8 Water Supply Equipment

This chapter provides information on the various components required at the supply end of a trickle irrigation system. Information on the selection of mainlines and pumps is provided. The methodology for calculating the total trickle irrigation system flow and pressure requirements is outlined.

8.1 Trickle Irrigation System Supply Components

Trickle irrigation systems can include various pieces of equipment prior to the lateral and emitter. Figure 8.1 shows components that are required from the water supply to the mainline going out to the field. The system components needed from the water source to the zone control valve are shown in order of installation. It is common for most trickle irrigation systems to include all of these components. An explanation of why some of the components are required follows.

Pressure Gauge

Pressure gauges are important components for monitoring the overall performance of the trickle system. It is important to establish normal operating pressure differences when the system is initially installed. There after a sudden large drop in system pressure could indicate a leak or broken pipe in the system. An increase in the pressure difference across the filtration system is an indication that the filter is clogged and needs cleaning.

Flow Meter

A flow meter is a quick indicator of potential problems in systems operation. The flow rate for each zone should be recorded when the system is first installed. Follow up readings will then give an indication of system performance. A decrease in the zone flow rate is an indicator that the emitters may be plugging up.

Pressure Regulator

Pressure regulators may be required at the trickle system inlet if the pressure available exceeds the rated pressure of system components such as the filters. Pressure regulators are required at the beginning of each zone to ensure the correct operating pressure for the emitters is achieved.

Backflow Preventor

Most trickle systems have injection systems to apply fertilizers to the crop or inject chemicals to the irrigation water for maintenance purposes of the trickle system. A backflow prevention valve is used to protect the source water supply from accidental contamination. Where water is taken from an irrigation district or other water purveyor a backflow preventor should always be used. See Chapter 12.

Pressure Relief Valve

On pumped systems pressure relief may be required to protect the system components from excessive pressure.

Air Relief

Air relief valves should be installed on all high points of the mainline system to remove air from the pipelines.

