Intermediate Water Math

NEVADA
RURAL WATER ASSOCIATION

CONVERSTIONS

1 psi	=	2.31 ft. of head
1 ft. of head	=	.433 psi
1 cuft of water	=	7.48 gallons
1 cuft of water	=	62.4 lbs.
1 gallon	=	8.34 lbs.
1 gallon	=	3,785 ml
1 Liter	=	1,000 ml
1 Liter	=	1,000 grams
1 mg/L	=	8.34 lbs/MG
1 ppm	=	1 mg/L
1 ml	=	1 gram
1 pound	=	453.6 grams
1 pound	=	7,000 grains
1 kilogram	=	1,000 grams
1 cuft/sec	=	448.8 gpm
1 MGD	=	1.55 cuft/sec
1 MGD	=	694.5 gpm
1 HP	=	33,000 ft.lbs./min
1 HP	=	.746 kilowatt
1 mile	=	5,280 feet

FLOW AND VELOCITY

"Q" = FLOW expressed in cubic ft per sec. (cfs)

"V" = VELOCITY expressed in ft per second (fps)

"A" = AREA expressed in square feet (sqft)

$Q = A \times V$

$V = Q \div A$

$A = Q \div V$

WATER-BRAKE-MOTOR HORSEPOWER

$$WHP = \frac{GPM \times \text{Total Head (ft)}}{3960}$$

$$BHP = \frac{GPM \times \text{Total Head (ft)}}{3960 \times E_p}$$

$$MHP = \frac{GPM \times \text{Total Head (ft)}}{3960 \times E_p \times E_m}$$

E_p = Pump Efficiency (%)

E_m = Motor Efficiency (%)

CONVERSION OF TEMPERATURES

$$^{\circ}F = (^{\circ}C \times 1.8) + 32$$

$$^{\circ}C = \frac{(^{\circ}F - 32)}{1.8}$$

Check your work: water freezes at 32°F and 0°C

water boils at 212°F and 100°C

OBJECT	AREA (ft^2)	VOLUME (ft^3)
Rectangle	Length' x Width'	Length' x Width' x Height'
Circle	.785 x D' x D'	
Triangle	1/2 (Base' x Altitude')	
Cylinder		.785 x D' x D' x Length'
Sphere		.5236 x D' x D' x D'

Diameter (D) = 2 x radius

Circumference = 3.14 x D

Perimeter = Sum of the Sides

FILTRATION RATE = Flow (gpm) ÷ Surface Area (sqft)

BACKWASH RATE = Flow (gpm) ÷ Surface Area (sqft)

SURFACE OVERFLOW RATE = Flow (gpm) ÷ Area (sqft)

DETENTION TIME = Volume (gals) ÷ Flow (gpm)

WEIR OVERFLOW RATE = Flow (gpm) ÷ Feet of weir

$$\text{SPECIFIC CAPACITY} = \frac{\text{Well yield (gpm)}}{\text{Drawdown (feet)}}$$

FILTRATION RATE: for every 1.6 in./min. of rise or fall = 1 gpm/ft^2

$$\text{Lbs. of chemical} = \frac{\text{ppm} \times 8.34 \times \text{MG}}{\text{\% purity}}$$

$$\text{ppm} = \frac{\text{lbs. of chemical} \times \text{\% purity}}{8.34 \times \text{MG}}$$

Cl_2 Dosage = Demand + Residual

$$\text{Specific Gravity} = \frac{\text{wt. of a particular liquid}}{\text{equivalent wt. of water}}$$

$$\text{Strength of Solution} = \frac{\text{wt. of chemical}}{\text{wt. of solution}}$$

Least Significant Figures:

The number with the least significant figures is how many significant figures to maintain.

Ex. 32.011 ft

5.325 ft

12.1 ft

Fewest decimals = significant figures

Added together, you will get 49.436 ft, but the sum should be reported as ‘49’ ft. for the least significant figure.

A Sodium Hypochlorite solution is being pumped from a small tank that is 3.5 ft in diameter. If the level in the tank drops .35 ft in 24.0 HR, how many milliliters per minute of hypochlorite solution was used? Make sure to use the appropriate number of significant figures in your answer.

a. 66 mL/min
b. 66.17 mL/min
c. 66.2 mL/min
d. 70 L/min
e. 66 mL/min

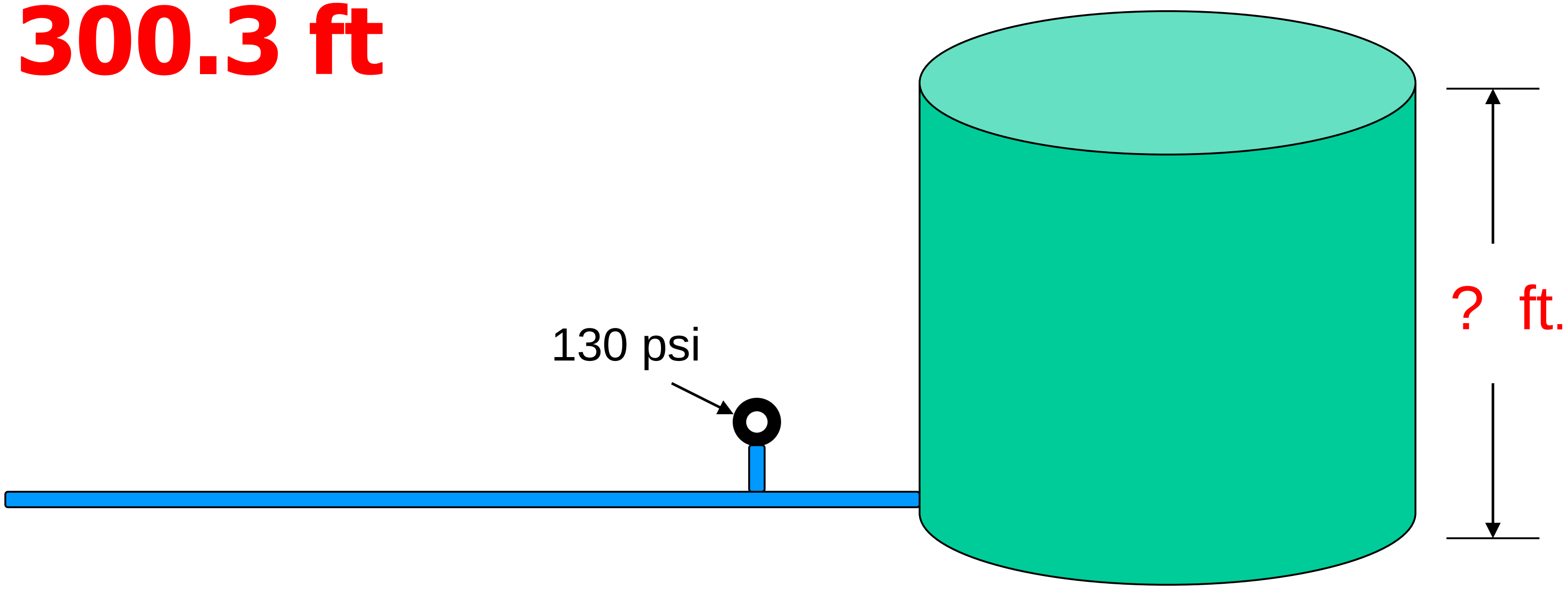
First, determine the gallons pumped.
.785 x 3.5 x 3.5 x .35 ft x 7.48 = 25.175 gal

Then determine the mL/min. and divide.

$$\frac{25.175 \text{ gal } (3785 \text{ mL/gal})}{1440 \text{ minutes /day}} = 66.17 \text{ mL/min, round to } 66 \text{ mL/min}$$

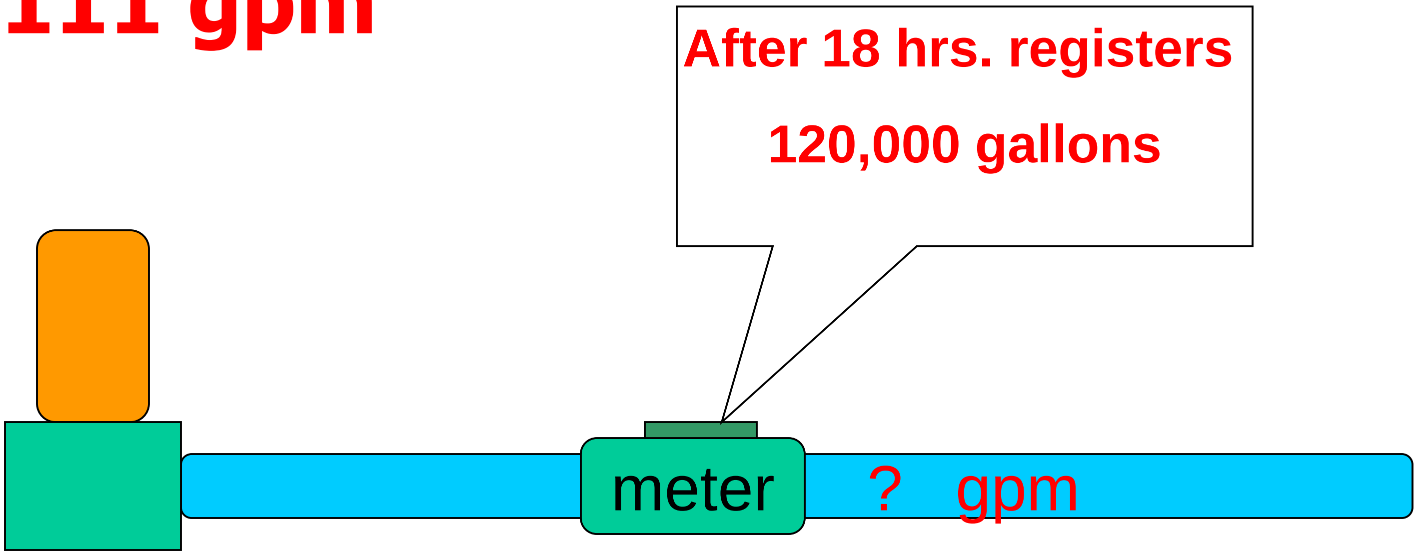
How many feet of head would create a pressure of 130 psi?

- Formula: psi x 2.31 = feet of head
- 130 psi x 2.31 ft/psi =
- 300.3 ft



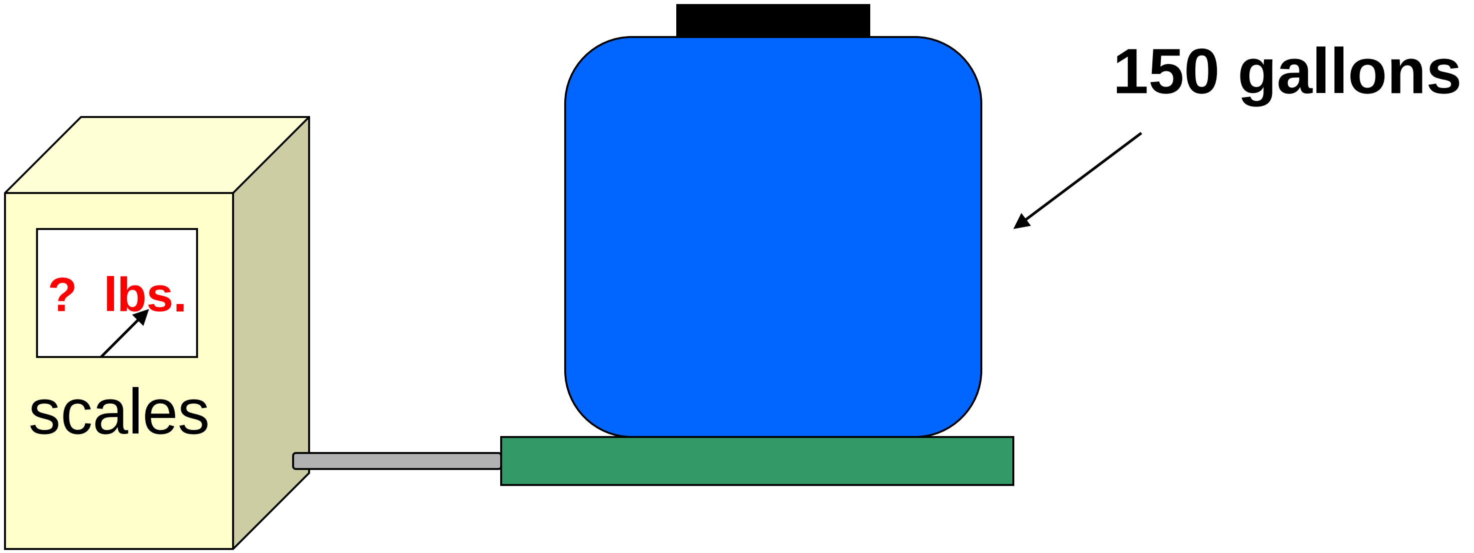
Pump runs 18 hours and pumps 120,000 gallons what is gpm pumping rate?

- **18 hours x 60 min = 1080 minutes**
- $\dfrac{\textbf{120,000 gallons}}{\textbf{1080 min}} =$
- **111 gpm**



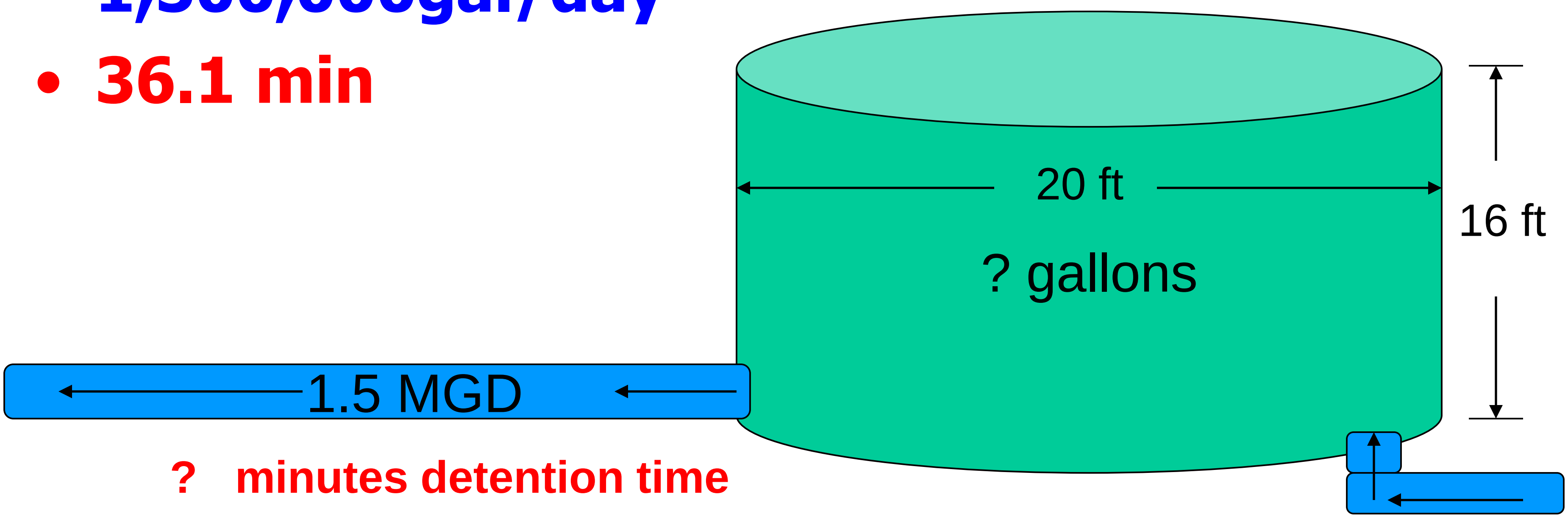
How much would 150 gallons of water weigh?

- Formula: gal. X 8.34 = lbs. of water
- 150 gal x 8.34 lbs./gal =
- 1,251 lbs.



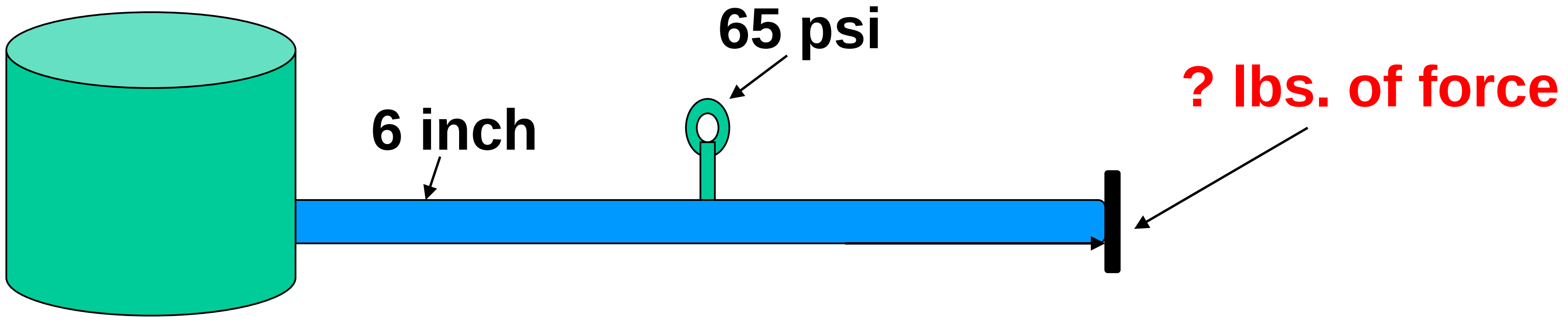
What is detention time in minutes of 20 ft diameter tank 16 ft deep with flow of 1.5 MGD?

