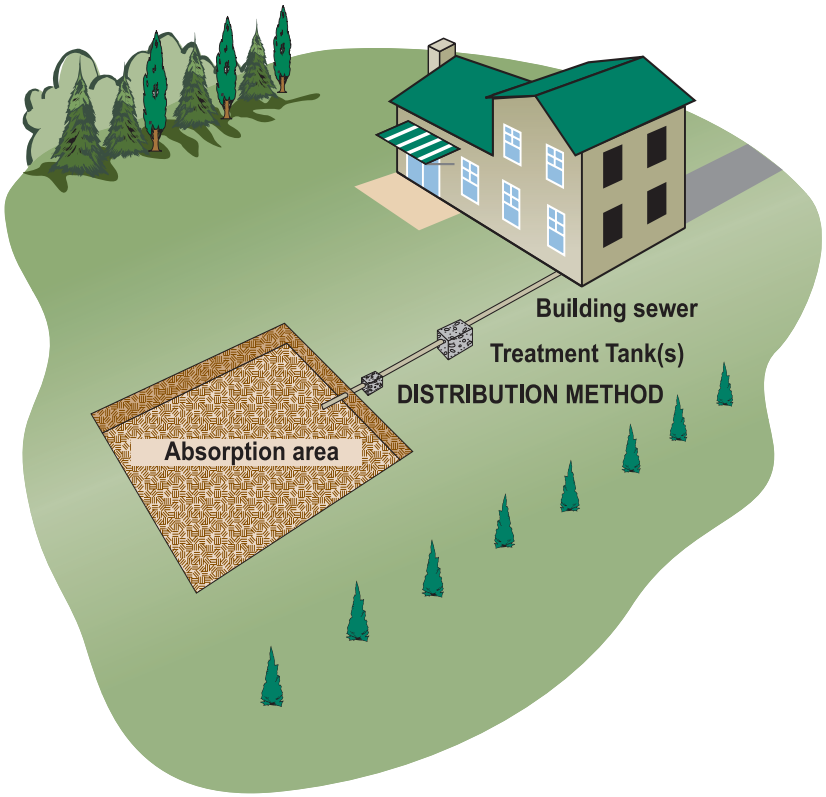
DISTRIBUTION SYSTEMS

14

OBJECTIVES

The purpose of this chapter is to:

- Learn the regulations for the piping distribution for systems.
- Calculate the size of pump needed to maintain a minimum 3 feet of head at the terminal end of the lateral for a pressure dosed system, using:
  - ✓ gpm (gallons per minute)
  - ✓ total dynamic head
- Calculate the volume of a dose.



Distribution

Section 73.41

NOTES

The distribution system is made up of the following:

1) the distribution method,
2) the delivery pipe, and
3) the lateral pipes in the absorption area.

Distribution method – Effluent may be distributed by either _____ _____ or _____ _____ _____.

Piping – All lines sloping away from the septic tank(s) must have a minimum drop in grade of ___ inch per foot.

GRAVITY FLOW

Section 73.42

A gravity system must be designed to deliver uniform distribution. To achieve this distribution, the distribution system must be _____.

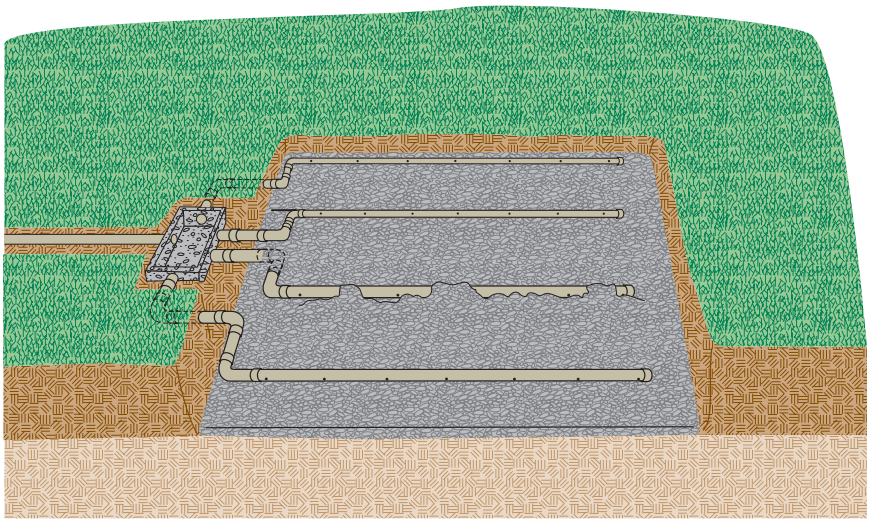
There are two ways of achieving uniform distribution in a gravity system:

