ft total pumping head. The output power of the pump is approximately ______ hp.
   a) 0.5
   b) 2
   c) 15
   d) 121

2. A sludge pump with a 6" bore and a 3" stroke pumps 60 cycles/minute. What is the pumping rate in gpm?
   a) 22 gpm
   b) 18 gpm
   c) 27 gpm
   d) 35 gpm

3. What is the flow rate (gpm) from a pump with a discharge diameter of 6" and a velocity of 5 ft/sec?
   a) 440 gpm
   b) 198 gpm
   c) 44 gpm
   d) 338.5 gpm

4. What is the pumping rate in gpm of the following piston pump? Diameter = 10 inches, Stroke length = 6 inches, Strokes/min = 30
   a) 60.6 gpm
   b) 293.6 gpm
   c) 86.9 gpm
   d) 45.5 gpm

5. A single-piston reciprocating pump has a 6" diameter piston with a 6" length of stroke. It makes 16 discharge strokes/min, the pumping rate is ______gpm.
a) 6
b) 12
c) 25
d) 47

6. A centrifugal pump is pumping 650 gal/min against a 32-foot total pumping head. What is the approximate output power of the pump?
a) 1 hp
b) 5 hp
c) 3 hp
d) 8 hp
?Operations Forum May 1997

7. A pump delivers 240,000 gallons per day at a static head of 275 feet. Calculate the pressure equivalent to this head, expressed in pounds per square inch.
a) 119 psi
b) 275 psi
c) 550 psi
d) 635 psi
?WEF/ABC 2002 Guide

8. Water is being pumped from a reservoir uphill 120 to a storage tank. Calculate the Brake Horsepower if the pump rate is 1200 gpm.
a. 15
b. 36
c. 120
d. 8

9. A 25 horsepower pump is used to dewater a lake. If the pump runs for 8 hours a day for 7 days a week, how much will it cost to run the pump per week? Assume energy costs of 0.07 dollars per kilowatt hour.
a. $27.50
b. $92.15
c. $73.11
d, $112.35

10. Calculate the water horsepower required for a pump to raise water 120 feet at a rate of 1200 gallons per minute. If the pump runs for 8 hours a day for 7 days a week, how much will it cost to run the pump for one year? Assume energy costs of 0.07 dollars per kilowatt hour.
a. $15.03
b. $105.27
c. $5,489.00
d. $489.12

JOB Pumps JOB NO. 116

SHEET NO. ____ OF ____

CALCULATED BY ____ DATE ____

CHECKED BY ____ DATE ____

SUBJECT ____

$$HP = \frac{(gpm)(\text{Total Dynamic Head, ft})}{(3960)}$$

$$BHP = \frac{(gpm)(\text{Total Dynamic Head, ft})}{(3960)(\text{Pump Efficiency})(\text{Motor Efficiency})}$$

TOTAL DYNAMIC HEAD = FT OF LIFT + FRICTION LOSSES

1. $HP = \frac{(gpm)(head, ft)}{3960 \times E_m}$

$HP = \frac{(200 gpm)(40 ft)}{3960}$

$HP = 2$

2. BORE = 6" = 0.5 ft = diameter

STROKE = 3" = 0.25 ft

Volume per Stroke = $\pi r^2 h$

$= (3.14)(0.25 ft)(0.25 ft)(0.25 ft)$

$= 0.049 ft^3$

$$\frac{0.049 ft^3}{stroke} \Big| \frac{7.48 gal}{1 ft^3} \Big| \frac{60 strokes}{1 min} \Big| \; 22.0 \frac{gal}{min}$$

3. Velocity = $\frac{Flow}{Area}$

$\frac{5 ft}{sec} = \frac{Flow}{0.196 ft^2}$

$0.98 ft^3/sec = Flow$

Area = πr^2

$= (3.14)(0.25 ft)(0.25 ft)$

$= 0.196 ft^2$

JOB Pumps JOB NO. 117

SHEET NO. ______ OF ______

CALCULATED BY ______ DATE ______

CHECKED BY ______ DATE ______

SUBJECT ______

3. (cont.) $\frac{0.98\ ft^3}{sec} \left| \frac{7.48\ gal}{1\ ft^3} \right| \frac{60\ sec}{1\ min} \Big| = 439.8\ \frac{gal}{min}$

4. DIAMETER = 10 inches = 0.83 feet
STROKE LENGTH = 6 inches = 0.5 feet

VOLUME PER STROKE $= \pi r^2 h$
$= (3.14)(0.415\ ft)(0.415\ ft)(0.5\ ft)$
$= 0.27\ ft^3$

$\frac{0.27\ ft^3}{stroke} \left| \frac{30\ strokes}{1\ min} \right| \frac{7.48\ gal}{1\ ft^3} \Big| = 60.6\ \frac{gal}{min}$

5. DIAMETER = 6" = 0.5 ft
STROKE LENGTH = 6" = 0.5 ft

VOLUME PER STROKE $= \pi r^2 h$
$= (3.14)(0.25\ ft)(0.25\ ft)(0.5\ ft)$
$= 0.098\ ft^3$

$\frac{0.098\ ft^3}{stroke} \left| \frac{16\ strokes}{1\ min} \right| \frac{7.48\ gal}{1\ ft^3} \Big| = 11.7\ \frac{gal}{min}$

6. $HP = \frac{(gpm)(head, ft)}{3960}$

$HP = \frac{(650\ gpm)(32\ ft)}{3960}$

$HP = 5.25$

JOB Pumps JOB NO. 118

SHEET NO. ______ OF ______

CALCULATED BY ______ DATE ______

CHECKED BY ______ DATE ______

SUBJECT ______

7. Convert feet to psi

$$275 \text{ feet} \left| \frac{0.433 \text{ psi}}{1 \text{ ft}} \right| = 119 \text{ psi}$$

8. $$HP = \frac{(\text{gpm})(\text{Head, ft})}{3960}$$

$$HP = \frac{(1200 \text{ gpm})(120 \text{ ft})}{3960}$$

$$HP = 36$$

9. $$25 \text{ hp} \left| \frac{0.746 \text{ kw}}{\text{hp-h}} \right| \frac{8 \text{ hr}}{\text{day}} \left| \frac{7 \text{ day}}{\text{week}} \right| = 1044 \text{ kw/week}$$

$$\frac{1044 \text{ kw}}{\text{week}} \left| \frac{0.07 \text{ \$}}{1 \text{ kw}} \right| = \$73.11$$

10. FROM #8, WE KNOW THAT THE PUMP IS 36 HP

$$36 \text{ HP} \left| \frac{0.746 \text{ kw}}{1 \text{ hp-h}} \right| \frac{8 \text{ hr}}{1 \text{ day}} \left| \frac{365 \text{ day}}{1 \text{ year}} \right| \frac{0.07 \text{ \$}}{1 \text{ kw}} \Big| = \$5,489$$