- **20 ft x 20 ft x 0.785 = 314 ft2**
- **314 ft2 x 16 ft = 5,024 ft3**
- **5,024 ft3 x 7.48 gal/ft3 = 37,579.5 gal**
- $\frac{\text{37,580 gal}}{\text{1,500,000gal/day}}$ **= .025 days x 1440 min=**
- **36.1 min**



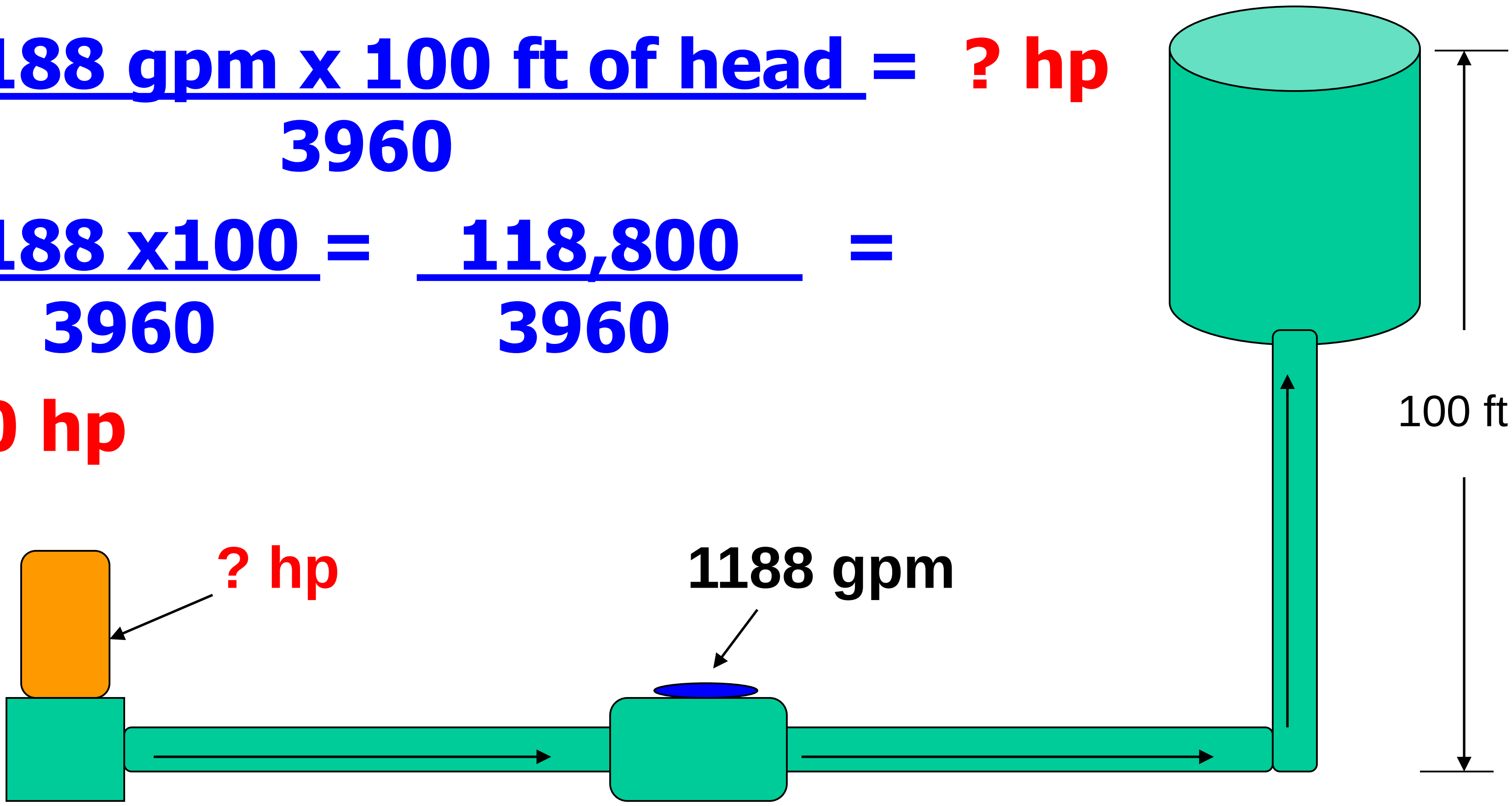
How much force on 6" blind flange with 65 psi?

- 6" x 6" x 0.785 = 28.26 in2
- 28.26 in2 x 65 psi =
- 1,836.9 pounds



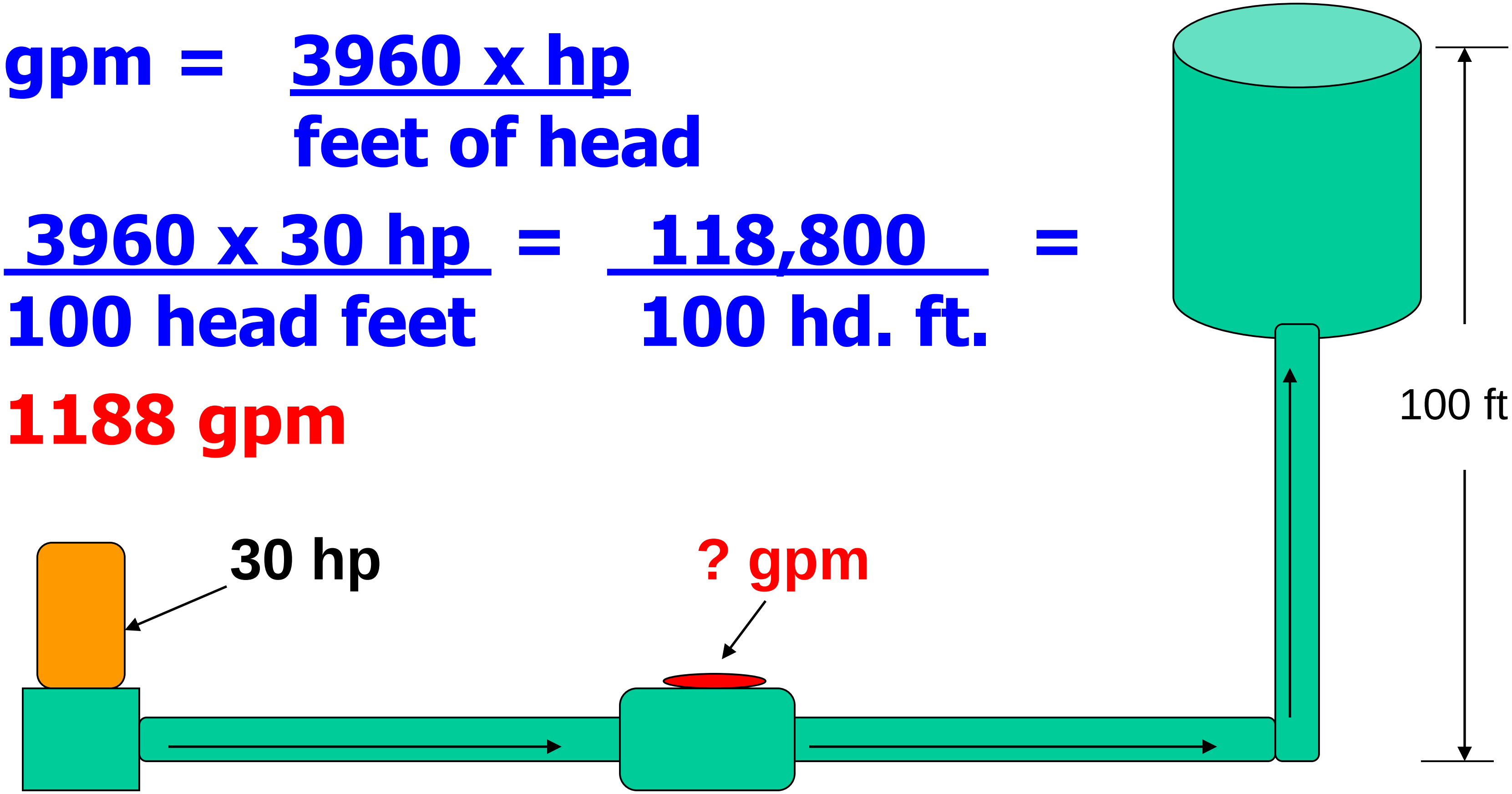
What would be the horsepower of a pump with 100 ft of head and 1188 gpm?

- hp = $\frac{\text{Flow as gpm x ft of head}}{3960}$
- $\frac{\text{1188 gpm x 100 ft of head}}{3960}$ = ? hp
- $\frac{1188 \times 100}{3960} = \frac{118{,}800}{3960}$ =
- 30 hp



What would be the maximum pumping rate in gpm of a 30 hp pump with 100 ft of head?

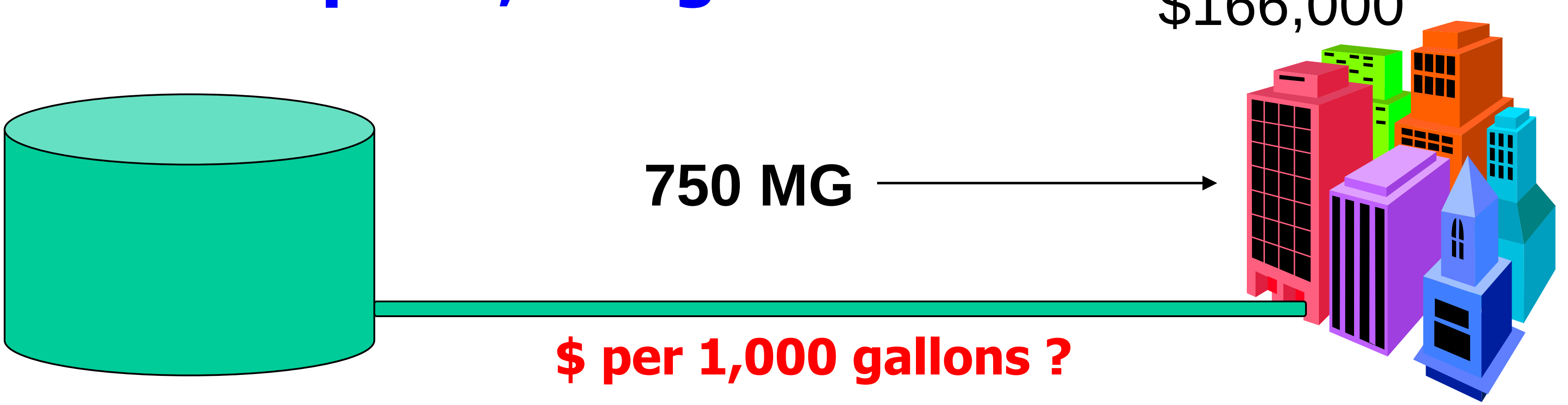
- $\frac{\text{100 ft of head x ? gpm}}{3960} = \text{30 hp}$
- $\text{gpm} = \frac{\text{3960 x hp}}{\text{feet of head}}$
- $\frac{\text{3960 x 30 hp}}{\text{100 head feet}} = \frac{\text{118,800}}{\text{100 hd. ft.}} =$
- 1188 gpm



City spends $166,000. per year and sells 750 MG, what is cost per 1,000 gallons?

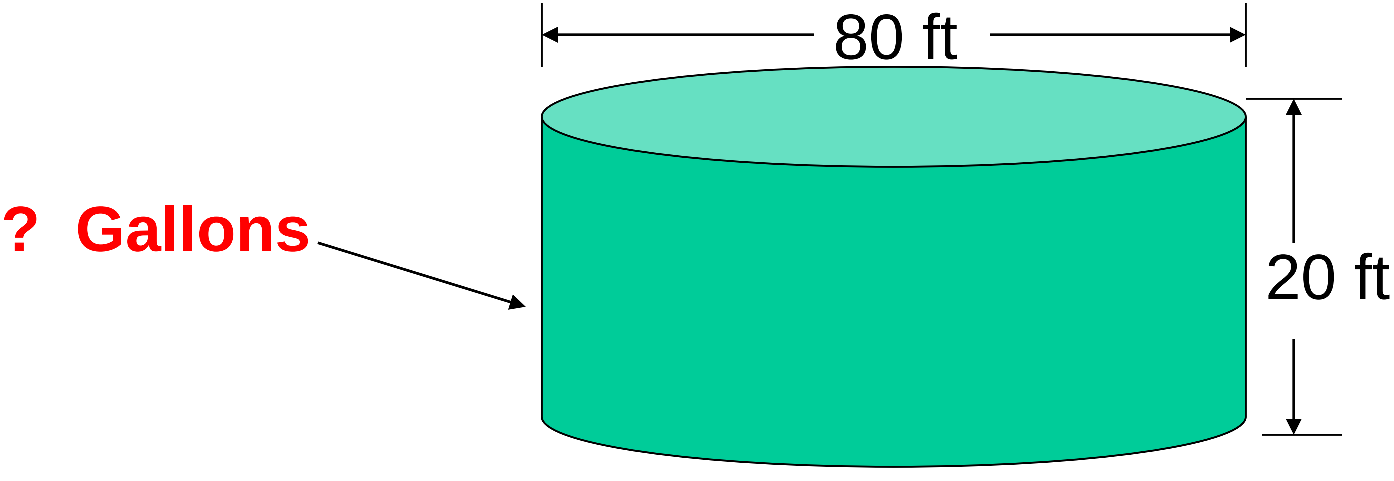
- **750 MG x 1,000,000 = 750,000,000 gallons**
- **<u>750,000,000 gal</u> = 750,000 units**
  1,000 gal/units

- **<u>$166,000</u> =**
  750,000 units
- **.22 cents per 1,000 gallons**



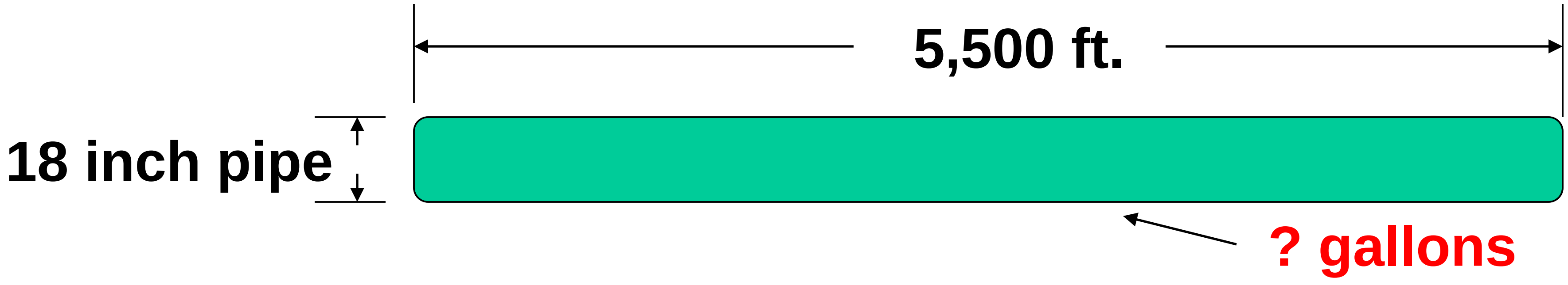
How many gallons in an 80 ft diameter tank filled 20 ft?

- 80 ft x 80 ft x 0.785 = 5,024 ft2
- 5,024 ft2 x 20 ft = 100,480 ft3
- 100,480 ft3 x 7.48 gal/ft3 =
- 751,590 gallons



How many gallons of water in an 18 inch pipe that is 5,500 ft long?

- $\frac{18 \text{ in}}{12 \text{ in}}$ = 1.5 ft x 1.5 ft x 0.785 = 1.766 ft2
- 1.766 ft2 x 5,500 ft = 9,714 ft3
- 9,714 ft3 x 7.48 gal/ft3 =
- 72,663 gallons

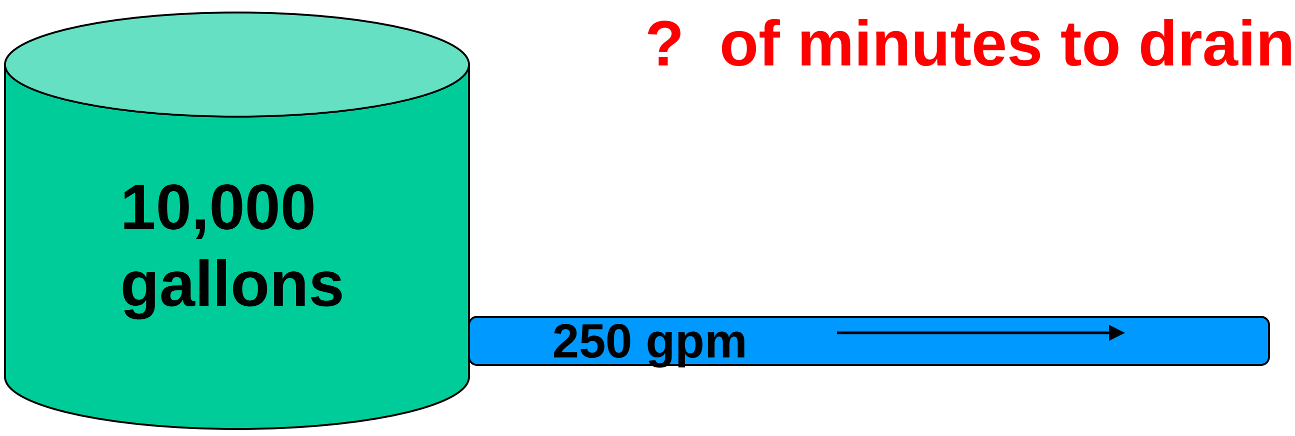


How long will a 10,000 gallon tank flow at 250 gpm?