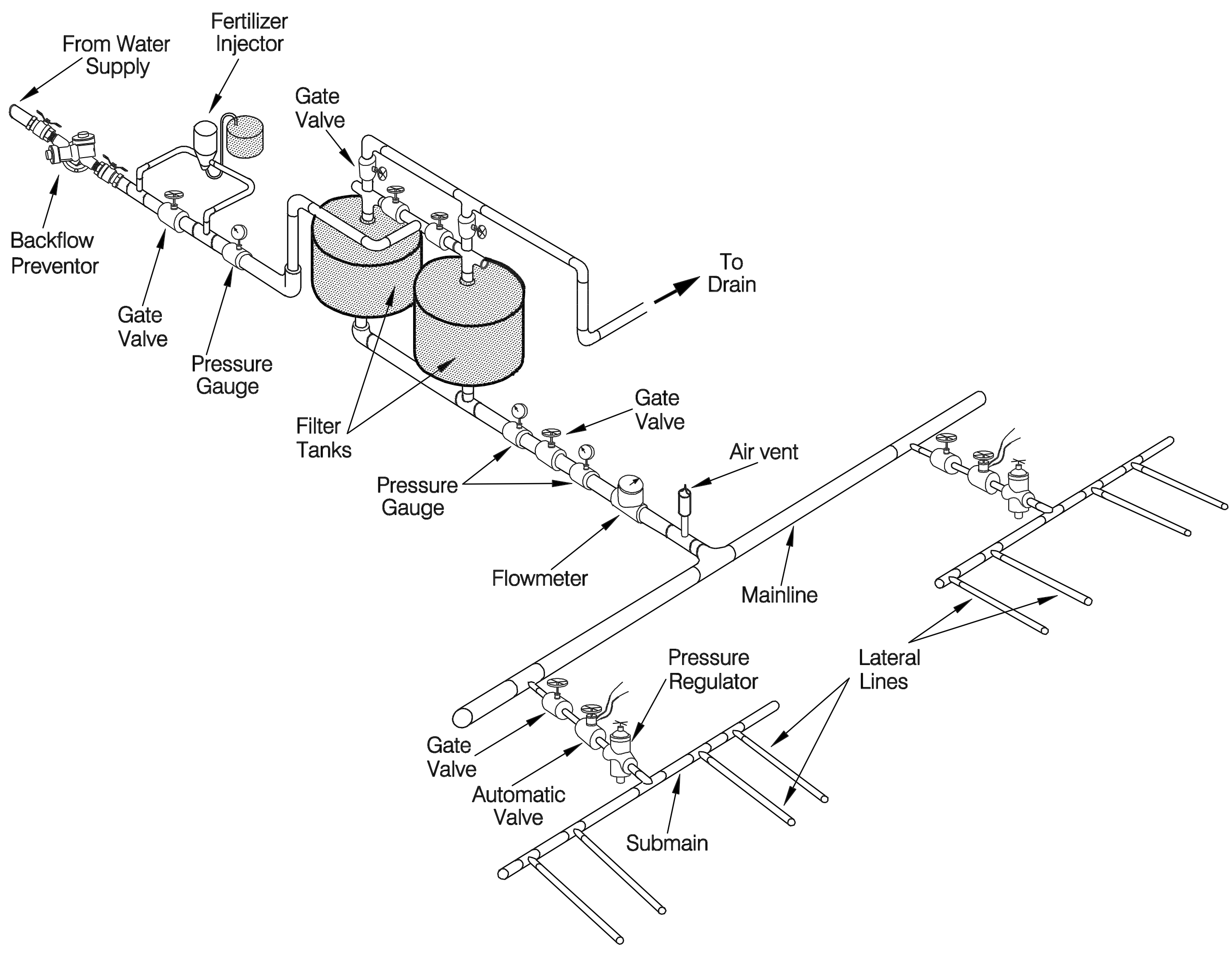


Figure 8.1 *Trickle Irrigation System Water Supply Components*

Figure 8.2 shows examples of trickle and drip system component setups for greenhouse and field operations. While the visual appearance may be different many of the components in Figure 8.1 are shown.