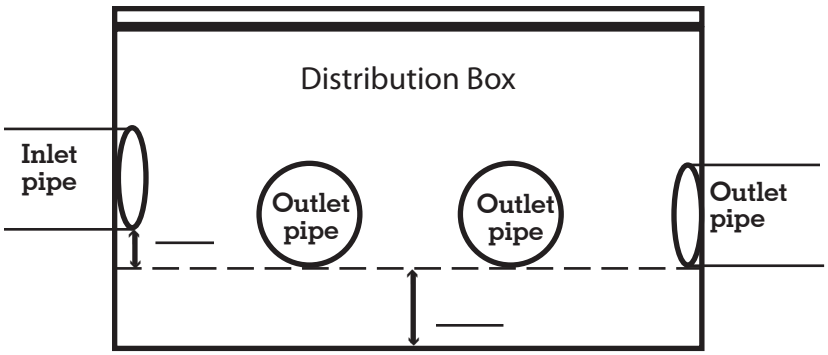
1) Distribution box
2) Header pipe (cannot be used with trenches)

1) DISTRIBUTION BOX ("D" BOX)

Section 73.42(d)

NOTES





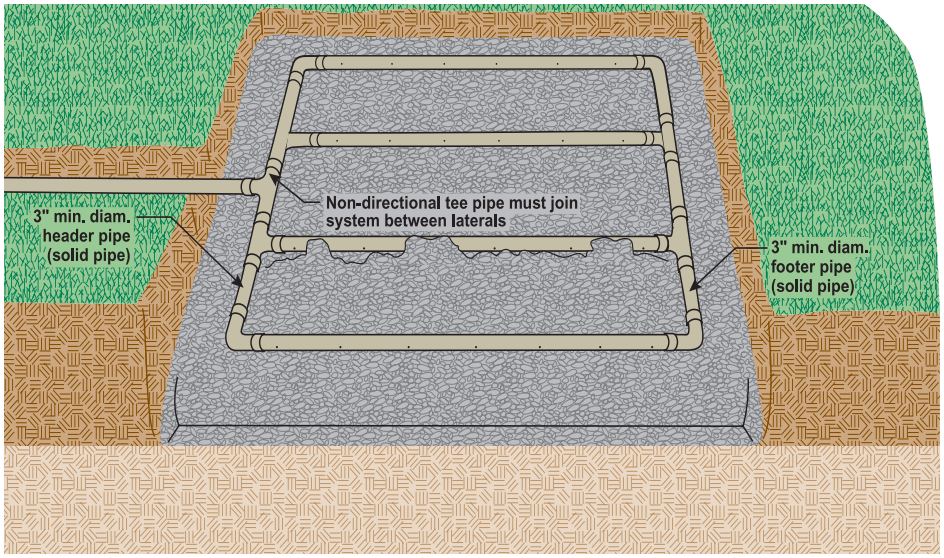
- When using a "D" box, the inlet must be at least ____ inch above the bottom of the outlet.

- The bottom of the outlet pipe must be at least ____ inches above the inside bottom of the box.

2) HEADER PIPE

Section 73.42(d)

NOTES



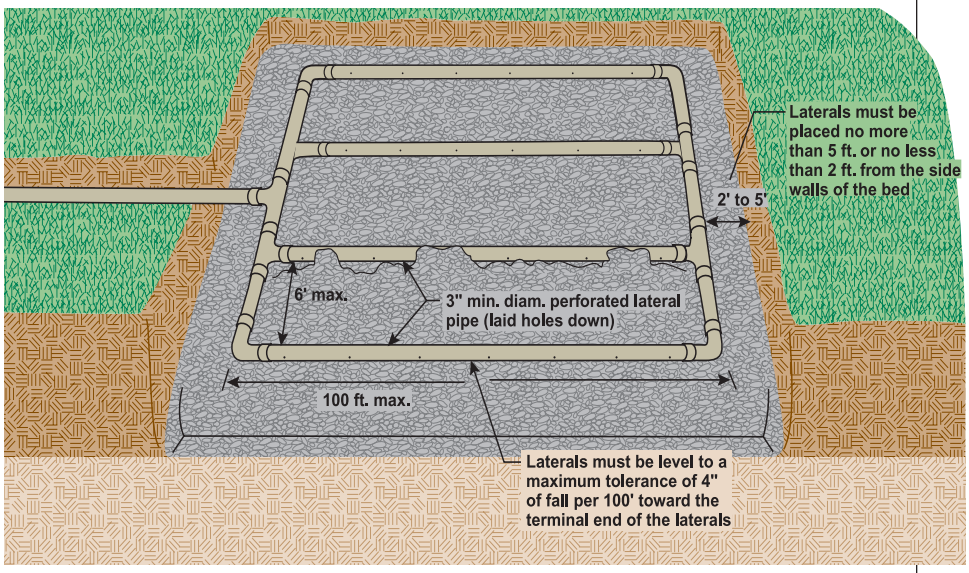
- The header pipe is _____. The lateral pipes are attached perpendicular to the header pipe.