- $\frac{10{,}000 \text{ gal}}{250 \text{ gal/min}} =$

- 40 min

? of minutes to drain

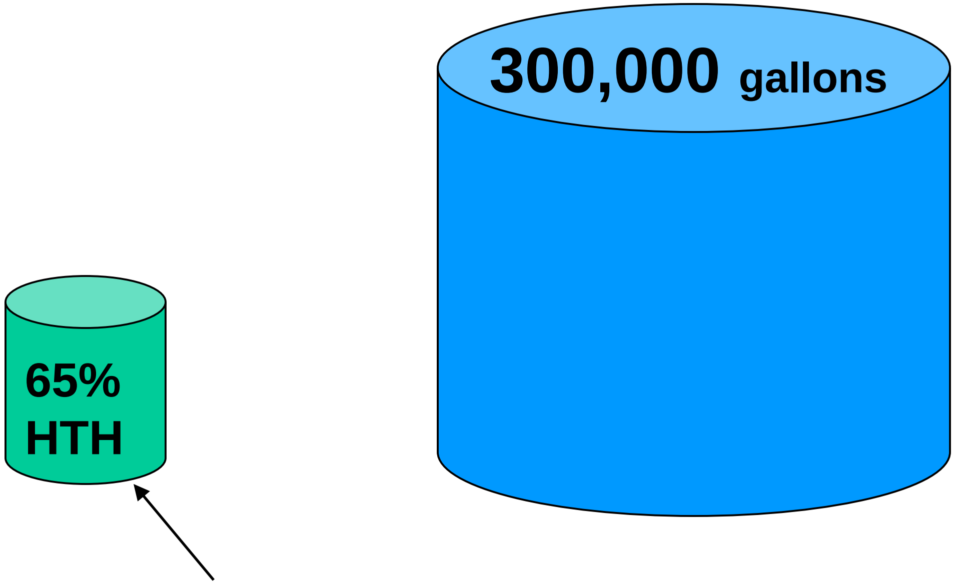


How many hours would it take to fill a 90 ft dia. tank 40 feet high pumping 2,400 gpm?

- 90 ft x 90 ft x 0.785 = 6,358.5 ft2
- 6,358.5 ft2 x 40 ft = 254,340 ft3
- 254,340 ft3 x 7.48 gal/ft3 = 1,902,460 gal.
- $\frac{1,902,460 \text{ gal.}}{2,400 \text{ gal/min}}$ = 792.7 min. $\frac{792.7 \text{ min.}}{60 \text{ min./hr.}}$ =
- 13.21 hrs. {0.21min x 60 min} = 12.6 min.
- 13 hrs. and 13 min.

How many pounds of 65% HTH would be needed to dose 300,000 gal. at 250 mg/L?

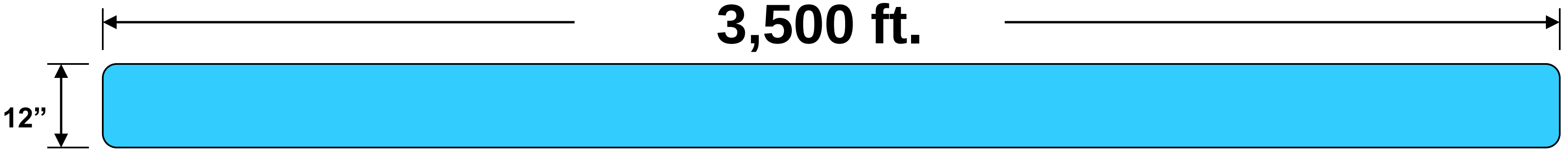
- $\frac{300{,}000 \text{ gal.}}{1{,}000{,}000}$ = 0.3 MG
- 0.3 x 250 mg/L x 8.34 =625.5 lbs.
- $\frac{625.5 \text{ lbs.}}{65\%}$ =
- 962 lbs.



? lbs. of to chlorinate at 250 mg/L

How many pounds of 65% HTH would be needed to dose 3,500 ft of 12 inch pipe to 50 mg/L?

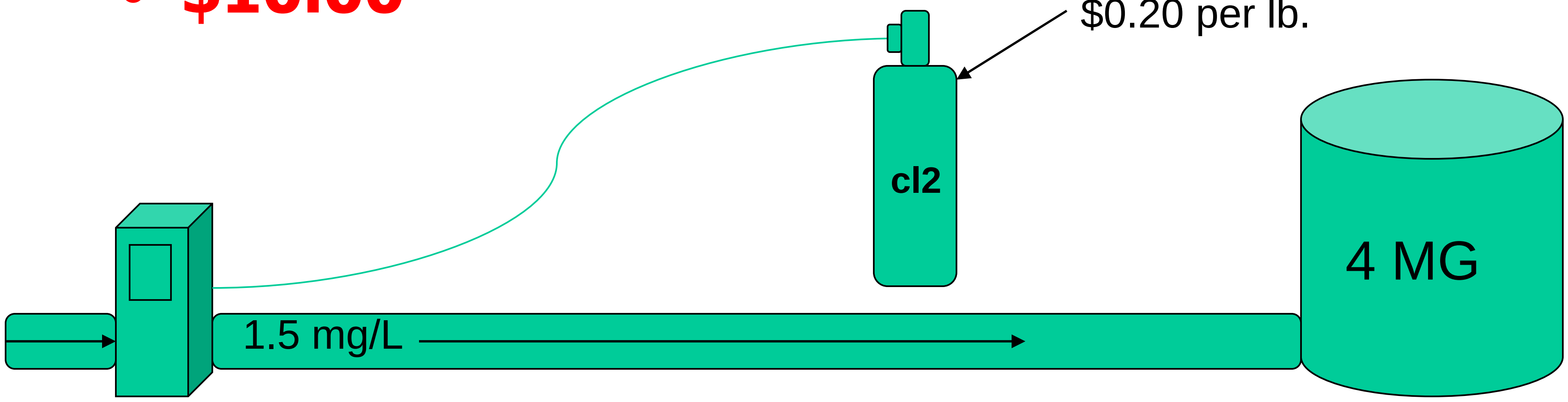
- $\frac{12"}{12"}$ = One Foot
- 1 ft x 1 ft x 0.785 = 0.785 ft2
- 0.785 ft2 x 3,500 ft = 2,747.5 ft3
- 2,747.5 ft3 x 7.48 gal/ft3 = 20,550 gal
- $\frac{20,550 \text{ gal.}}{1,000,000}$ = 0.021 MG x 50 mg/L x 8.34=
- $\frac{8.757 \text{ lbs.}}{.65}$ = **13.5 lbs.**



How much 65% HTH to chlorinate this pipe at 50 mg/L?

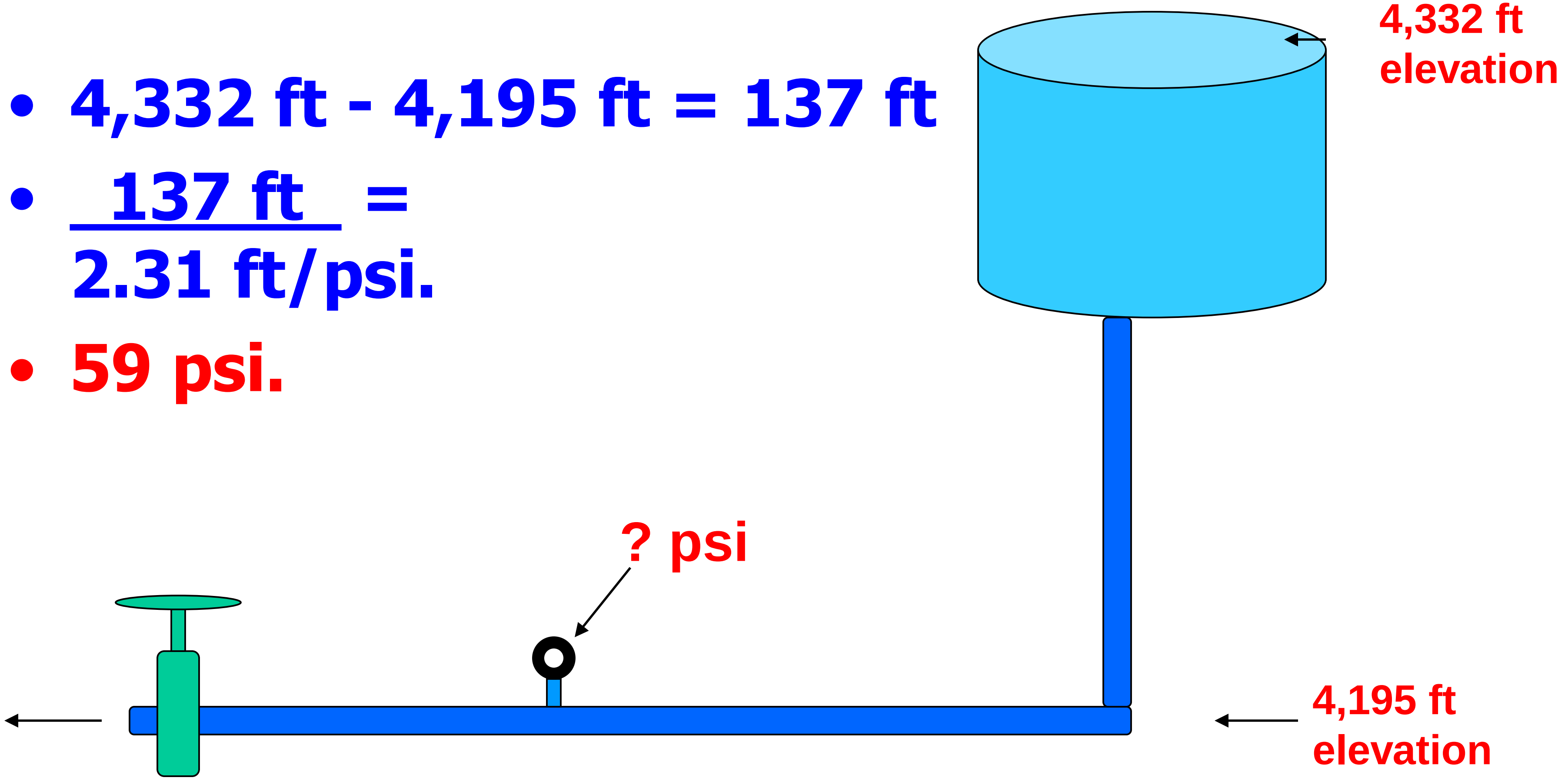
What would be the cost per day to chlorinate 4 MG at 1.5 mg/L if chlorine cost 20 cents per pound?

- **4 MGD x 1.5 mg/L x 8.34 = 50.04 lbs**
- **50.04 lbs. x $0.20 per lbs. =**
- **$10.00**



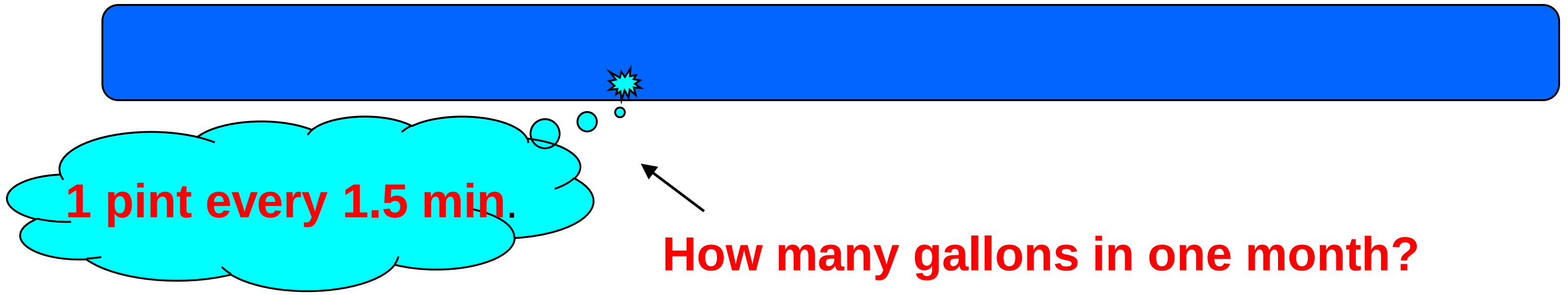
What would the psi at an outlet at elevation of 4,195 ft if the water level in the tank above is 4,332 ft?

- 4,332 ft - 4,195 ft = 137 ft
- $\frac{137 \text{ ft}}{2.31 \text{ ft/psi.}}$ =
- 59 psi.



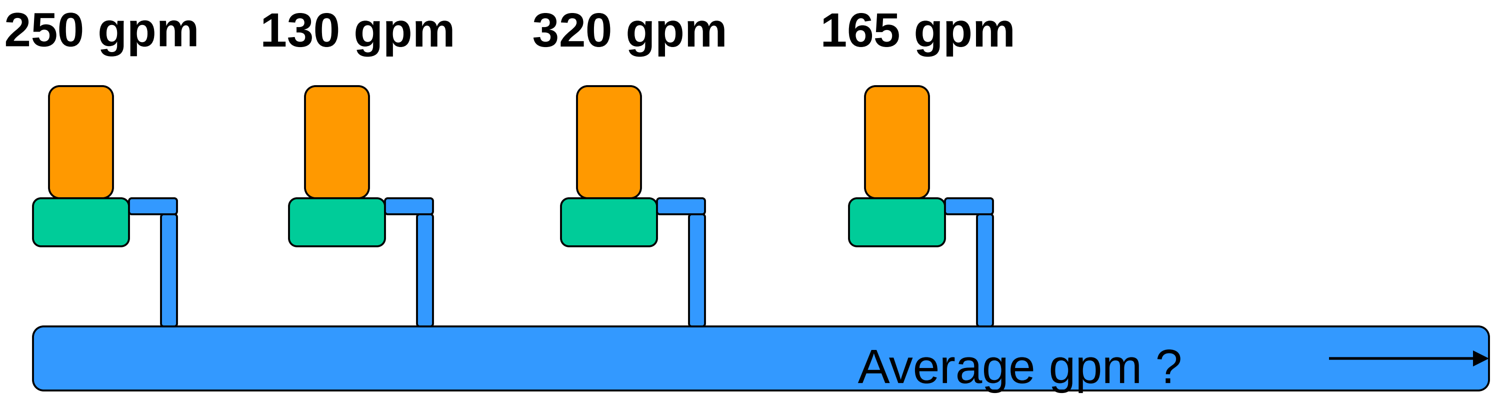
A leak of 1 pint every 1.5 min. would leak how many gallons in 30 days?

- $\frac{\text{1 pint}}{\text{1.5 minutes}}$ = .667 pints/minute
- .667 pints/min x 1440 min/day = 960.48 pints/day
- 30 days x 960.48 pints/day = 28814.4 pints
- $\frac{\text{28814.4 pints}}{\text{8 pints/gallon}}$ =
- 3,602 gallons/month



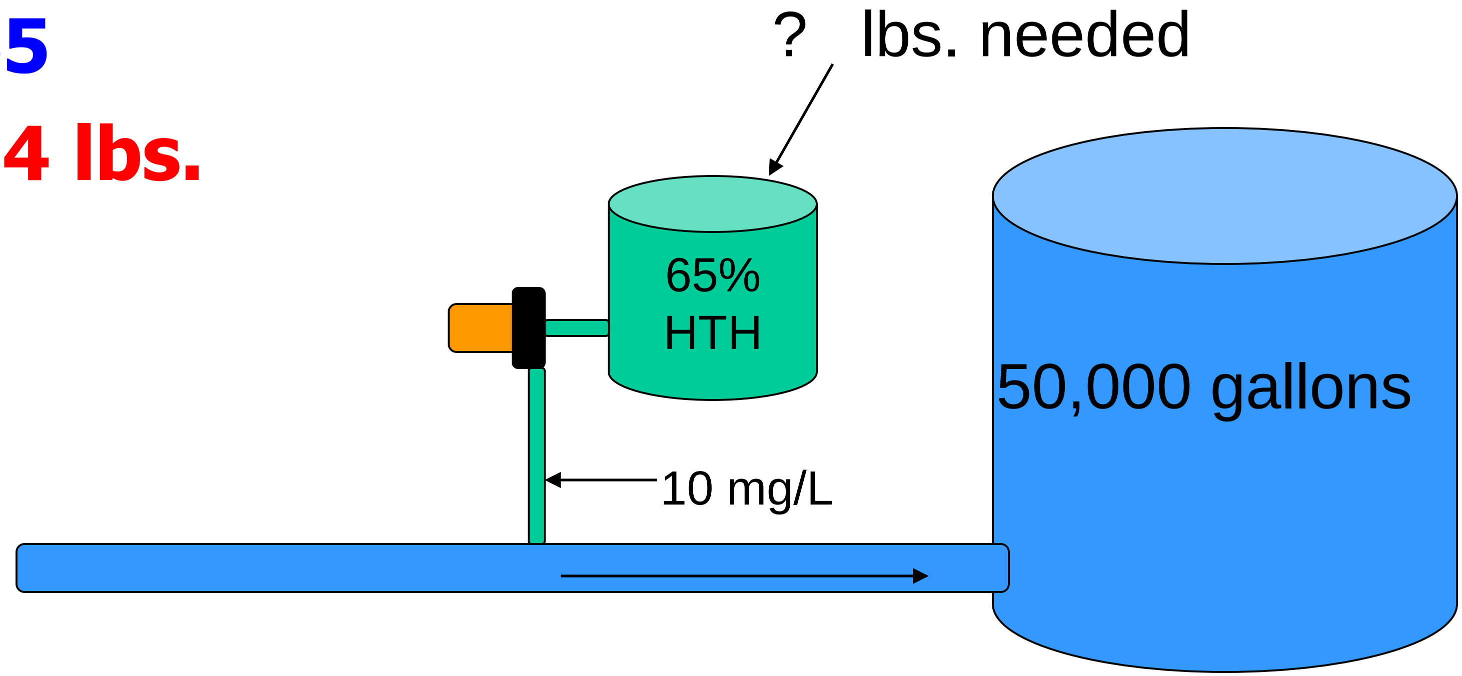
What would be the gpm average of the following 4 wells that flow at a rate of 250 gpm, 130 gpm, 320 gpm and 165 gpm?