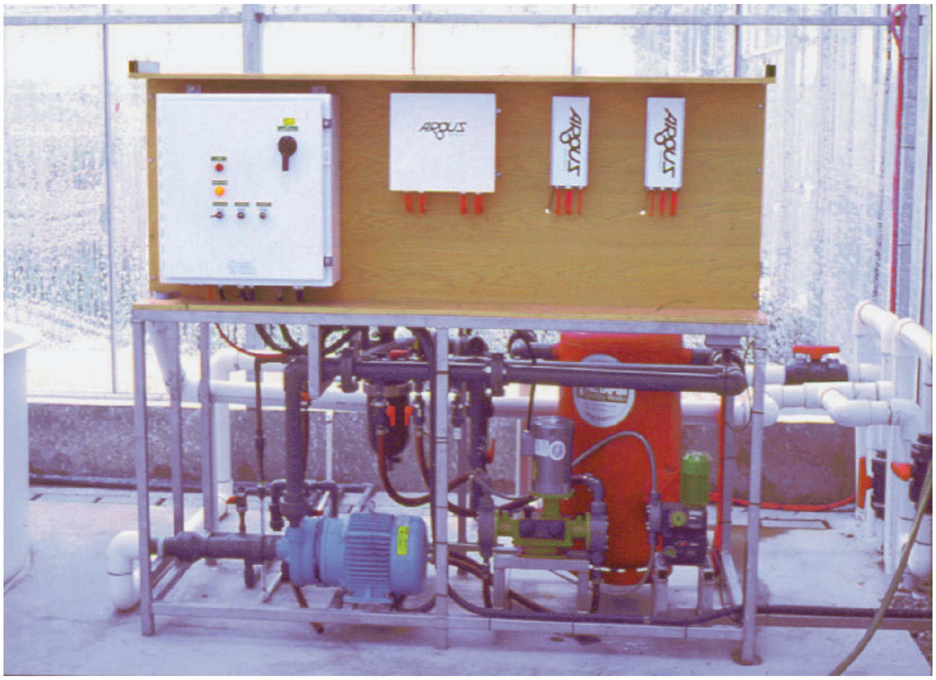


Figure 8.2 *Trickle Irrigation Water Supply*

Trickle system irrigation zones can be controlled manually as they are operated on a daily basis. Figures 8.3 and 8.4 shows the equipment that must be installed for manual and automatic zone control. A manual valve is installed before the automatic valve for maintenance purposes. In the event that an automatic valve fails the zone can be shut down manually, allowing the automatic valve to be serviced without the rest of the system having to be shut down.

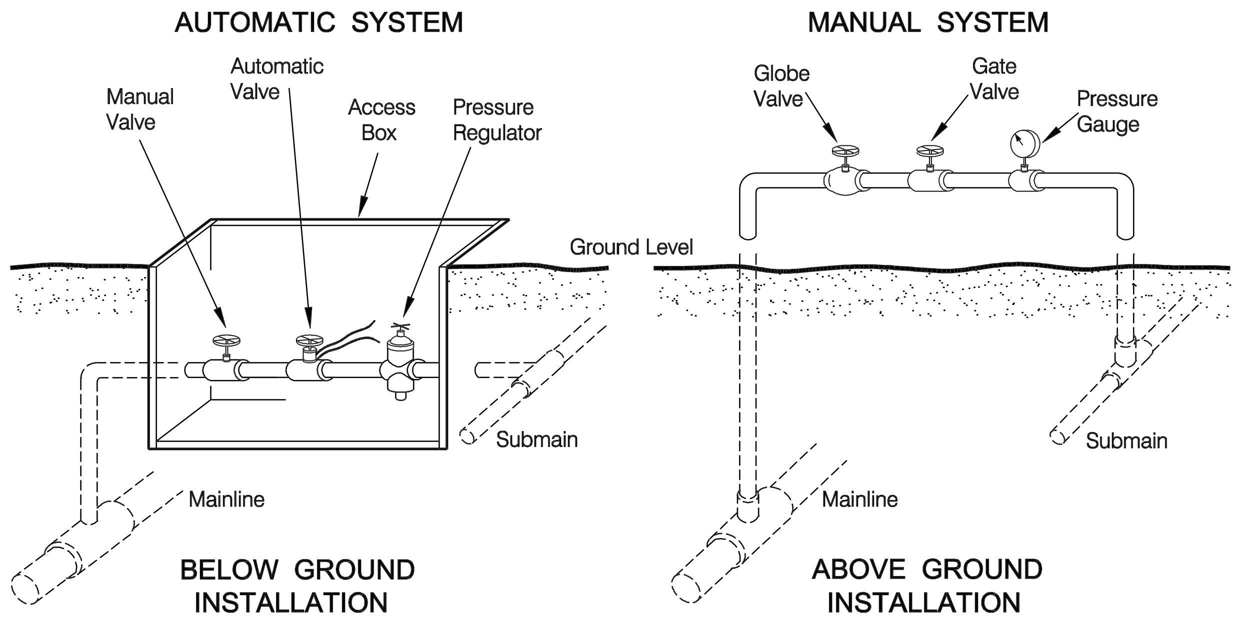


Figure 8.3 *Control Valve Installation on Sub-main*

Figure 8.4 *Zone Control Valve*

For manual control two valves are required if a pressure reducing valve is not used. The first valve turns the zone on or off while he second valve is adjusted to regulate the zone pressure. A pressure gauge is required to monitor the zone pressure. For this kind of setup the zone pressure will change if the water supply pressure changes. A pressure regulating valve would do this automatically.

8.2 Mainline Selection

Selection of an adequate mainline to deliver water from the source to the trickle irrigation system will depend upon:

- the amount of water to be delivered
- the allowable friction loss in the mainline
- the type of pipe to be used
- the length of mainline required

The length of mainline and amount of water to be delivered can be determined from the trickle irrigation design plan and layout. A choice of pipe material must be made prior to calculating the mainline friction loss.