- At the other end of the laterals, another pipe (the _____ pipe must connect all of the laterals making the system a continuous loop.

LATERAL PIPES FOR BOTH "D" BOX AND HEADER PIPE SYSTEMS

NOTES

Sections 73.42, 73.52, & 73.53



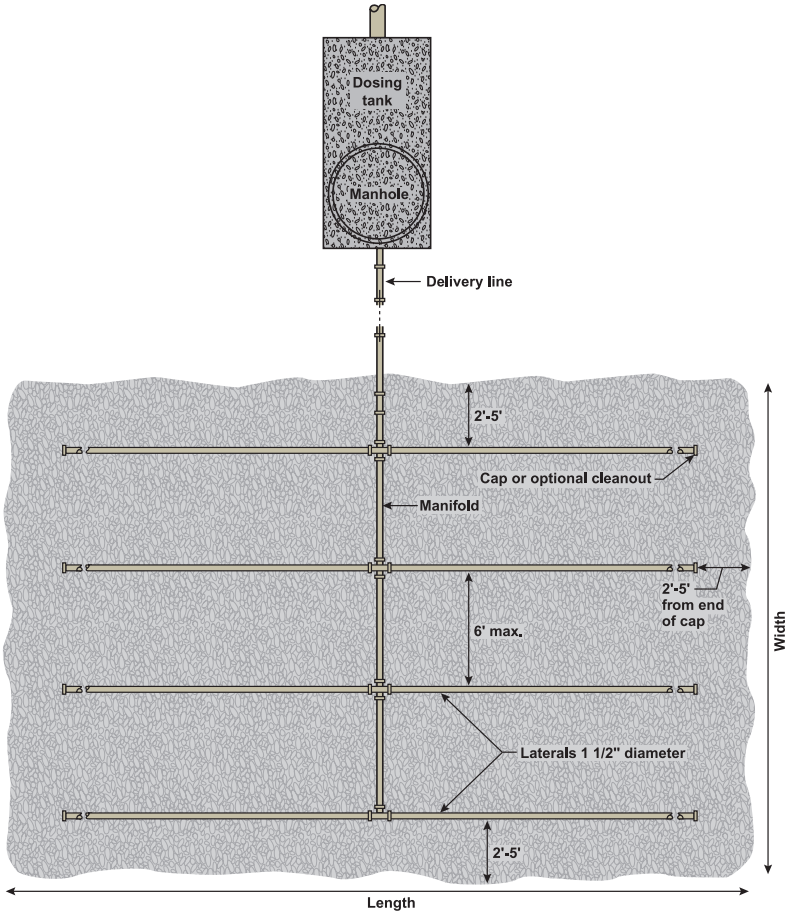
- The lateral pipes for both "D" box and header pipe systems are _____.
- Laterals must be equally spaced a maximum of _____ feet on center.
- Maximum length of lateral is _____ feet.
- Laterals must be a minimum of _____ inches in diameter unless specified by local plumbing or building codes.
- Laterals pipes must be level to a maximum tolerance of _____ inches of fall per 100 feet toward the terminal end of the lateral.
- There must be a ____- to _____-foot barrier from the edge of the absorption area aggregate to the pipe, ____ feet being the minimum and ____ feet being the maximum distances.

PRESSURE DOSING

Section 73.44

NOTES

Gravity flow is one way effluent is distributed to the absorption area. The second way is by pressure dosing.



DISTRIBUTION METHOD

With the dosing system, you need a dosing tank with a _____ or _____.

Note: A siphon works with a downward change in elevation to the absorption area. It creates a vacuum to dose the absorption area and does not require a pump. For further explanation on siphon operation, reference Field Manual 111-C-13.

PIPING

Delivery Line

Check valves are prohibited on delivery pipes. Delivery pipes take the effluent from the dosing tank to the absorption area.

NOTES

Center Manifold

Section 73.44(b)(3)

In a pressure dosed system, there must be a ___ _____ center manifold for delivering the effluent to the absorption area.