- 250 gpm + 130 gpm + 320 gpm + 165 gpm =
- 865 gpm
- 865 gpm = 4 wells
- 216.25 gpm



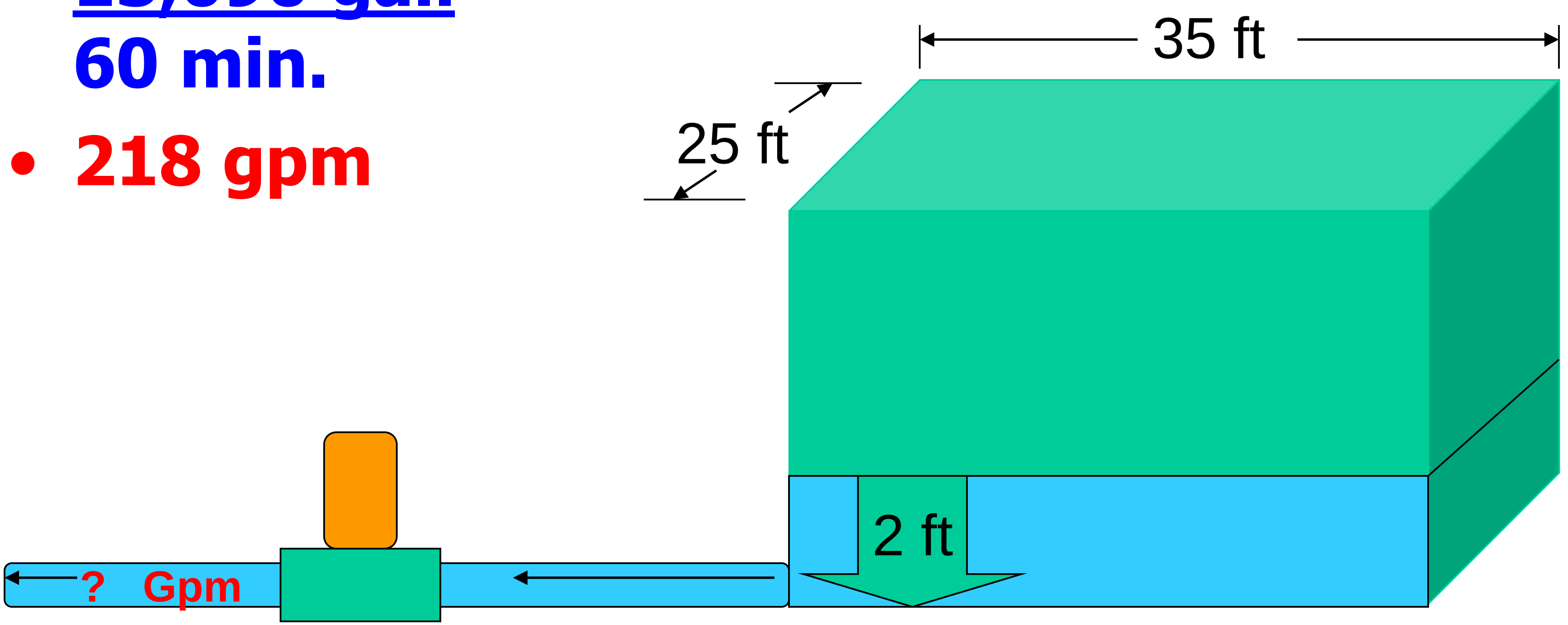
How many lbs. of 65% HTH would be needed to disinfect 50,000 gal. at 10 mg/L?

- $\frac{50{,}000\ \text{gal.}}{1{,}000{,}000}$ = 0.05 MG x 10 mg/L x 8.34= 4.17 lbs.
- $\frac{4.17\ \text{lbs.}}{.65}$ =
- 6.4 lbs.



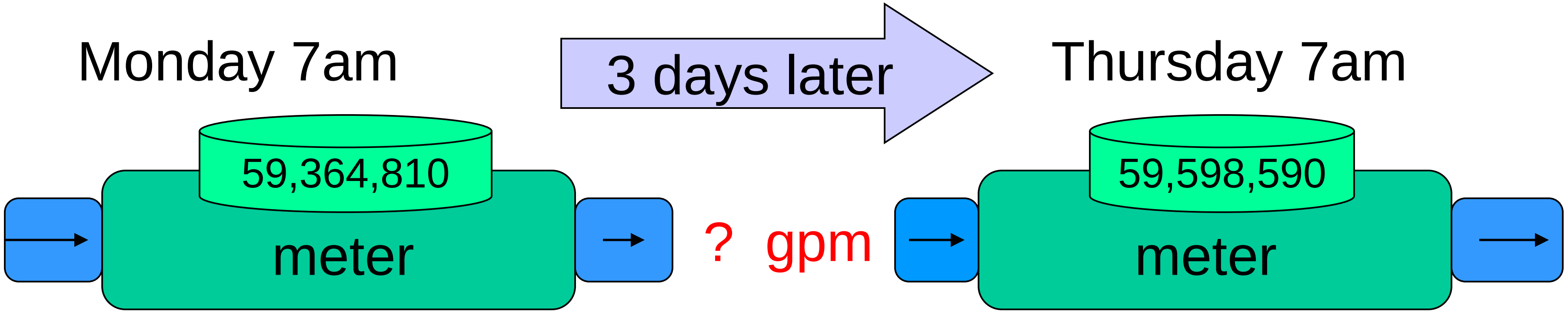
What is the pumping rate in gpm if the pump drains 2 ft out of a 25 ft x 35 ft basin in 1 hr.?

- **2 ft x 25 ft x 35 ft = 1,750 ft3**
- **1,750 ft3 x 7.48 gal/ft3 = 13,090 gal.**
- **<u>13,090 gal.</u>=**
  60 min.
- **218 gpm**



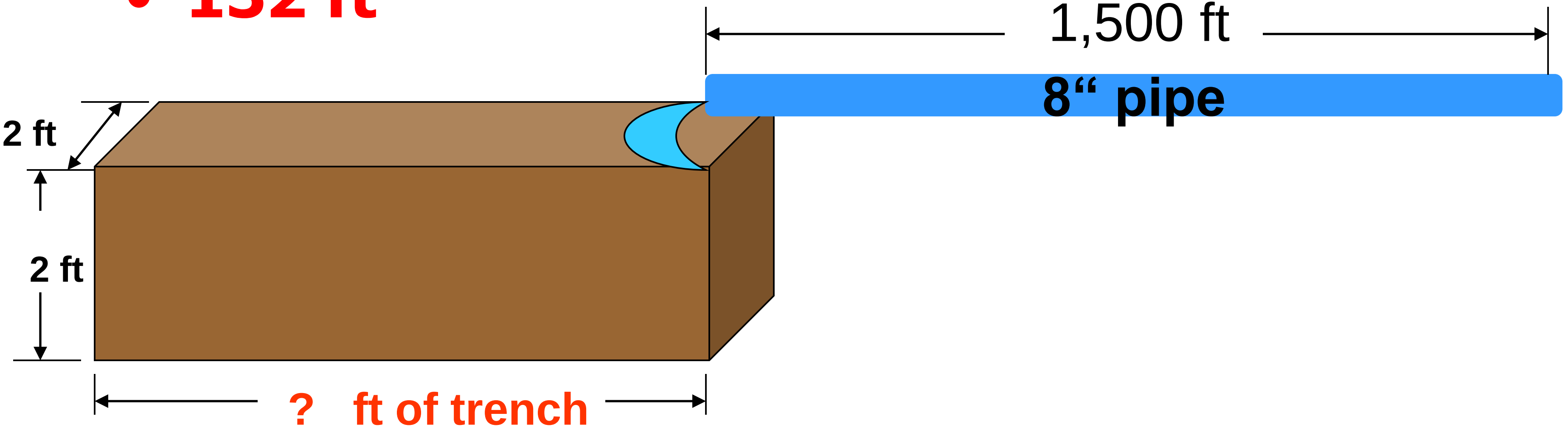
What is the gpm flow of the following meter readings taken three days apart? First reading 59,364,810 gal. Three days later 59,598,590 gal.

- **59,598,590 gal. - 59,364,810 gal = 233,780 gal**
- $$\frac{233{,}780 \text{ gal}}{1{,}440 \text{ min/day} \times 3 \text{ days}} = \frac{233{,}780 \text{ gal.}}{4{,}320 \text{ min.}} =$$
- **54.1 gpm**



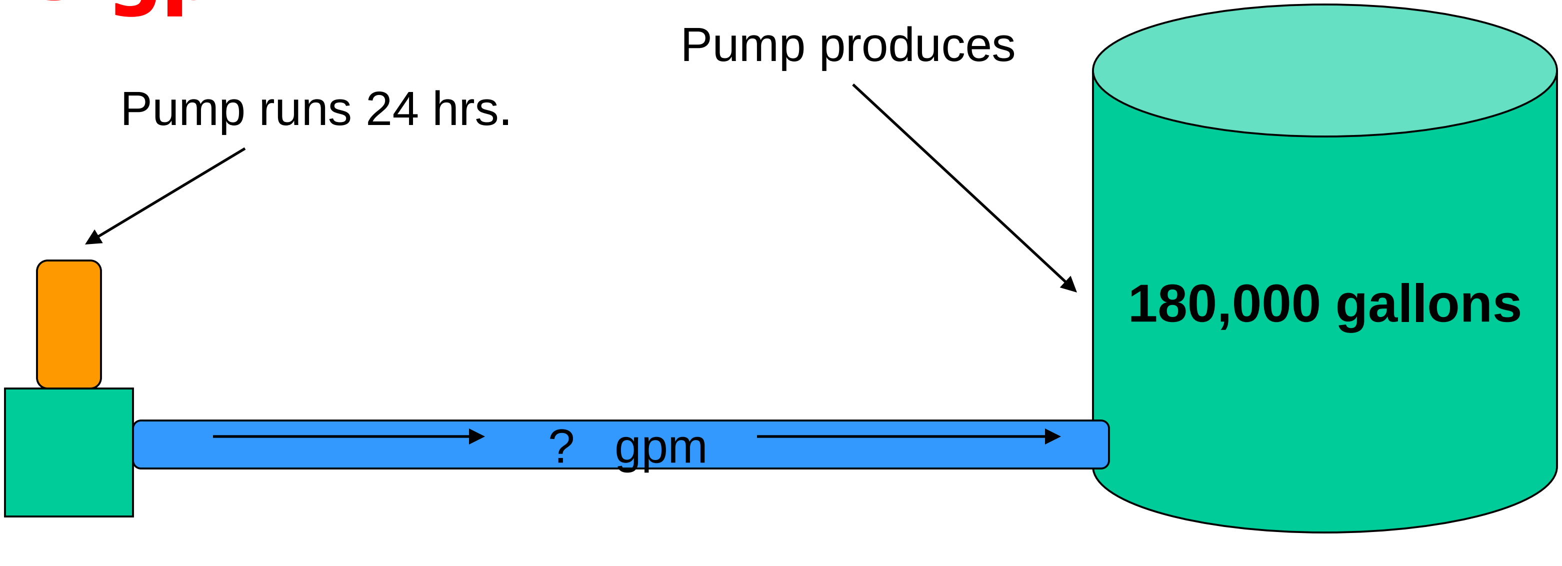
How long of a 2' wide by 2' deep trench will be needed to drain water from 1,500' of 8" water line?

- $\frac{8"}{12"}$ = 0.67'
- 0.67 x 0.67' x0.785 = 0.352 ft2 x 1,500' =528 ft3
- $\frac{528 \text{ ft3}}{2' \times 2'} = \frac{528 \text{ ft3}}{4 \text{ ft2}}$ =
- 132 ft



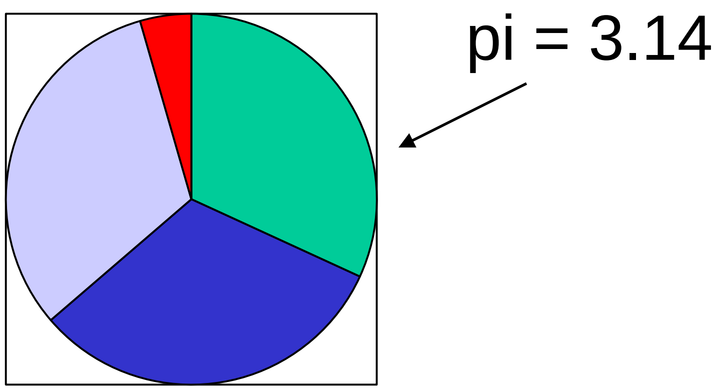
If a pump runs for 24 hours and delivers 180,000 gallons, what is the gpm flow rate?

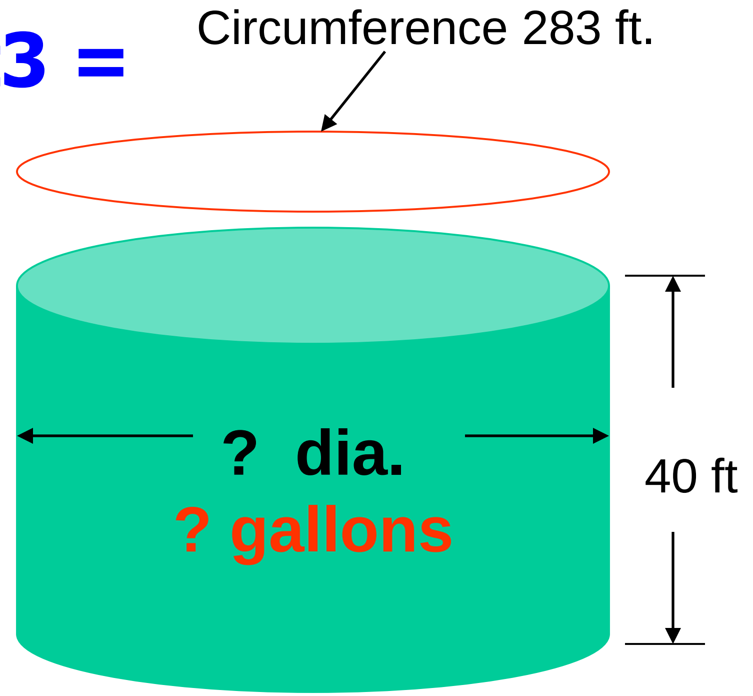
- **24 hours = 1,440 minutes**
- **180,000 gallons = 1,440 minutes**
- **125 gpm**



How many gallons will a 40' high tank with a circumference of 283' hold when it is full?

- $\frac{283 \text{ ft}}{3.14}$ = 90 ft dia.
- 90ft x 90 ft x 0.785 = 6,358.5 ft2
- 6,358.5 ft2 x 40 ft = 254,340 ft3
- 254,340 ft3 x 7.48 gal/ft3 =
- 1,902,463 gallons

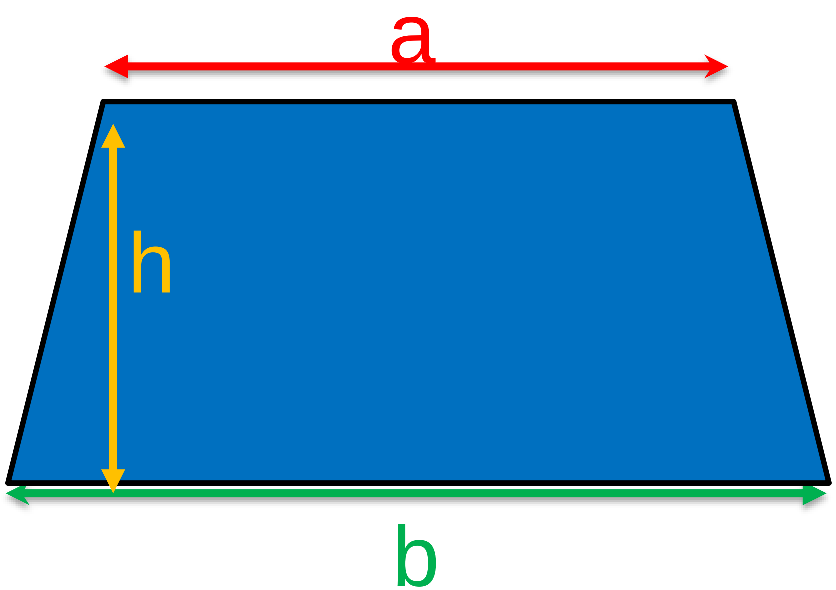




Area: Trapezoid

<u>Trapezoid Area</u>

$$= \frac{(a+b)}{2} \times h$$

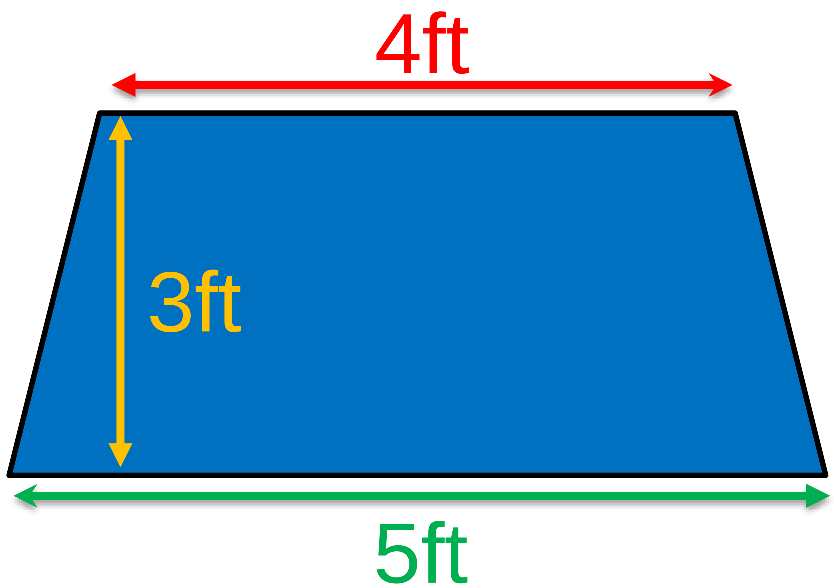


<u>Trapezoid Area</u>

$$= \frac{(4ft+5ft)}{2} \times 3ft$$

$$= \frac{(9ft)}{2} \times 3ft \quad = (4.5ft) \times 3ft$$

$$= 13.5ft^2$$



Trapezoid

- **A trapezoidal ditch measures 20 feet across the top, 16 feet across the bottom, 12 feet deep and 3 miles long. How much water will this ditch hold when it is full?**