Figure 8.5 *Irrigation System Mainline Installation*

Pipe Type Selection

There are four common types of pipe material used in irrigation systems.

Aluminum
Aluminum is lightweight, easy to assemble and used extensively for above ground portable irrigation systems. Trickle irrigation systems do not often use this pipe as it cannot be buried without a protective coating and it is difficult to attach polyethylene laterals.

Steel
Steel is more commonly used for larger diameter or high pressure installations (10” diameter and larger) where its weight and cost are not prohibitive. Steel is quite susceptible to corrosion but protection such as wrapping, galvanizing and rust resistant paints are available to allow for burial of steel pipe. Steel pipe is not commonly used for trickle irrigation systems.

Polyvinyl Chloride (PVC)
PVC pipe is available in numerous classes depending on the working pressures and site conditions that will be encountered. It is lightweight, durable, easy to install and has excellent resistance to most chemicals making it popular for buried irrigation systems. While ultraviolet resistant PVC is available, ordinary PVC deteriorates when exposed to sunlight and becomes brittle at freezing temperature making it impractical for most exposed work. See Table C.2 to C.5 in Appendix C for friction loss values of PVC pipe.

Polyethylene(PE)
Polyethylene has similar characteristics to PVC except that it is more flexible. PE is more commonly used for small diameter and low pressure situations and is often used for drip or trickle systems. For mainline sizes exceeding 2” or pressures greater than 75 psi, PVC pipe is more commonly used than PE. PE is quite responsive to temperature changes and may require special attention during installation. See Table C.1 in appendix C for friction loss values of polyethylene pipe.

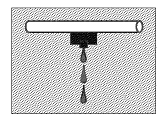
PVC and PE are commonly used mainline materials for trickle irrigation systems.

8.3 Calculating Mainline Size

The mainline pipe size will be determined from the allowable friction loss and quantity of water to be delivered. To limit potential surge pressures, the maximum flow velocity in the mainline piping should not exceed 5 ft/sec. The tables in Appendix C have dark lines indicating at which flow rate the 5 ft/sec flow velocity for each pipe size is reached. Friction values below the dark lines in these tables are in excess of 5 ft/sec and should therefore be avoided.

The pipe size may also be limited by the maximum allowable pressure loss in the mainline if the pressure available is limited. The following example uses a gravity feed example to illustrate this point.

Example 8.1 Mainline Selection for the Point Source Emitter System



The point source emitter system from example 7.2 required 110 gpm to be be supplied. The water source is a gravity feed system with an elevation drop of 135 ft from the intake to the trickle system. The distance from the intake to the trickle filtration station is 2000 ft. The operating pressure required at the filtration system is 50 psi. The trickle system requires 30 psi to operate.

What size PVC Class 160 mainline is required to carry this flow within the friction loss allowed?

The available pressure due to gravity is:

$$\frac{135 \text{ ft}}{2.31 \text{ ft / psi}} = 58.5 \text{ psi}$$

The allowable pressure loss in the mainline is:

$$58.5 \text{ psi} - 50 \text{ psi} = 8.5 \text{ psi}$$

$$\text{Maximum allowable friction loss per ft} = \frac{8.5 \text{ psi}}{2000 \text{ ft}} = 0.00425 \text{ psi/ft}$$

$$\text{loss per 100 ft} = 0.00425 \text{ psi / ft} \times 100 = 0.425 \text{ psi / 100 ft}$$

Table C.3 lists the friction losses for Class 160 PVC in psi / 100 ft. To limit the flow velocity to 5 ft /sec only the friction losses above the dark line should be used. At a flow rate of 110 gpm the friction loss for 3” Class 160 PVC is 0.848 psi / 100 ft and 4” is 0.249 psi / 100 ft. The right selection would be 4” PVC.