- For an absorption area of 200 to 1,199 square feet – the manifold must be at least _____ inches in diameter.
- For an absorption area of 1,200 to 2,500 square feet – the manifold must be at least _____ inches in diameter.
- For an absorption area greater than 2,500 square feet – there is no restriction on the diameter of the manifold.

Lateral Pipes

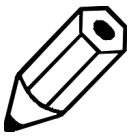
Section 73.44(b)(5)

- The lateral pipes must be _____-inch diameter pipe if the absorption area is ≤ 2,500 square feet

Holes in Laterals

Sections 73.44(b)(6) & (7)

- The first hole must be _____ feet from the manifold.
- All other holes will be placed _____ feet on center with the last hole at the end.
- The maximum length of a lateral from the manifold is _____ feet, containing nine holes.
- Minimum hole size:
  - ✓ Pump – _____ inch
  - ✓ Siphon – _____ inch
  - ✓ These holes are drilled into the pipe bottom.



NOTES

Feet of Head

Sections 73.44(c)(5) & 73.44(b)(11)

With a _____ _____ system, there is a continuous flow of effluent in the form of a trickle into the absorption area.

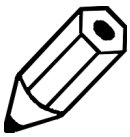
With a _____ _____ system, effluent is only dosed into the absorption area when the pump or siphon operates. The pump or siphon must guarantee a minimum 3 feet of design head at the terminal end of the lateral

Feet of design head – This is the amount of pressure forcing the liquid through the pipes. We will go into more detail later in the chapter.

The system must be designed to maintain a minimum of _____ feet of design head at the terminal end of each lateral.

BARRIER FROM EDGE

Sections 73.53(5) & (6)



NOTES

The following information applies to both gravity flow and pressurized systems.

There must be a 2- to 5-foot barrier from the edge of the absorption area aggregate to the pipe, with 2 feet being the minimum and 5 feet being the maximum distances. This applies to all systems that have a bed.

Pump Size

To calculate the necessary size of pump, you will need to determine the total dynamic head.

Total dynamic head = 1+ 2 + 3 = _____

1) Design head needed at end of lateral = _____

2) Elevation change (static head) = _____

3) Friction loss _____

To calculate friction loss, you need to know:

a) Rate of flow (gpm) _____

b) Length and diameter—
delivery line/manifold _____

c) Equivalent fitting length _____

* Mark this page as you will refer back to it to fill in the blanks as we progress through the chapter.

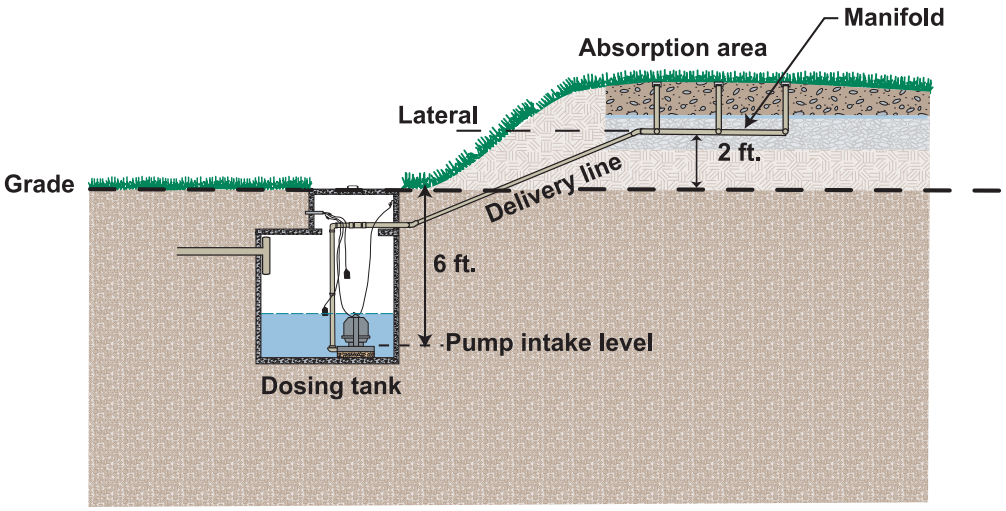
The total dynamic head is calculated to give us the information needed to choose the correct size of pump for the system. With the total dynamic head and gpm of flow for a system, the pump curve chart is used to find the correct pump.

NOTES

1) DESIGN HEAD

2) ELEVATION CHANGE

The elevation change is the change in elevation from the pump intake to the laterals in the absorption area. The pump will have to pump the effluent to that higher elevation.



Elevation change from pump intake to grade = 6 ft.

Elevation change from grade to laterals = 2 ft.