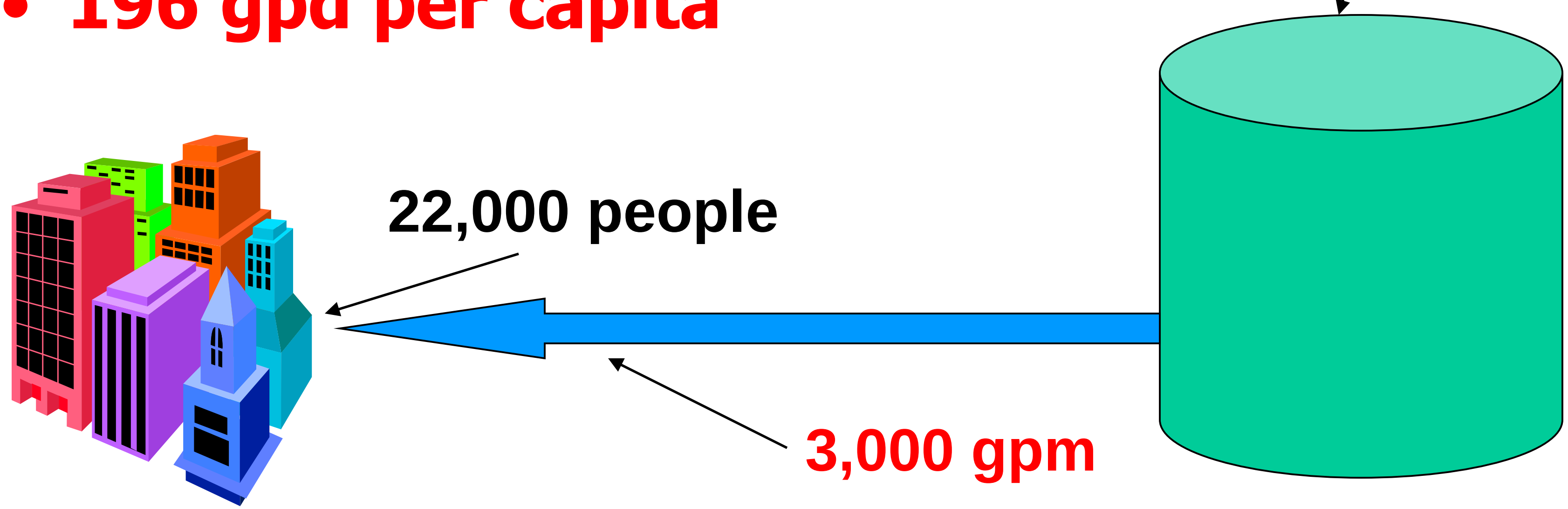
  - **25 million gallons**
  - **30 million gallons**
  - **35 million gallons**
  - **40 million gallons**

Trapezoid

- 20′ top width plus 16′ bottom width / 2
- 36/2 = 18′ for width
- 3 miles = 3 x 5,280′= 15,840′ for Length
- 18′w x 12′d x 15,840′L =3,421,440 cu/ft
- 3,421,440 x 7.48 = 25,492,371 gal
- 25,492,371 / 1,000,000 = 25 MG

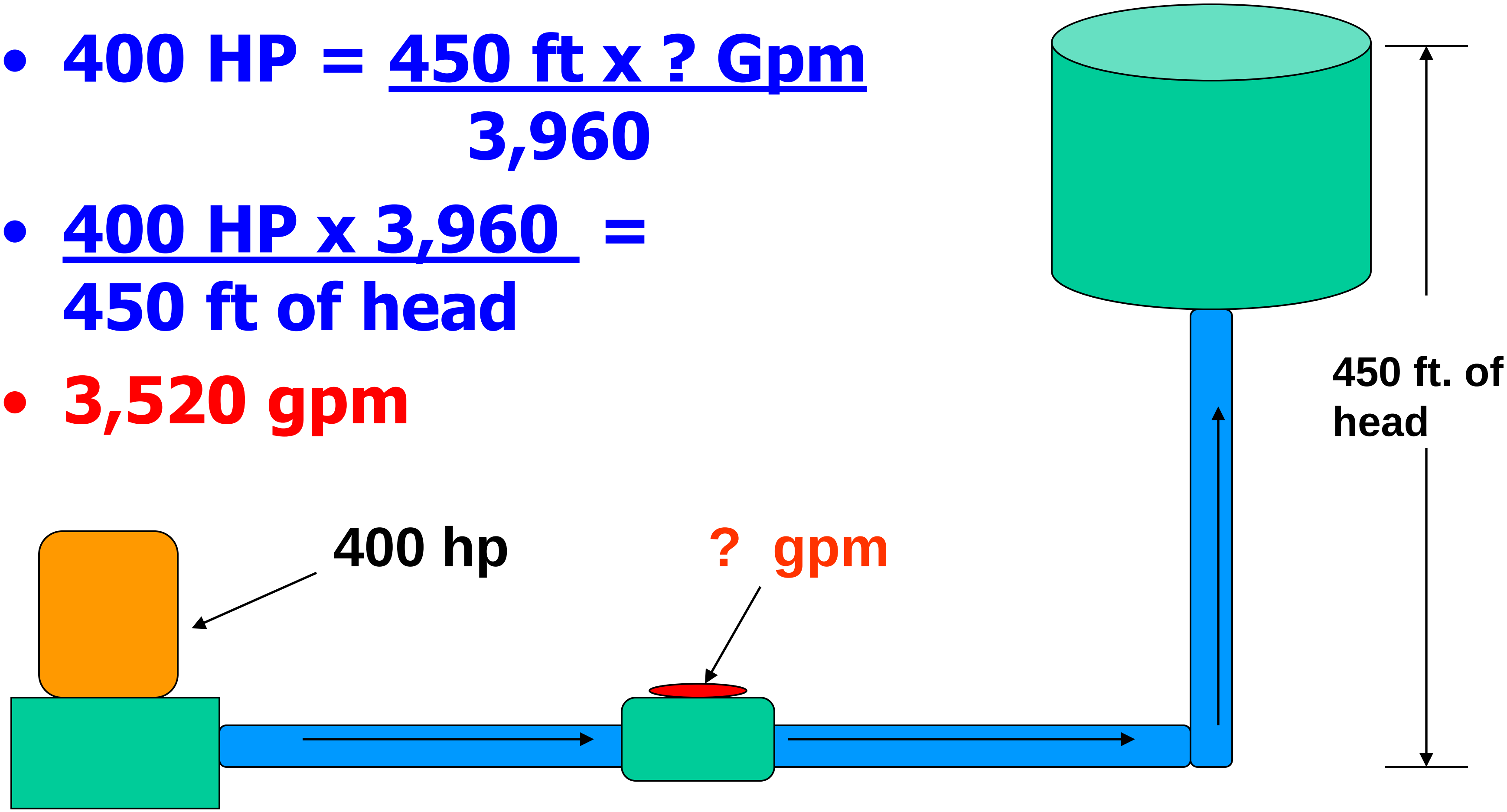
What is the per capita production in gallons per day for a system that produces 3,000 gpm for a population of 22,000?

- 3,000 gpm x 1,440 min/day = 4,320,000 gpd
- $\frac{\text{4,320,000 gpd}}{\text{22,000 people}}$ =
- 196 gpd per capita



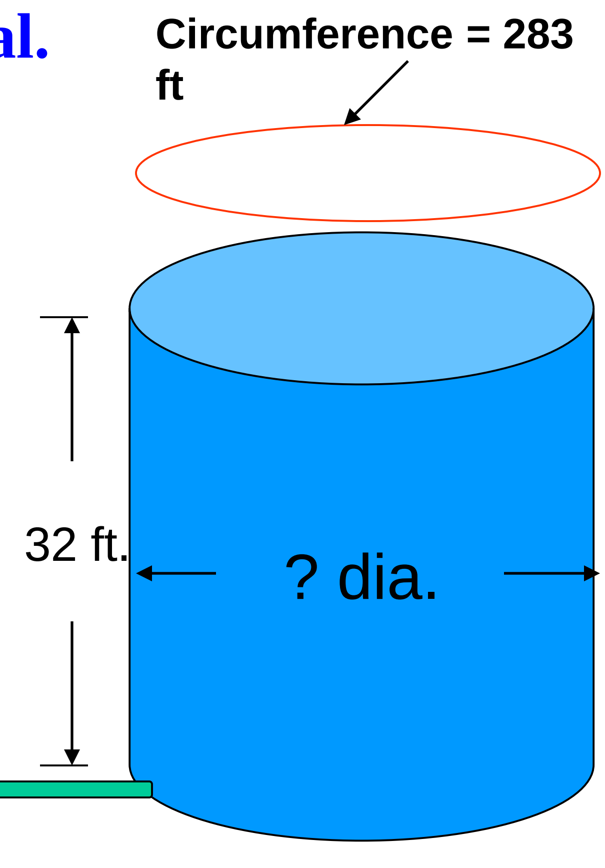
What is the maximum gpm pumping rate of a 400 HP pump with 450 ft of head?

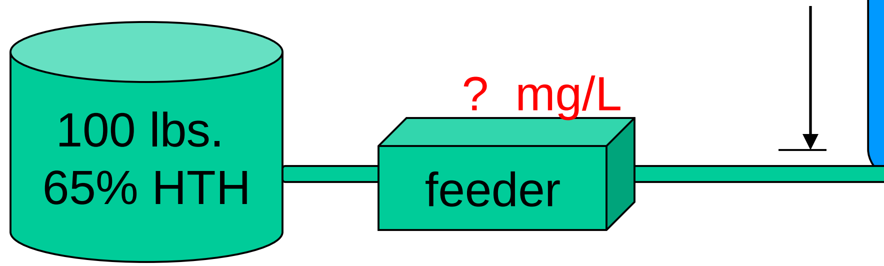
- $HP = \dfrac{\text{ft of head} \times \text{gpm}}{3{,}960}$
- $400\ HP = \dfrac{450\ ft \times ?\ Gpm}{3{,}960}$
- $\dfrac{400\ HP \times 3{,}960}{450\ \text{ft of head}} =$
- 3,520 gpm



What would be the chlorine dosage if 100 lbs. of 65% HTH was put in a 283 ft circumference tank that had 32 ft of water?

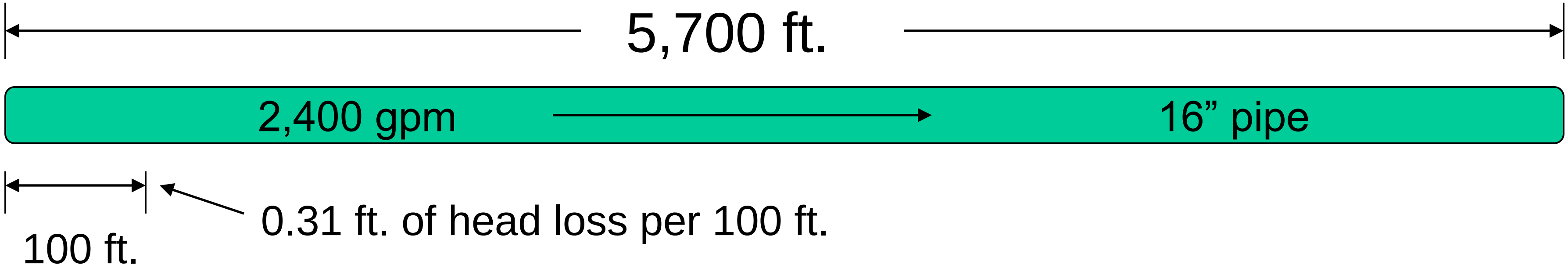
- $\frac{283 \text{ ft}}{3.14}$ = 90 ft x 90 ft x 0.785 = 6,358.5 ft2
- 6,358.5 ft2 x 32 ft = 203,472 ft3
- 203,472 ft3 x 7.48 gal/ft3 = 1,522,000 gal.
- $\frac{1{,}522{,}000 \text{ gallons}}{1{,}000{,}000}$ = 1.52 MG
- 1.52 MG x ? mg/l x 8.34 = 100 lbs.
- ? mg/l = $\frac{100 \text{ lbs.}}{1.52 \text{ MG x } 8.34}$ = $\frac{100 \text{ lbs.}}{12.68}$ =
- 7.89 mg/l x 0.65 =
- 5.13 mg/l





What is the total <u>head loss in feet</u> of 5,700 ft. of 16 in. pipe with a flow of 2,400 gpm if the head loss is calculated at 0.31 psi per 100 ft.?

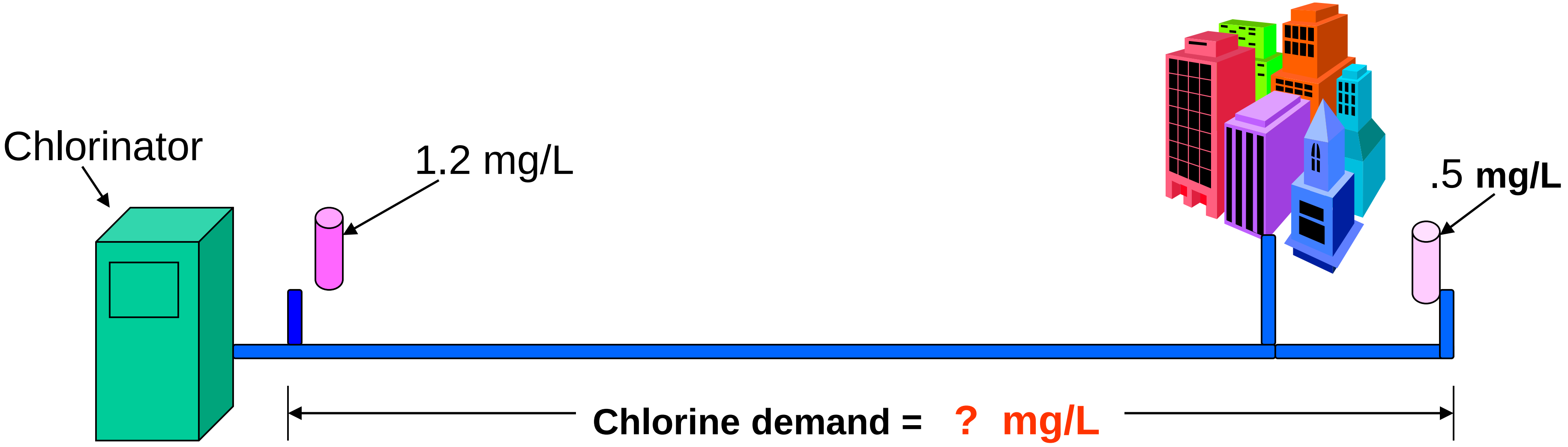
- **$\frac{5{,}700 \text{ ft.}}{100 \text{ ft.}}$ = 57 x 0.31 psi=**
- **17.67 psi x 2.31 ft/psi=**
- **40.8 feet of head loss**



? total head loss in feet

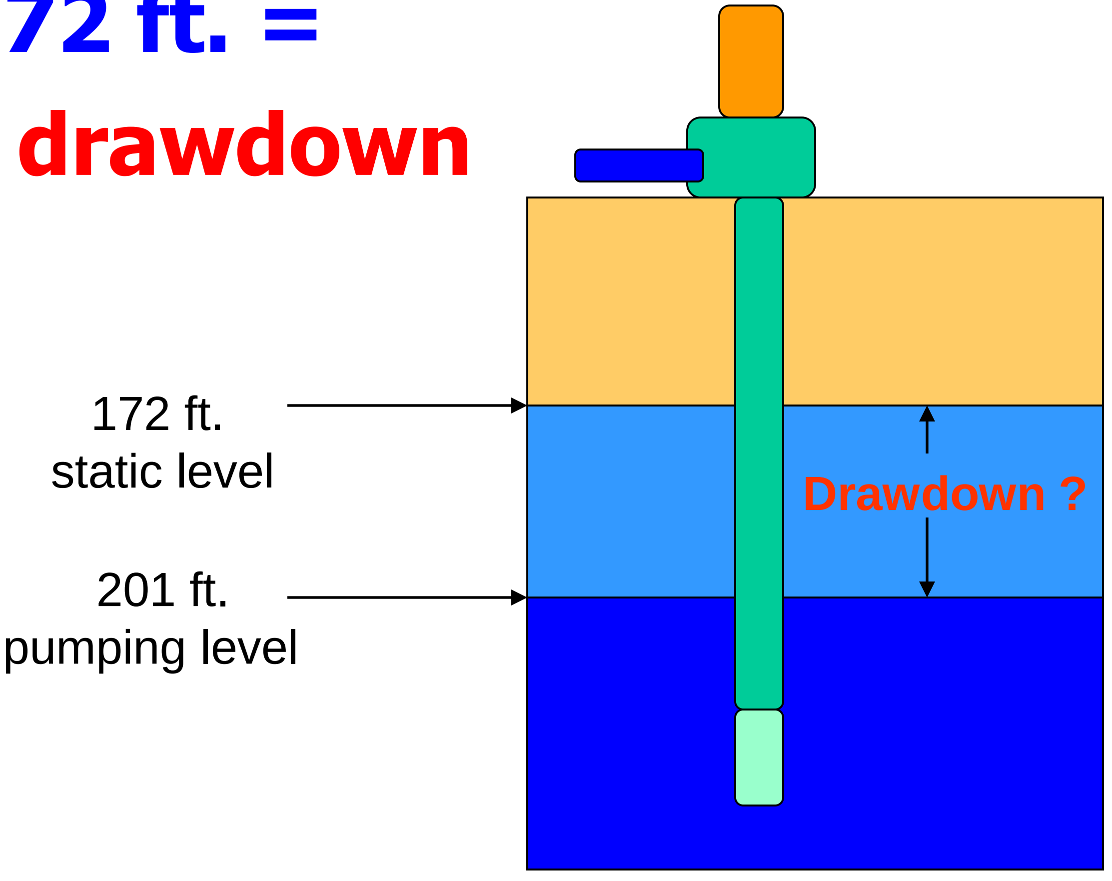
If a chlorine residual is 1.2 at the chlorinator and 0.5 in the distribution system, what is the chlorine demand?