The mainline selected should be large enough to accommodate future flow requirements, be able to withstand the maximum pressures exerted on the system and be adaptable to the type of installation. Large pipe is usually a good investment but pipe cost must also be considered.

8.4 Pump Selection

Centrifugal Pump

Centrifugal pumps are a good choice to pump water from lakes, rivers, creeks or shallow wells.

A horizontal centrifugal pump is most commonly used for irrigation applications where static suction head conditions are less than 20 ft. The pump selected should provide the operating requirements of the irrigation system at or close to its best efficiency point. (B.E.P.) The B.E.P. of centrifugal pumps vary from 45% to 80% but consideration should be given to selecting pumps that have efficiencies of 65% or better. A centrifugal pump should not be operated at less than 80% of its B.E.P. (i.e. If a pump has a B.E.P. of 80%, it should not be allowed to operate at an efficiency less than 64%).

Pump capacity and efficiency are reduced by excessively high suction lifts. To ensure efficient pump operation the calculated Total Dynamic Suction Lift (TDSL) must be less than the allowable TDSL shown on the pump performance curves. *See the B.C. Sprinkler Irrigation Manual for more information on centrifugal pump selection.*

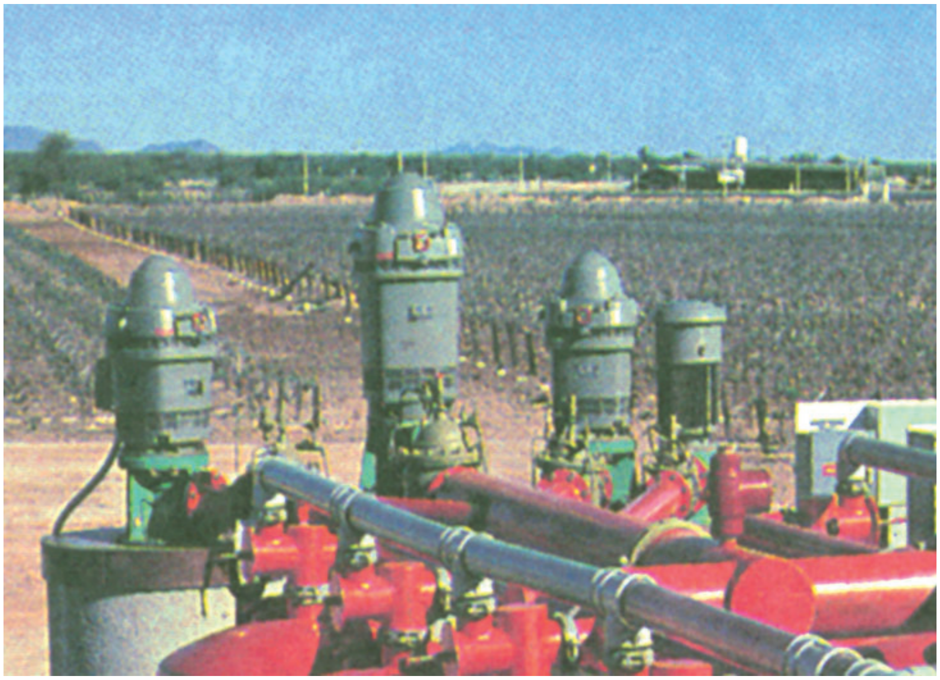
From: Cornel Pump Co.

Figure 8.6 *Centrifugal Pump*

Turbine and Submersible Pumps

Turbine and submersible pumps are used for well and high lift installation. Wells exceeding 25-30 ft in depth will require a turbine or submersible pump. Turbines are generally used for total pressure requirements exceeding 500 ft of total dynamic head (TDH).

For optimum life turbines should not exceed 1800 rpm. Submersible pumps usually operate at 3600 rpm which may allow for smaller well diameters than a turbine pump. Wells should be constructed at least one nominal size larger than the pump size. Table 8.1 should be used to select a well diameter that will ensure a pump of sufficient size can be installed.