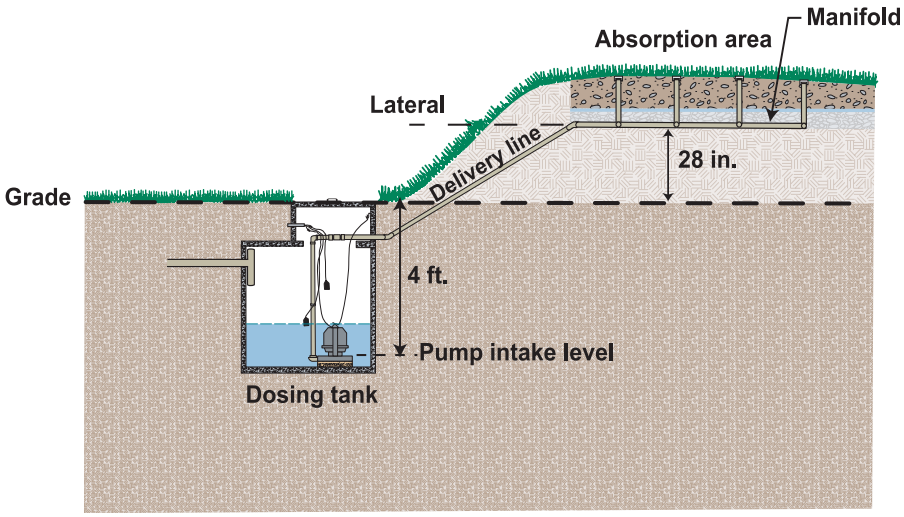
Change in elevation in feet = _____

EXERCISE 14-1

Solve for the change in elevation.

1) Elevated System

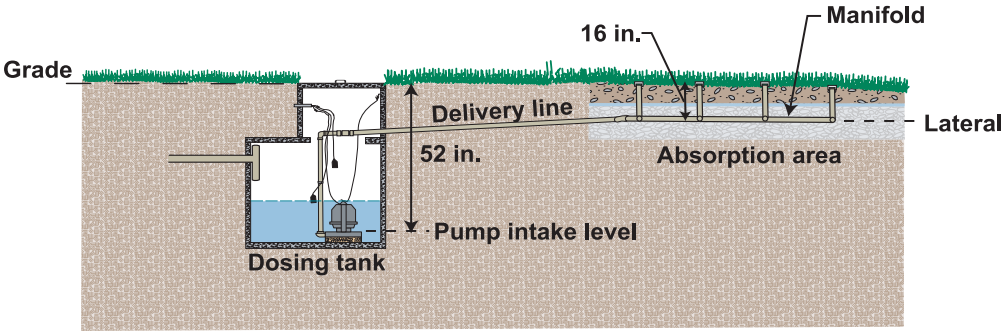
Elevation change from pump
intake to grade = 4 ft.
Elevation change from grade
to laterals = 28 in.
Change in elevation (in feet) = _____



NOTES

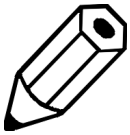
2) In-ground System

Elevation change from pump intake to grade = 52 in.
Elevation change from grade down to the laterals = 16 in.
Change in elevation (in feet) = _____



NOTES

3) FRICTION LOSS



NOTES

Friction loss is the last element that needs to be determined for total dynamic head.

Friction loss occurs as liquid flows though the pipes and fittings of distribution systems.

The amount of friction that is created depends on three factors.

To calculate friction loss, you need to know:

a)

b)

c)

a) RATE OF FLOW IN GPM

To calculate the friction loss, you need the gallons per minute (gpm) flow that the absorption area will require. This number will be used again to help size the pump at the end of this chapter.

Section 73.44(c)(3)

$$gpm = 11.82 (d^2) (\sqrt{h})$$

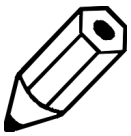
d = diameter of hole in inches. (This is the hole drilled in the laterals.)

h = head in feet to be maintained at terminal ends of laterals

For onlot systems, 3 feet minimum of design head must be maintained at the terminal end of the lateral.

SAMPLE PROBLEM

Find the total gpm for the absorption area using the example below.



NOTES

Simplify diameter of hole (d):

Example: hole diameter is 5/16

d: 5 ÷ 16 = _____

d^2: _____ × _____ = _____

Simplify design head maintained at terminal ends of laterals (h):

h: 3 feet

$\sqrt{h}$: _____

Solve for gpm for a single hole:

gpm: 11.82 × (d^2) × ($\sqrt{h}$) = gpm for each hole

11.82 × (_____) × (_____) = _____ gpm for each hole

Solve for total gpm for the absorption area:

Formula: gpm × total # of holes drilled in absorption area

Example: 12 holes total

_____ gpm × 12 holes = _____ total gpm for the absorption area

Appendix 14-A has a hole discharge calculation (gpm) chart.