- **1.2 mg/l - 0.5 mg/l =**
- **0.7 mg/l chlorine demand**



What is the drawdown in a well with a static water level of 172 ft. and a pumping water level of 201 ft.?

- **201 ft. - 172 ft. =**
- **29 feet of drawdown**



Well Specific Capacity

- Specific Capacity is the Well Yield (GPM) divided by Drawdown (Feet)

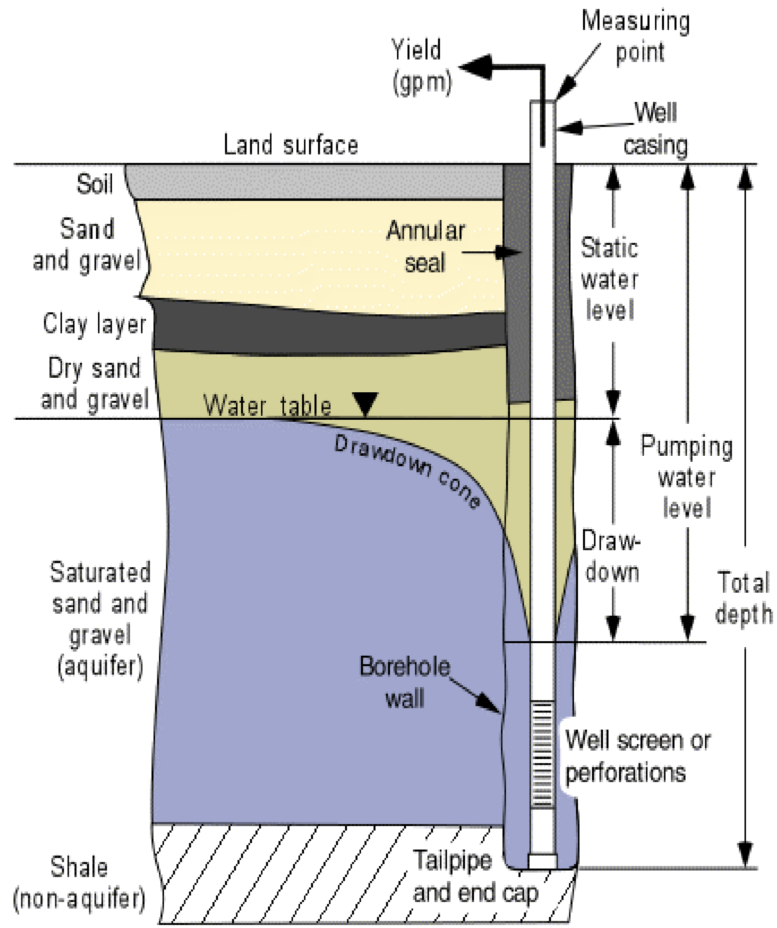
Well Yield/100gpm ÷ 29Drawdown/Ft=

Specific Capacity

100 GPM ÷ 29 ft/drawdown

Specific Capacity

= 3.45 gpm/ft of drawdown

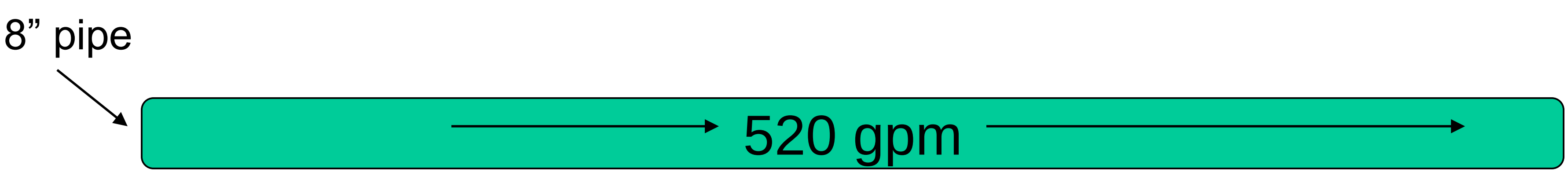


What is the velocity of the water in fps of an 8 inch pipeline with a flow of 520 gpm?

- **Q = A x V**
- **Flow as CFS = Area, sq ft x Velocity as fps**

- **Conversion from gpm to cfs = 448.8**

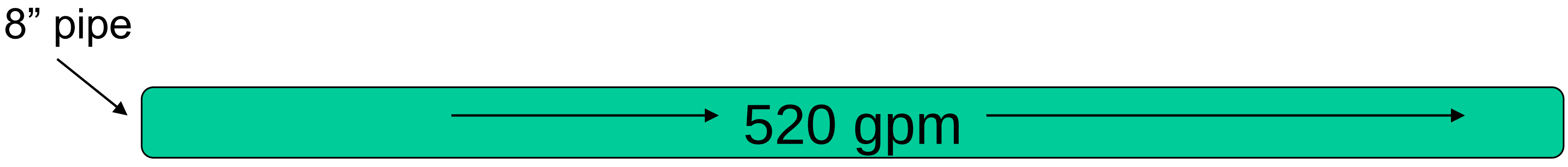
Continued…



Velocity = ? feet per second

What is the velocity of the water in fps of an 8 inch pipeline with a flow of 520 gpm?

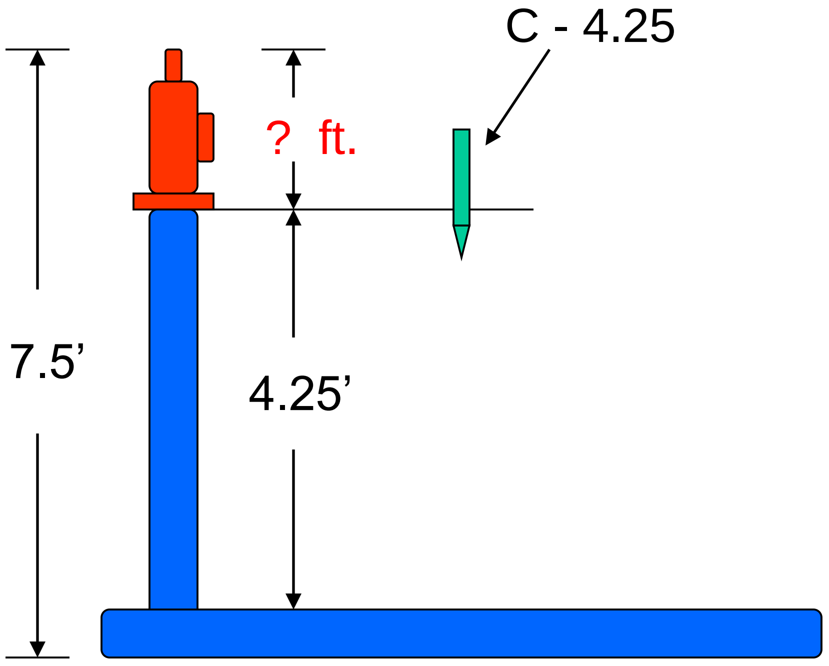
- **New Formula Velocity = Q/A**
- **520 gpm / 448.8 gpm/cfs = 1.16 cfs**
- **8 in / 12 in = 0.67 x 0.67 x 0.785 = 0.352 ft2**
- **Q, 1.16 ft3/sec / A, 0.352 ft2 =**
- **V = 3.3 fps velocity**



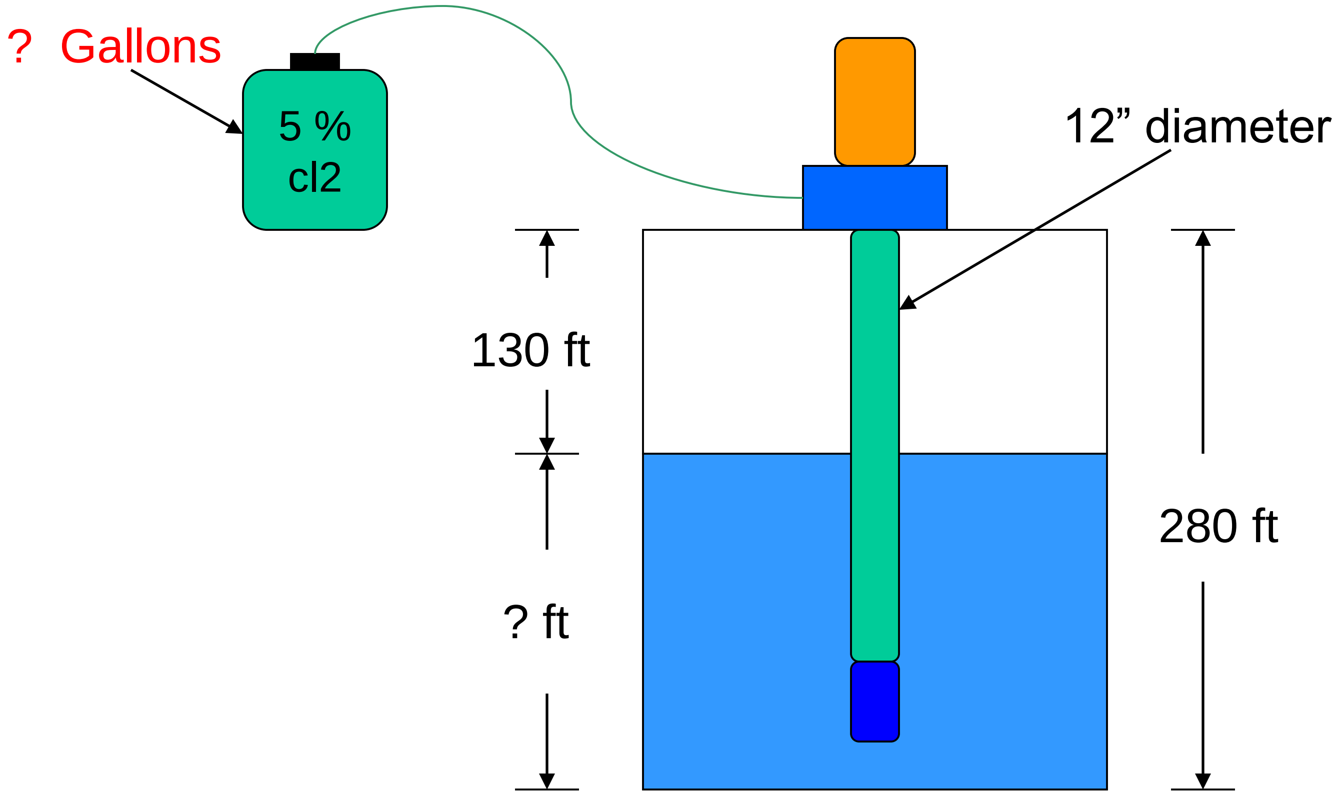
Velocity = 3.3 feet per second

If the cut stake for a fire hydrant is marked AC-4.25@ and the hydrant is 7 ft. 6 in. tall, how high will the top be above the finished grade?

- **6" = 0.5 ft**
  12 in/ft
- **7.5 ft. - 4.25 ft. =**
- **3.25 ft.**



How many gal. of 5% sodium hypochlorite will be needed to disinfect a 12 in. diameter well that is 280 ft. deep with a static water level of 130 ft. to a dosage of 50 mg/l?



NEXT SLIDE

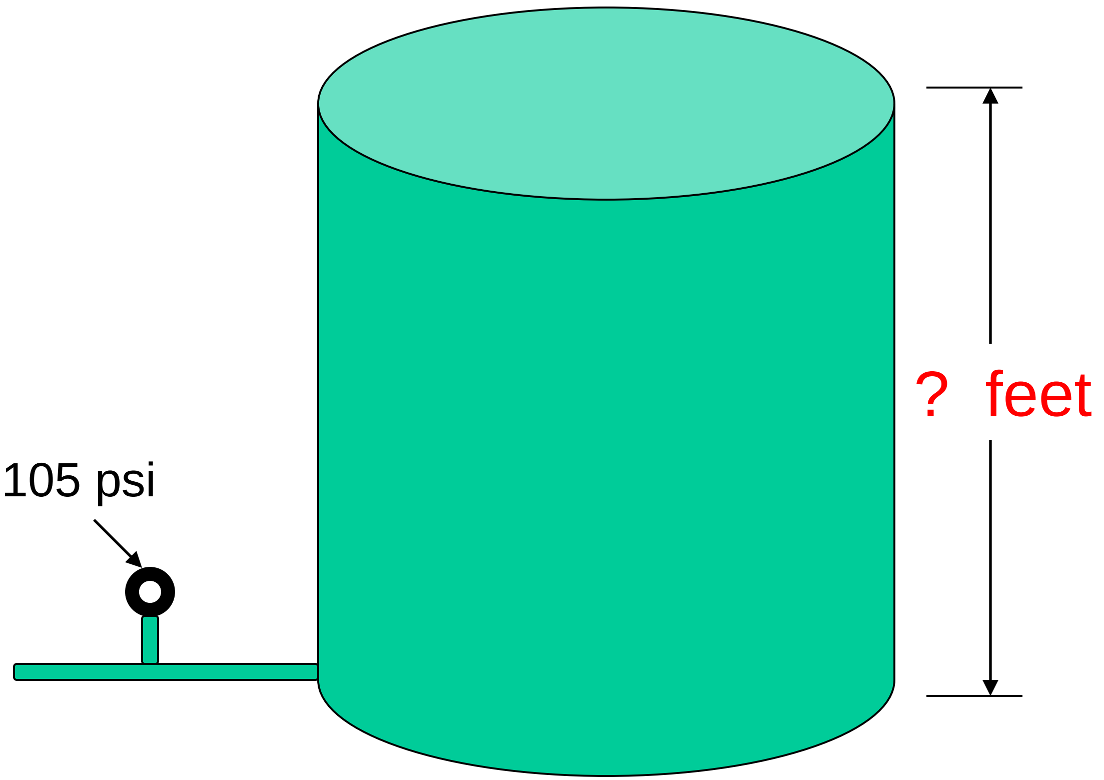
CONTINUED

How many gal. of 5% sodium hypochlorite will be needed to disinfect a 12 in. well that is 280 ft. deep with a static water level of 130 ft. to a dosage of 50 mg/l?

- 280 ft. - 130 ft. = 150 ft.
- $\frac{12"}{12"}$ = 1 ft. x 1 ft. x 0.785 = 0.785 ft2
- 0.785 ft2 x 150 ft. = 117.75 ft3
- 117.75 ft3 x 7.48 gal/ft3 = 881 gal.
- $\frac{881 \text{ gal.}}{1{,}000{,}000 \text{ gal/MGD}}$ = 0.001 x 50 mg/l x 8.34= 0.417 lbs.
- $\frac{0.417 \text{ lbs.}}{0.05}$ =
- 8.34 lbs. or 1 gallon

What depth of water would create a <u>force</u> of 105 psi.?