From: Yardney

Figure 8.7 *Turbine Pump*

Table 8.1 Recommended Wall Diameters

Anticipated Well Yield (gpm)	Nominal Size of Pump Bowls (in)	Optimum Size of Well Casing (in)	Smallest Size of Well Casing (in)
Less than 100	4	6 ID	6 ID
75 to 175	5	8 ID	8 ID
150 to 400	6	10 ID	8 ID
350 to 650	8	12 ID	10 ID

8.5 Total System Pressure Requirement

The irrigation system total pressure requirement will be slightly different if calculated for a gravity system, pressurized supply from a water purveyor or self pumping from a surface water source or groundwater.

Pump Horsepower

The system flow rate and total dynamic head (Equation 8.1) must be calculated to determine the pump horsepower. The pump horsepower can be calculated using Equation 8.2.

System Flow Rate Calculation
The irrigation system flow rate used is usually the flow rate of the largest zone. If more than one zone is operating at the same time the flow rate will be the summation of the two zones.

Total Dynamic Head Calculation
The total dynamic head (H_T) of an irrigation pump consists of four factors:

Equation 8.1

$$H_T = H_s + H_e + H_f + H_P$$

where H_S = static suction head (vertical distance from the water level to the centre of the pump impellor)

H_e = static discharge head (elevation difference from the centre of the impellor to the highest point of the irrigation system)

H_f = friction head (total friction loss of all suction and mainline fittings between the pump and the zone pressure control valve)

H_p = pressure head (the pressure required at the zone pressure control valve)

Calculating Pump Horsepower
The brake horsepower required by an irrigation pump can be calculated by the formula:

Equation 8.2

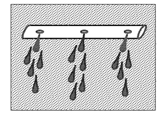
$$H.P. = \frac{Q \times H_T}{3960 \times E}$$

where Q = trickle irrigation system flow rate (gpm)

H_T = total dynamic head (ft)

E = pump efficiency at the flow rate and total dynamic head required given as a decimal.

Example 8.2 Pump Requirements for Linear Drip Tape System



The linear tape system used in Example 7.1 is supplied from a well with a flow capacity of 30 gpm. The irrigation system design indicates the largest zone required 32 rows at a flow rate of 0.88 gpm each. The depth to the water level in the well from the surface while the system is operating is 115 ft. The pump is located 300 ft from the filtration station which is located 25 ft higher than the pump site. The pressure required at the filtration station is 40 psi. **See Figure 8.8.** A submersible pump will be used to deliver the water to the irrigation system. The friction loss in the riser pipe and fittings is 3 psi. (This has not been calculated but is given for this example.

What is the pump horse power required?

The flow rate required is: = 32 rows @ 0.88 gpm each = 28.2 gpm

The total dynamic head is:

H_S = static suction head. There is no static suction head for a submersible pump.

H_e = elevation difference

= 115 ft for the well depth plus 25 ft up to the filtration station (field elevation)

= 140 ft

H_f = friction head

H_p = pressure head

The pressure required at the filtration station is 40 psi. From Example 7.1 the operating pressure of the linear tape system is only 8 psi. The pressure difference between the filtration system and the zone control valve is approximately 30 psi. This pressure difference more than makes up for the friction losses of all piping, valves and equipment between the hookup to the filtration station and the zone control valve. The friction loss of the riser and mainline from the pump to the filtration station must still be calculated.

The pressure head (Hp) = 40 psi

= 92.5 ft

Mainline Friction Loss

From Table C.3 - 1 ½" - Class 160 PVC is required for a flow rate of 28 gpm.
- 1 ½" - Class 160 PVC @ 28 gpm has a friction loss of 1.5 psi / 100 ft.

$$\text{Friction loss} = 300 \text{ ft} \times \frac{1.5 \text{ psi}}{100 \text{ ft}} = 4.5 \text{ psi}$$

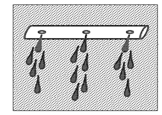
If 30% is allowed for fittings the total loss is:

0.30 x 4.5 psi = 1.4 psi

Total Mainline Loss = 5.9 psi

(Continued)

Example 8.2 Pump Requirements for Linear Drip Tape System *(Continued)*



Riser Loss = 3.0 psi

H_f = mainline friction loss and riser friction loss = 5.9 psi + 3.0 psi

H_f = 8.9 psi

= 20.6 ft

Total dynamic head H_T = $H_e + H_f + H_p$

= 140 ft + 20.6 ft + 92.5

= 253.1 ft

The pump efficiency is determined from the manufacturer's charts. For this example an efficiency of 70 % will be used.

$$\text{H.P.} = \frac{Q \times H_T}{3960 \times E}$$

$$\text{H.P.} = \frac{28 \text{ gpm} \times 253 \text{ ft}}{3960 \times 0.70} = 2.6 \text{ h.p.}$$

A 3 h.p. pump will be required.

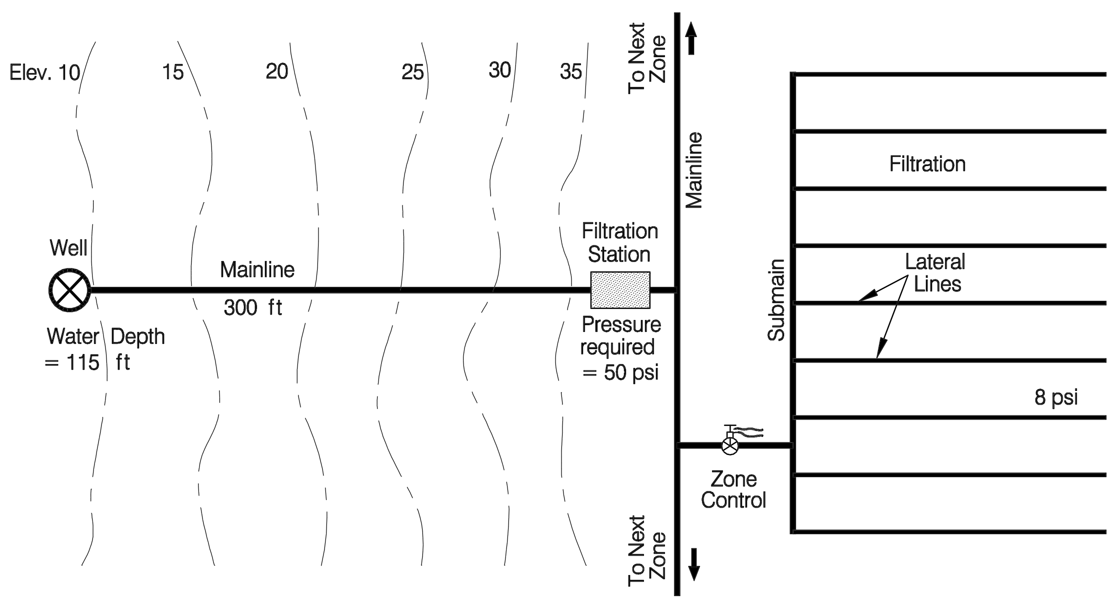


Figure 8.8 *Layout for Example 8.2*

Gravity System or Pressurized Irrigation District Supply

The process used to calculate the total pressure requirement for systems supplied by a gravity feed system or a pressurized supply from a water purveyor is slightly different than for a pump system.

Pressurized Irrigation Supply

- The pump suction lift can be eliminated.
- Determine pressure available from irrigation district or water purveyor.
- Determine system pressure head, elevation losses or gains and friction losses from point of connection. The total system pressure requirement must be less than the minimum pressure supplied by the purveyor.

Gravity Feed

- The pump suction lift can be eliminated.
- The pressure available will be the elevation difference from the system intake to the field minus the friction loss in the mainline supplying the flow. Example 8.1 provides a methodology on how this is calculated.
- The elevation throughout the field, friction losses and system pressure needs must be less than the pressure available from the gravity system.