EXERCISE 14-2

Calculate the gpm for an absorption area using the information below:

Diameter of the holes is ¼ inch
12 holes total

NOTES

(b + c) TOTAL FEET OF PIPE

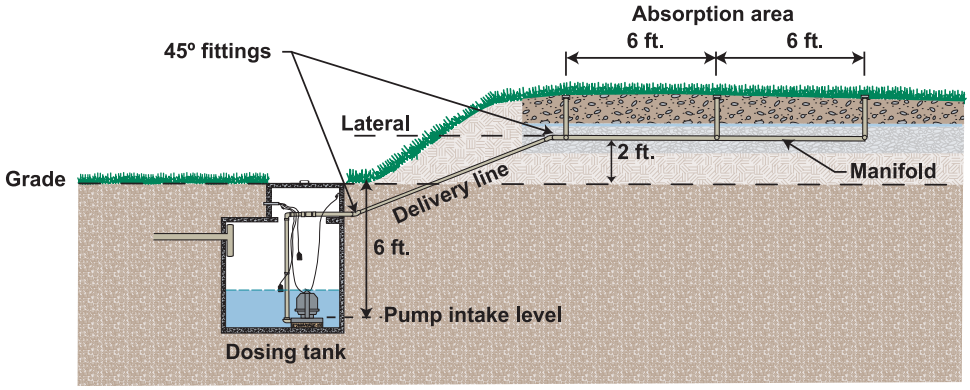
NOTES

To solve for friction loss, we have already determined the first factor: gpm for the absorption area.

Next we need to add together the length of delivery/manifold pipe (b) and the fitting equivalent lengths (c) in feet to solve for friction loss.

b) Length—Delivery Pipes and Manifold

Section 73.44(b)(14)

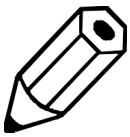


Add the lengths of all the sections of pipe from the pump to the manifold, including the manifold. Do not include the lateral pipes; the head loss due to friction in the laterals is assumed to be 0.

In the example above:

5 ft. (vertical pipe in dosing tank)
+ 5 ft. (horizontal pipe in dosing tank)
+ 23 ft. (delivery line)
+ 12 ft. (manifold pipe)

c) Fittings



NOTES

The fittings that connect the pipes together will also cause friction loss. This is the resistance against the pipes that liquid must overcome to get around a curve or through a fitting.

Sample Problem – Fittings

Use the first box below to determine the equivalent pipe length in feet for each of the fittings listed in the second box.

The second box lists fittings that are used in this onlot system design. The numbers in parentheses indicate how many of each kind of fitting were used in this example. For this example, assume a 2-inch delivery pipe.

Finally, solve for the total feet.

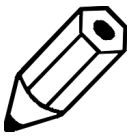
Equivalent lengths of plastic pipe for various fittings

	Diameter of Fitting					
Type of Fitting	1½ in.	2 in.	3 in.	4 in.	6 in.	8 in.
	Equivalent Length in Feet					
90° ELBOW	4.73	5.55	8.23	10.8	16.2	22.4
45° ELBOW	2.01	2.58	3.84	5.03	7.58	9.98
FOUR-WAY CROSS	2.70	3.50	----	----	----	----
CHECK VALVE	12.0	15.4	22.9	30.0	45.2	59.5
COUPLING	1.05	1.35	2.01	2.64	3.98	5.23
QUICK DISCONNECT	1.05	1.35	2.01	2.64	3.98	5.23
STANDARD T		11.10				

2-inch Delivery Pipe

FITTINGS	EQUIVALENTS FROM THE TABLE	TOTAL
90° elbow (1)	_____	_____ft.
Quick disconnect (1)	_____	_____ft.
45° elbow (2)	_____	_____ft.
Coupling (2)	_____	_____ft.
Cross (1)	_____	_____ft.
	Total feet	_____ft.

SOLVE FOR FRICTION LOSS



NOTES

Friction loss = total feet [delivery pipe/manifold (b) + fitting equivalents (c)] × head loss due to friction for 1 foot of pipe

Total feet (b + c):

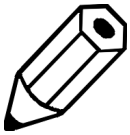
First add up b) and c) to get total feet.

Total length delivery pipe/manifold ⇒ _____
\+ Fitting equivalent lengths ⇒ _____
Total feet ⇒ _____

Head loss due to friction:

To get head loss due to friction, use the table in 14-B of the appendix. To use the table, you need to know gpm flow and diameter of pipe.