- **105 psi. x 2.31 ft/psi =**
- **242.5 feet**



Pounds of Force

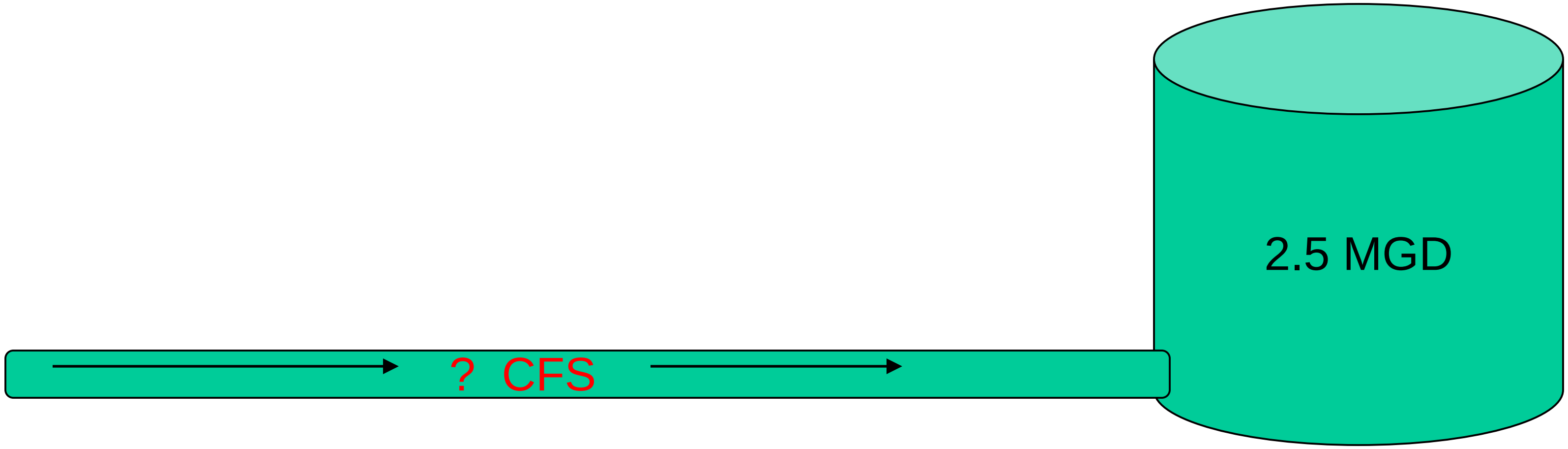
- **If a partially-buried water storage tank measuring 50 feet long, 40 feet wide and 30 feet tall was empty and the water table around the tank rose to 6 feet above the tank bottom, what would the upward force on the bottom of the tank be?**
  - ❑ **748,598 pounds**
  - ❑ **448,800 pounds**
  - ❑ **3,742,992 pounds**
  - ❑ **5,865,456 pounds**

Pounds of Force

- 40'Wide X 50'Long X 30'Height X 6' groundwater
- The formula is: 40'W X 50'L X 6' =
- 12,000 cu/ft
- Upward Force = lbs/gal/cu/ft 8.34 x 7.48 = 62.38 pounds of force
- 12,000 x 62.4 = 748,598

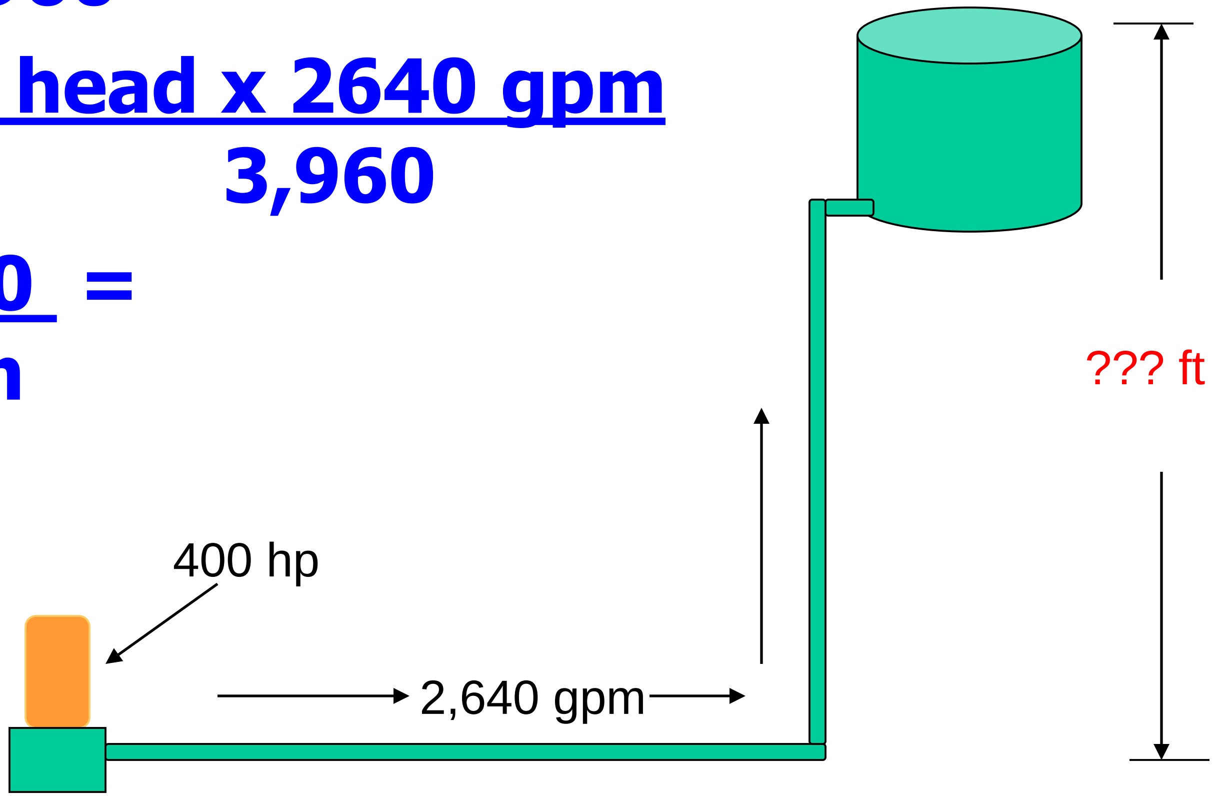
How many cfs of water would 2.5 MGD be?

- **2.5 MGD x 1.55 cfs/MGD =**
- **3.875 cfs**



What is the feet of head with a 400 HP pump and a pumping rate of a 2,640 GPM?

- **HP = $\frac{\text{ft of head x gpm}}{3,960}$**
- **400 HP = $\frac{\text{ft of head x 2640 gpm}}{3,960}$**
- **$\frac{\text{400 HP x 3,960}}{\text{2640 gpm}}$ =**
- **600 ft of head**



HORSEPOWER

- *Work* = involves the operation of a force (lbs) over a specific distance (ft). The *amount of work* accomplished is measured in foot-pounds.
- Power =The rate of doing work.
- The rate at which a horse was determined to work was to be about 550 ft-lbs/sec (or expressed as 33,000 ft-lbs/min).
- 1 HP = 33,000 ft-lbs/min
- $\frac{33{,}000 \text{ ft-lbs/min}}{8.34 \text{ lbs/gal}} = 3{,}960 \text{ft} - \text{gals/min/hp}$

HORSEPOWER

$$\textbf{Horsepower, Brake, hp} = \frac{(\text{Flow, gpm})(\text{Head, ft})}{(3{,}960)(\text{Pump Efficiency, \% expressed as a decimal})}$$

$$\textbf{Horsepower, Brake, kW} = \frac{(9.8)(\text{Flow, m}^3/\text{sec})(\text{Head, m})}{(\text{Pump Efficiency, \% expressed as a decimal})}$$

$$\textbf{Horsepower, Motor, hp} = \frac{(\text{Flow, gpm})(\text{Head, ft})}{(3{,}960)(\text{Pump Efficiency, \% expressed as a decimal})(\text{Motor Efficiency, \% expressed as a decimal})}$$

$$\textbf{Horsepower, Motor, kW} = \frac{(9.8)(\text{Flow, m}^3/\text{sec})(\text{Head, m})}{(\text{Pump Efficiency, \% expressed as a decimal})(\text{Motor Efficiency, \% expressed as a decimal})}$$

$$\textbf{Horsepower, Water, hp} = \frac{(\text{Flow,gpm})(\text{Head,ft})}{3{,}960}$$

$$\textbf{Horsepower, Water, kW} = (9.8)(\text{Flow, m}^3/\text{sec})(\text{Head, m})$$

What is the Brake Horsepower of a pump with 65%Efficiency, 600 feet of Head and 2,640 gpm?

- **WHP = $\frac{\text{ft of head 600 x gpm 2640}}{3{,}960}$ = 400 HP**

- **$\frac{\text{600 ft head x 2640 gpm}}{\text{3960 x .65Ep}}$**

- **$\frac{1{,}584{,}000}{2574}$ = 615 BHP**

So now, our last formula looked like this:

$$\frac{1,584,000}{2574} = 615 \text{ BHP}$$

When we factor in a 60% Motor Efficiency we get:

$$\frac{1,584,000}{2574(.60)} = 1025 \text{ MHP}$$

Pumping Cost

- Pumps are determined on the basis of two primary considerations:
  - Kilowatt-hours of pump operation, and
  - Power cost per kilowatt-hour
- Kilowatt-hours of pump operation are determined by multiplying power drawn by the pump (kW) by the hours of operation (hrs.) (kW) x (hrs) = kWh Used

- Once the Kilowatt-hours of power use has been determined, then determine the cost of that power use using the cost factor (kWh) x ($/kWh) = Total Cost

Pumping Cost

42 motor horsepower (mhp) is required for a pumping application.

If the cost of power is $0.0567/kWh, and the pump is in operation 24 hrs/day, what is the daily pump cost?

Pumping Cost

- First convert mhp to kWh

$$\frac{42 \text{ mhp}}{} \bigg| \frac{.746 \text{ kW}}{1 \text{ hp}} = 31.33 \text{ kW}$$

- The kWh of power consumption can now be determined:

$$31.33\text{kW} \times 24 \text{ hr} = 751.92 \text{ kWh/day}$$

- Now complete the cost calculation:

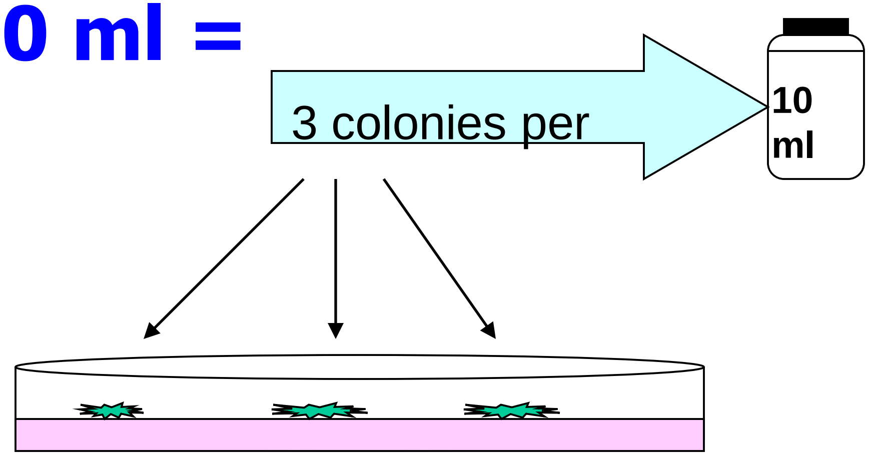
$$751.92 \text{ kWh/day} \times \$0.0567 = \$42.63\text{/day}$$

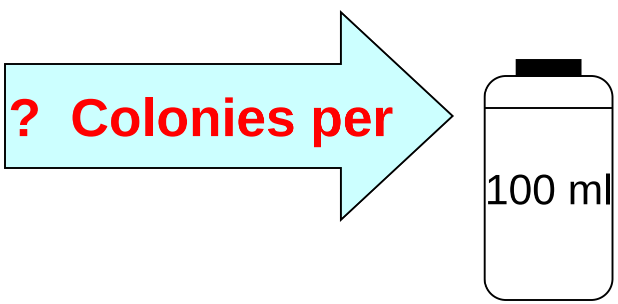
Horsepower Expressions

- **WHP =** $\dfrac{\text{ft of head x gpm}}{3{,}960}$
- **BHP =** $\dfrac{\text{ft of head x gpm}}{3{,}960(Ep)}$
- **MHP =** $\dfrac{\text{ft of head x gpm}}{3{,}960(Ep)(Em)}$

If a 10 ml portion of water developed 3 coliform bacteria colonies what would be the number of colonies per 100 ml?

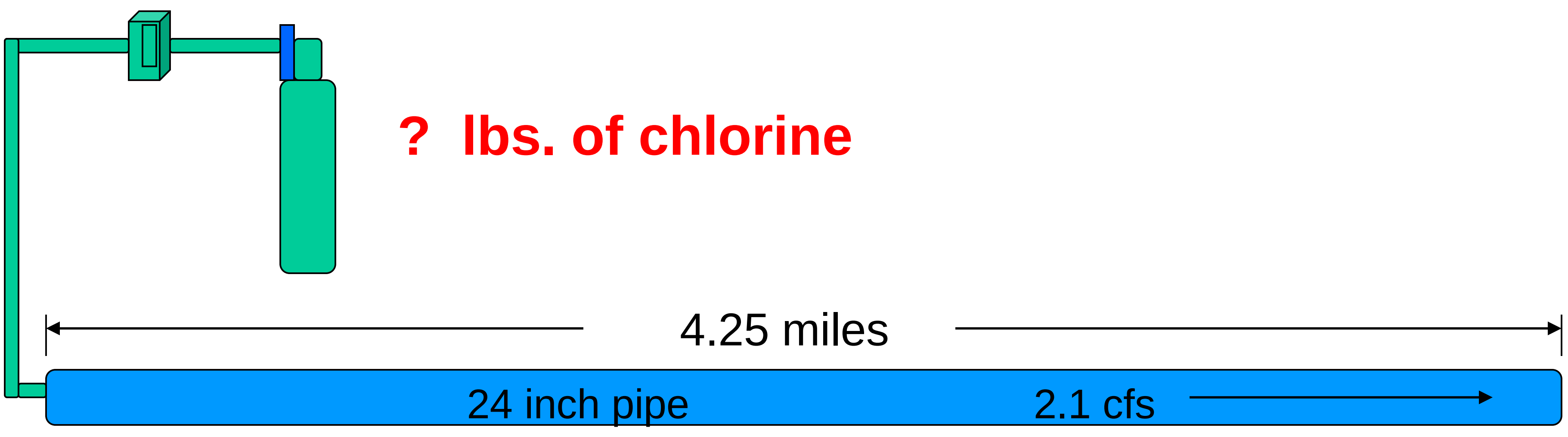
- $\frac{\text{3 colonies}}{\text{10 ml}}$ = .3 colonies/ml
- .3 colonies/ml x 100 ml =
- 30 colonies





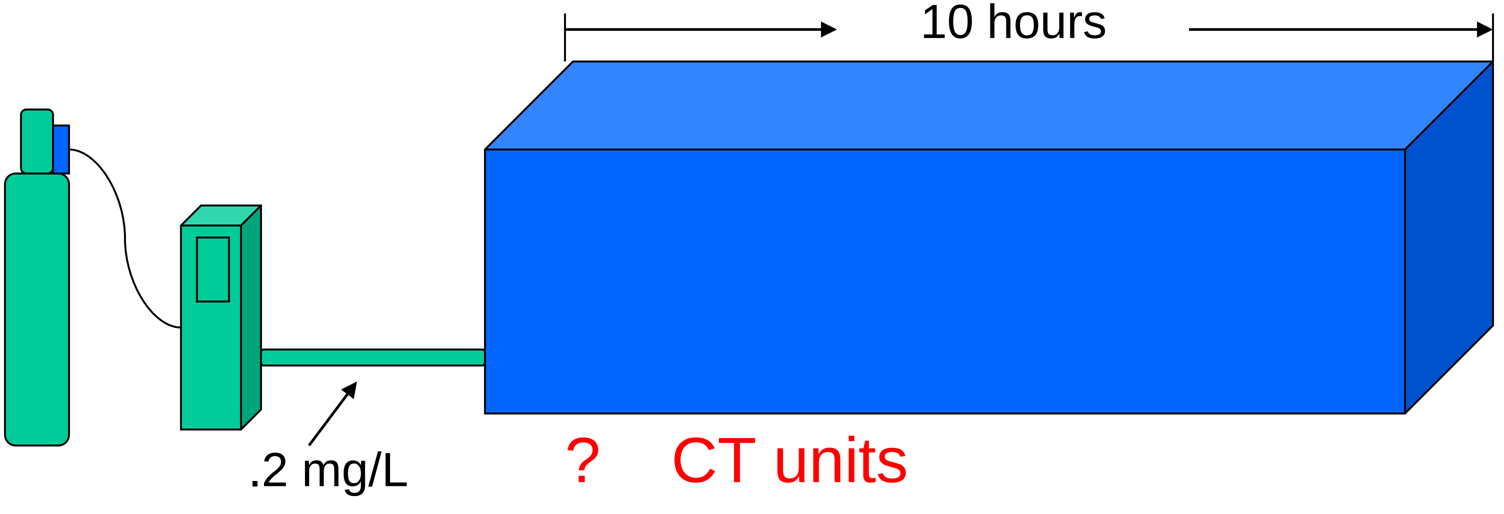
How many pounds of gas chlorine would be needed to dose 1.5 mg/l to a 4.25 mile section of 24 in. pipeline flowing at 2.1 cfs?

- $\frac{2.1 \text{ cfs}}{1.55 \text{ cfs/MGD}} = 1.35 \text{ MGD}$
- 1.35 MGD x 1.5 mg/l x 8.34 =
- 16.9 lbs.



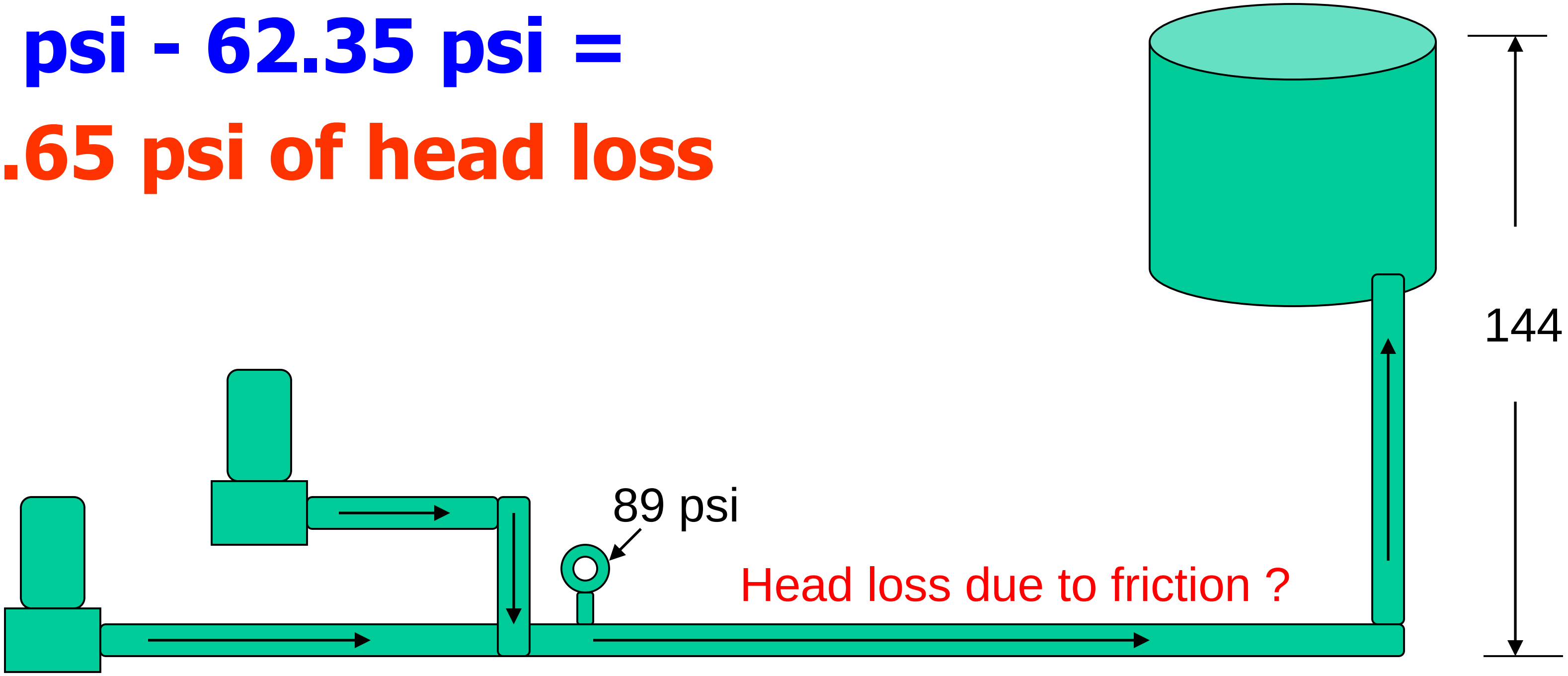
What is the contact time for a 10 hour period of a basin being dosed at .2 mg/L?