SAMPLE PROBLEM - FRICTION LOSS



NOTES

Solve for the friction loss, using the head loss due to friction found in appendix 14-B. Round the gpm up to the next whole chart number.

Example:

- 24 gpm ⇒ round up to 25 gpm
- 2-inch pipe

Head loss due to friction in feet = _____ per 100 feet of pipe.

Calculate for 1 foot:

The head loss due to friction chart gives the friction loss per 100 feet of pipe. To solve for friction loss, you need the head loss due to friction for 1 foot so you must divide the number from the chart by 100.

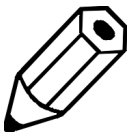
_____ ÷ 100 = .011

Friction loss = total feet of pipe (delivery pipe/ manifold and fitting equivalent lengths) × head loss due to friction in 1 foot of pipe

Formula: (Total feet) × (head loss for 1 foot of pipe due to friction) = feet of friction loss

(_____) × (_____) = _____feet of friction loss

SOLVE FOR TOTAL DYNAMIC HEAD



NOTES

We now have all the factors we need to solve for total dynamic head.

Total Dynamic Head:

1) Head to be maintained in lateral _____

2) Elevation change: _____

3) Friction loss: _____

Total _____

REVIEW

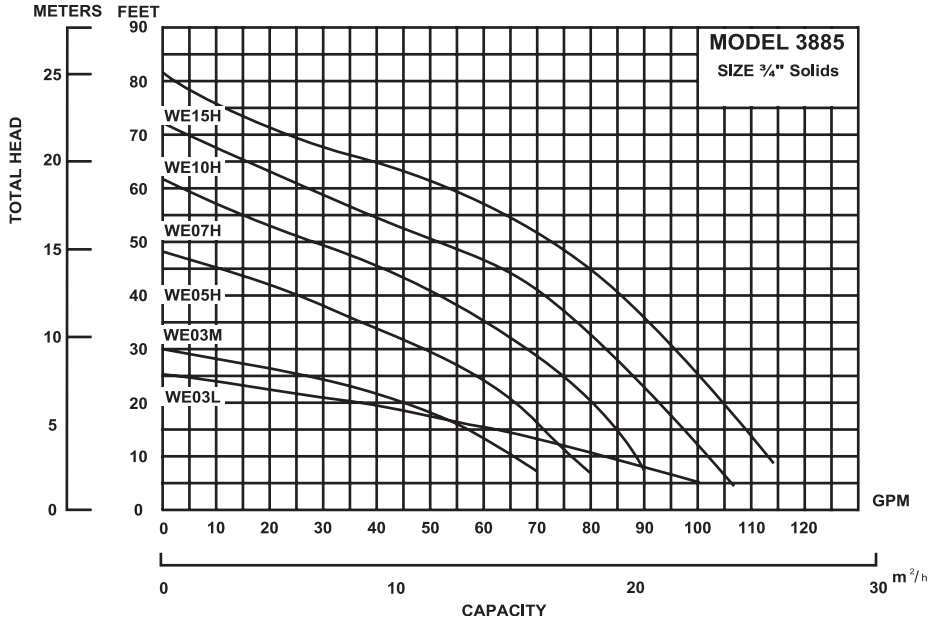
Why did we just go through all those calculations? What does this number for total dynamic head mean?

PUMP CURVE

NOTES

Now you have the information you need to determine the size of pump needed to properly deliver the effluent to the pressure dosed absorption area.

With the total dynamic head and the gpm, use the pump curves to find a pump that will have enough power to deliver the minimum flow and maintain at least 3 feet of head at the end of a lateral.



SAMPLE PROBLEM – PUMP CURVE

Total dynamic head = _____

gpm = ____

Pump = _____

Section 73.46(a)(7)

The pump curve must be attached to the permit.

Volume of Dose

Section 73.45(2)

The minimum volume of the dose must be _____ gallons or _____ times the internal capacity of the delivery pipe, manifold, and laterals, whichever is greater.

Example - Feet of pipe

1½-inch diameter pipe:
Laterals (6 × 9 ft.) = 54 ft.

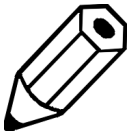
2-inch diameter pipe:
Delivery pipe and manifold = 45 ft.

Total feet of each diameter pipe × (gallons/1 ft. of pipe) = internal capacity of the total of each diameter pipe

Internal capacity of each diameter pipe must be added together to obtain total internal capacity of the total pipe.

NOTES

SAMPLE PROBLEM – VOLUME OF DOSE



NOTES

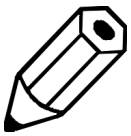
Calculate the internal capacity for each diameter of pipe. Total the internal capacity for the pipe used in this system. Then calculate what would be the dose for this system.