- CT = Chlorine concentration x Time in min.
- 10 hr. x 60 min. = 600 min.
- .2 mg/L x 600 min. =
- 120 CT units

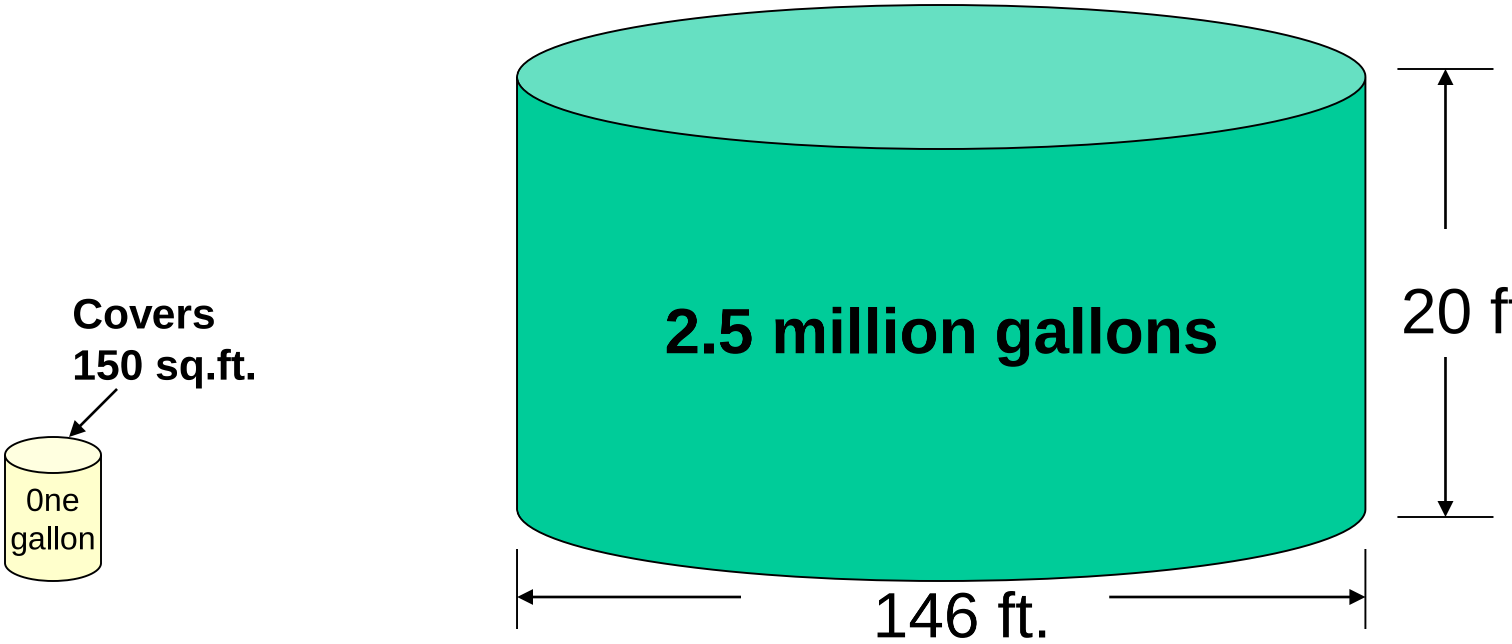


Two pumps are running with an output of 2500 gpm. The pressure gauges read 89 psi on the discharge pipe and the distance between the gauges and the water level in the tank is 144 ft. What is the head loss due to friction?

- **GPM has nothing to do with figuring the answer.**
- **Convert 144 ft to psi 144 x .433 = 62.35 psi**
- **89 psi - 62.35 psi =**
- **26.65 psi of head loss**



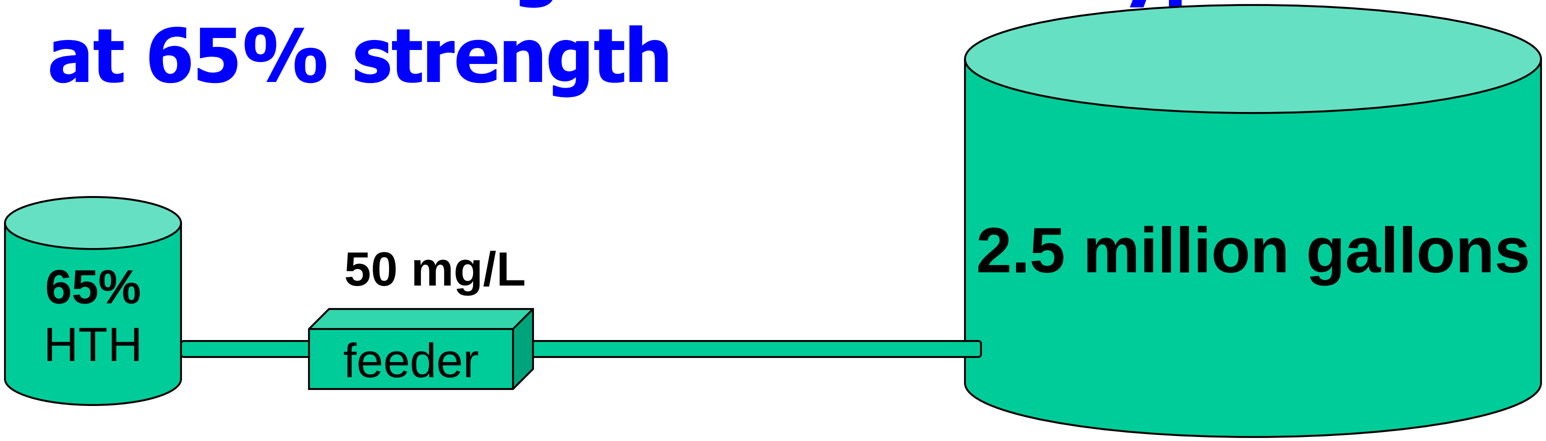
This year your maintenance crew has been given a work order to paint the 2.5 million gallon reservoir. You need to figure how much paint it will require to paint the reservoir inside and out. The reservoir is 146′ in diameter and 20′ high. A gallon of paint will cover 150 square feet.



- **Formula: Paint required= total area in square feet divided by coverage, sq.ft. per gallon.**
- **Top & bottom: 146′ x 146′ x .785 x 3 sides =**
- **Top & bottom: 50,199 sq.ft.**
- **Sides= pi or 3.14 x 146 dia. x 20′ x 2 sides**
- **Sides = 18,338 sq.ft.**
- **50,199 sq.ft. + 18,338 sq.ft. = 68,537 sq. ft.**
- **68,537 sq.ft. =**
  150 sq.ft./Gal
- **457 gallons of paint**

Disinfecting the Reservoir

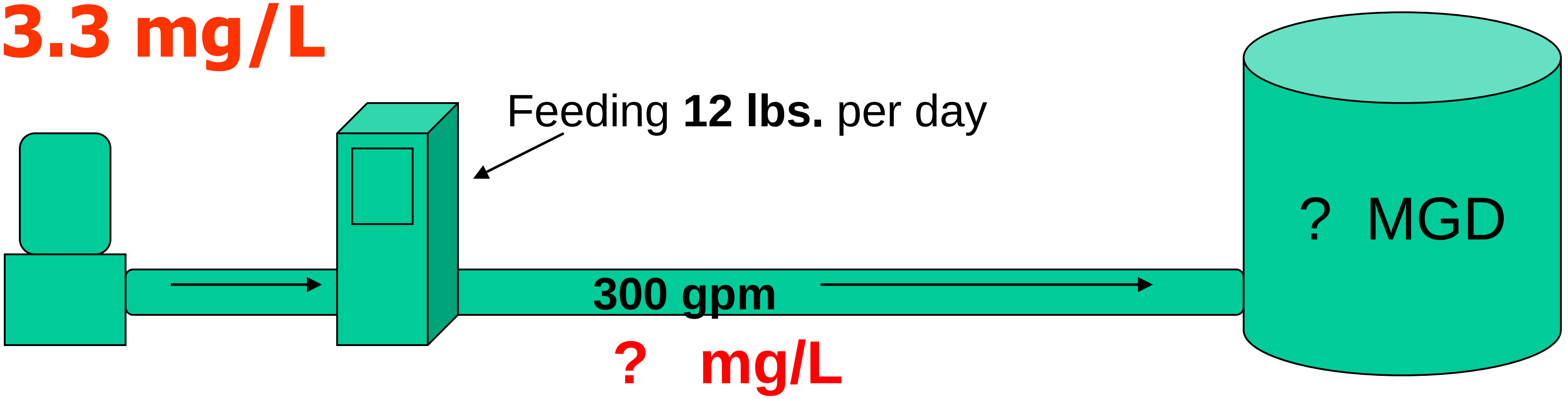
- After painting the reservoir you need to disinfect it per AWWA standards.
- Rules say to use AWWA standard C652-92
- One method states you must maintain 50 mg/L residual for 6 hours
- You are using HTH calcium hypochlorite at 65% strength



- **Formula: lbs. per day= MGD x 8.34 x ppm**
- **Known 50 mg/L and 2.5 MGD**
- **2.5MGD x 50 mg/L x 8.34 lbs./gallon=**
- **1043 lbs.**
- **1043 lbs./.65% =**
- **1605 lbs. of HTH**

A chlorinator is set to feed 12 lbs. per day to a flow of 300 GPM. What is the dose in mg/L?

- Dose mg/L = $\frac{\text{lbs. per day}}{(\text{MGD})(8.34)}$
- 300 gpm x 60 min. x 24 hr = 432,000 GPD
- $\frac{432{,}000 \text{ GPD}}{1{,}000{,}000 \text{ MGD}}$ = .432 MGD
- $\frac{12 \text{ lbs.per day}}{(.432)(8.34)} = \frac{12 \text{ lbs.}}{3.6} =$
- 3.3 mg/L



A hydrofluosilicic acid (H_2SiF_6) chemical feed pump is feeding a 30 percent by weight solution (specific gravity = 1.26) at the rate of .025 gpm in a plant operating at 12 mgd. The resulting fluoride dosage is ______ mg/L.

a. 1.4
b. 1.13
c. 0.90
d. 0.71

.30 x 1.26 x (.025 x 1440)= 36 x 8.34 = 113.49

12 mgd x 8.34 = 100.08

113.5 lbs chemical = 1.134 mg/L
100.08 lbs solution
b. is correct

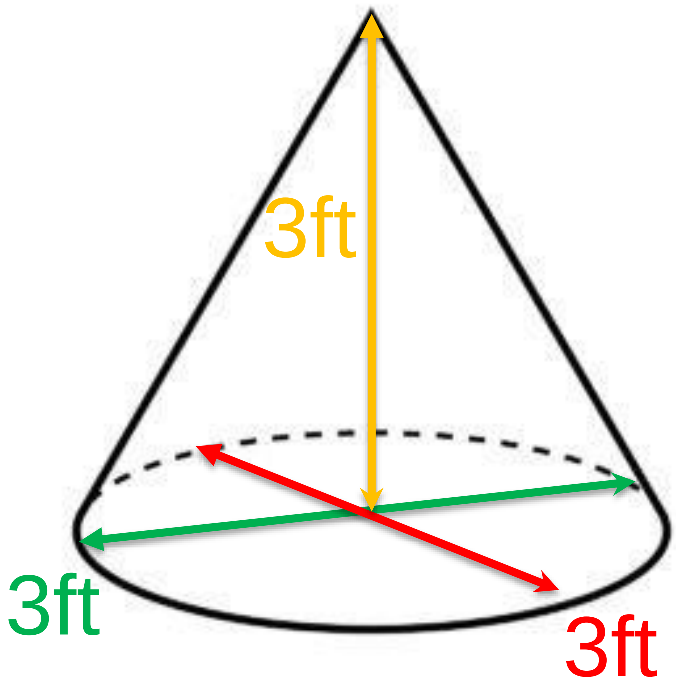
Volume: Cone

Volume of a cone is 1/3 the volume of a cylinder

(1/3) x dia x dia x .785 x depth = volume

$$\frac{.785 \times 3ft \times 3ft \times 3ft}{3}$$

$$\frac{21.2ft}{3} = 7.1ft^3$$



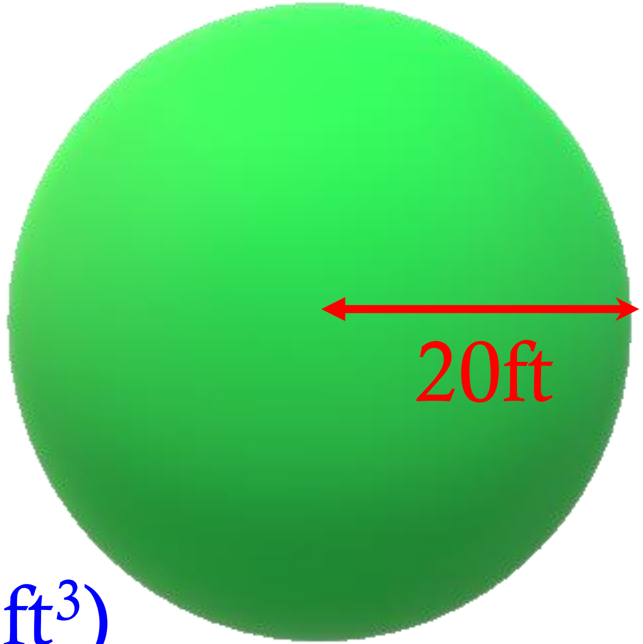
Volume: Sphere

Volume = $4/3(\pi)r^3$

Volume = $\frac{4(\pi)}{3}\ (20ft)^3$

Volume = $1.33 \times (3.14) \times (8{,}000ft^3)$

Volume = $33{,}409.6ft^3$



Backwash Formulas

Filter Flow Rate or Backwash Rate

$$\frac{\text{Flow, gpm}}{\text{Filter Area, sg/ft}} \quad \text{or} \quad \frac{\text{Backwash Rate, gpm/ft}^2}{\text{7.48 gal/cuft}}$$

If the maximum backwash rate of flow is 3,820 gpm, and the filter is 16 ft x 12 ft, what is the maximum backwash rate of flow, in gallons per minute per square foot of filter media?

a) 448 gpm/sq ft
b) 20 gpm/sq ft
c) 12.6 gpm/sq ft
d) 4.5 gpm/sq ft

Gallons per minute per square foot

$$\frac{\text{3,820 flow as gpm}}{\text{16 ft x 12 ft, Area}} =$$

$$\frac{\text{3,820 gpm}}{192\ ft^2} = 19.895\ gpm/\ ft^2$$

b) 20 gpm/sq ft

Metering Pump Setting

Speed, 0 -100%

Stroke, 0 – 100%

Express each as a decimal, 0 to 1.0

50% = 0.50

Speed x Stroke = Output Setting

0.50 speed x 0.50 stroke = 0.25 output

Nameplate gpd x output = gpd at that setting

Metering Pump Setting

- Pumping 12.5% bleach which was diluted 3:1
- using a 10 gpd metering pump
- Speed set at 80%, Stroke set at 45%
- How many gallons per day of the bleach solution will be injected ?

Metering Pump Setting

- Speed = 80%
- Stroke = 45%
- Nameplate gpd = 10

- 0.80 x 0.45 = .36 Output
- .36 X 10 = 3.6 gpd solution injected

Metering Pump Setting

In the previous problem, if the well is producing 125 gpm, what is the chlorine dose ?

3.6-gal x (12.5 % Chlorine x .33 dilution/100) x 8.34 (lbs/gal) = **1.24 lbs. Chlorine**

125 gpm X 1440 min/day = 180,000/1,000,000 = 0.18MG X 8.34 = **1.5 lbs. Solution**

<u>1.24 chlorine</u> = .83 mg/l dose
1.5 Solution

- **Strength of Solution = <u>wt. of chemical</u>**
  wt. of solution

The TWO Normal Formula

The ABC formula sheet has the Two Normal Formula $(N1)x(V1) = (N2)x(V2)$

N = Normality = Concentration

Volume/Concentration Formula V1C1 = V2C2

(1 gal) x (125,000 ppm) = (30 gal) x (? ppm)

$$\frac{1 \text{ gal} \times 125{,}000 \text{ ppm}}{30 \text{ gal}} = ? \text{ ppm}$$

= 4166.67 ppm