Diameter of Pipe	No. of Feet Used	Gallon/Foot	Internal Capacity (gallons)
1½ in.		.09	
2 in.		.16	
3 in.		.37	
4 in.		.66	
			Internal Capacity _____ gal.

Internal capacity of _____ gal. × 5= _____

What would be the minimum volume dose for this system?

ON-AND-OFF MECHANISM TO DELIVER THE CALCULATED DOSE



NOTES

An on-and-off mechanism will be installed with a certain number of inches between the on switch and the off switch. This amount of inches represents the amount of effluent that is dosed to the absorption area.

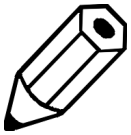
CALCULATE THE INCHES OF DEPTH FOR A DOSE

The next step is to calculate the vertical inches of depth in the dosing tank that will equal the calculated dose.

For homework last night (HW–E), you calculated the gallons in one vertical inch of depth. This is the number you will use to calculate the number of inches needed for the dose.

$$\frac{\text{Dose volume}}{\text{gallons per vertical inch of depth}} = \text{inches of depth for a dose volume}$$

SAMPLE PROBLEM – INCHES OF DEPTH FOR A DOSE



NOTES

Calculate the inches of depth for a dose.

3.92 gallons per inch of depth in the dosing tank

Required dose for system = 100-gallon min.

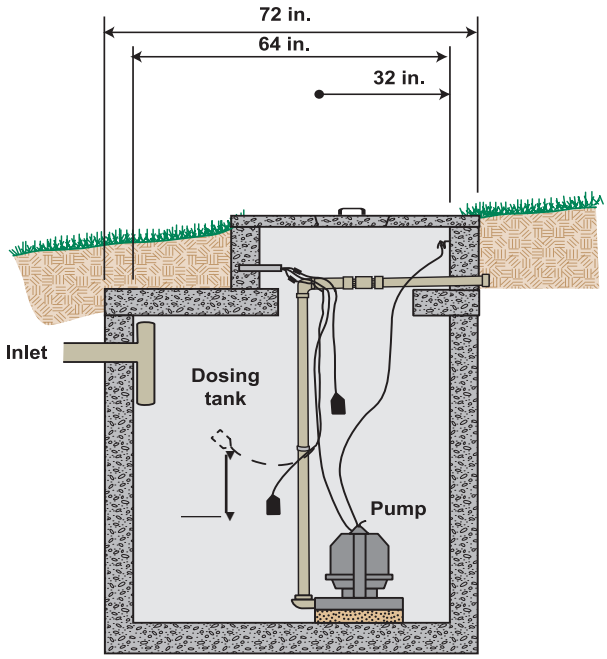
$$\frac{\text{100-gallon dose}}{\text{13.92 gal./in. of depth in dosing tank}} = \text{\_\_\_\_ in. of depth}$$

Inches of depth for a dose = _____

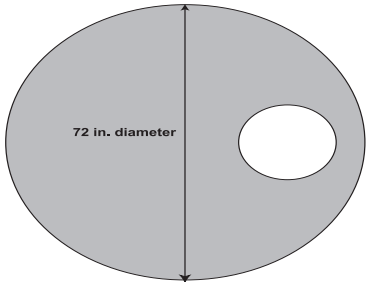
The on-and-off switch must be _____ inches apart.

Note: It is recommended that the pump be submersed in liquid at all times.

Side view of round tank



Overhead view of round tank



Note: When calculating the liquid capacity of the pump tank, the area below the top of the pump cannot be considered part of the liquid capacity. It is not usable liquid.

NOTES

Electrical Connections

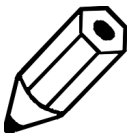
Section 73.45(5)

- The electrical connections must be positioned at a point higher than the inlet pipe.
- All connections must be moisture resistant. Use a shrink tube, moisture-resistant plugs, or a watertight plastic box.

Alarm

Section 73.46(a)(5)

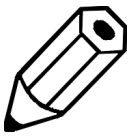
- All pump tanks must have an audible alarm and visual warning device to alert the residents that the pump is not properly working.
- The warning device needs to be on a _____ circuit from the pump.



NOTES

KEY POINTS

- Distribution systems are designed to equally distribute effluent to the absorption area.
- The pump must be sized to maintain a minimum of 3 feet of head at the terminal end of the lateral.
- The minimum dose volume to the absorption area is 100 gallons or five times the internal capacity of the delivery pipe, manifold, and laterals, whichever is greater.
- All electrical connections must be moisture resistant.



NOTES