15 Landscape Micro Irrigation

Note: The Irrigation Association's "Drip Irrigation in the Landscape" has been used to develop portions of this chapter.

Drip irrigation is a good application for watering trees, shrubs, ground cover, flower and vegetable gardens. Why use a drip irrigation system instead of a sprinkler system? The advantages of drip systems for landscape designs include:

- System components are inexpensive providing that elaborate filtration is not required. Most landscapes are supplied with water from the domestic supply, which provides exceptional water quality. It is suggested that a 150 mesh screen filter be used as a precaution.
- Runoff can virtually be eliminated as the rate of application is very slow. Drip irrigation can therefore operate on steep slopes where sprinkler or spray systems may cause runoff.
- Drip systems are more efficient as water is applied directly to the plant's root zone, reducing evaporation losses. Sprinkler systems throw water in the air and onto the plants resulting in high evaporation loss.
- Weed growth is reduced as the entire area is not irrigated.
- Plants that are spaced far apart can be irrigated individually.
- Small irregular shaped areas can be easily irrigated without applying water outside the target area.

Drip irrigation systems should not be operated on the same circuit as rotor or spray head systems. Drip systems must be zoned separately so that trees and shrubs are watered separately. Drip systems can accommodate plants with different water requirements by using a base plant scheduling system explained later in this chapter.

Many of the concepts outlined in this manual also apply to landscape drip irrigation systems. However, while agricultural systems determine plant water requirements on a plant area basis, this is not always possible for landscape systems. Landscapes can have greater plant variety resulting in different size and spacing of plants. The water requirement for each plant will be different, resulting in a challenge for the drip irrigation designer.

There are two methods for determining plant water requirements for the design of landscape drip systems. Similar to agricultural systems the first method is the gallon per plant per day method, used to calculate water requirements for an individual plant. The second method, the landscape coefficient method, is used for dense tree plantings or flower beds where the mm / day or inches / day required is calculated.

15.1 Gallons per Plant per Day

Equation 15.1 should be used to calculate plant water requirements for an individual plant that is to be supplied with water from a specified emitter or group of emitters. Some examples of this application are:

- Vegetation that is sparse or spaced far apart with no cover crop in between. See Figure 15.2.
- Plants that are grown in pots. See Figure 15.3.
- Plants grown in small narrow beds that are supplied by a point source drip system. The amount of water applied to each bed can then be easily determined. See Figure 15.4.

The formula is similar to Equation 3.1. A crop species factor has been added to provide flexibility for the large variety of species that occur in landscape systems. The application efficiency is incorporated directly into the formula while the soil storage factor has been eliminated.

Equation 15.1

$$G/P/D = \frac{0.623 \times A \times K_s \times ET_o}{E \times CE}$$

where

0.623	=	$\frac{27{,}152 \text{ gal/ac-in}}{43{,}560 \text{ ft}^2\text{/acre}}$	(conversion factor)
A	=	Plant root zone area (ft^2)	
K_s	=	Crop species factor (Table 15.2)	
ET_o	=	Reference evapotranspiration rate for location (in/day) (Table 2.1)	
E	=	Application efficiency (Table 3.8)	
CE	=	Climate Efficiency (Table 15.1)	

Figure 15.1 graphically shows how Equation 15.1 is applied to landscape systems.

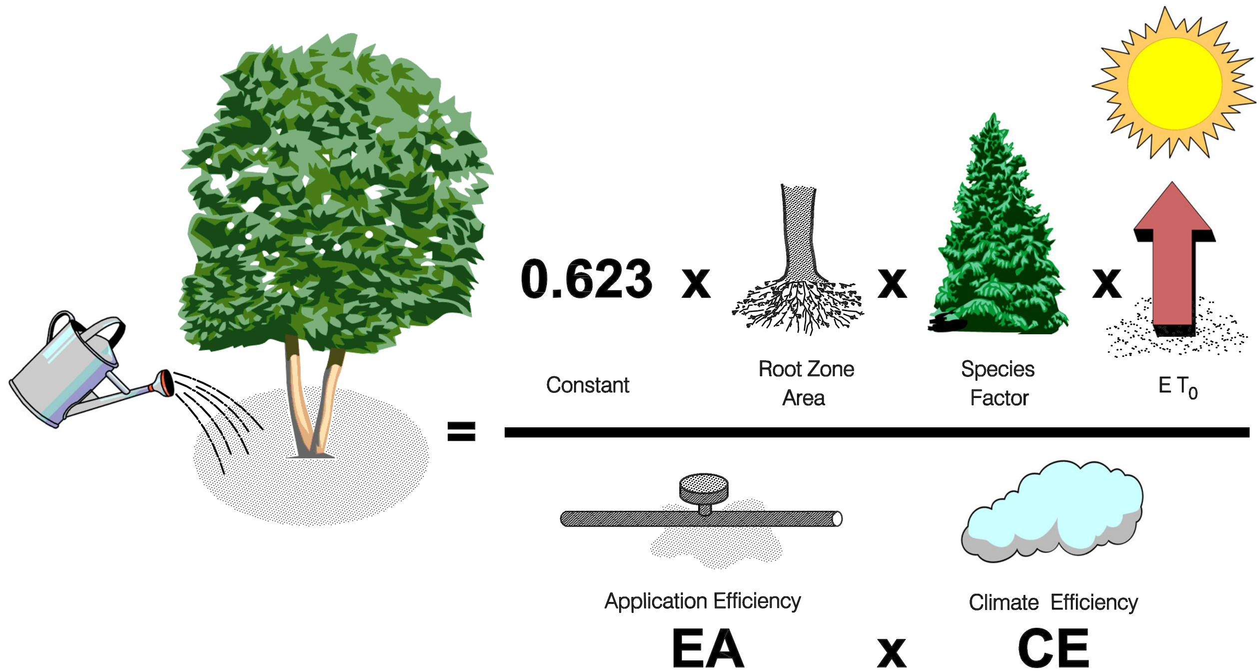

Figure 15.1 *Graphic Description of Gallons per Plant per Day for Landscape*

The Plant Area (A) is determined from estimating the rooting area of the plant. Checking the area of the plant canopy is one method of determining root zone area. Since landscapes are not often planted in uniform rows this may be more accurate than using the plant spacing as an area measurement.

Figure 15.2 *Sparsely Spaced Landscape*

The Crop Species Factor (K_s) takes into account the difference between trees, shrubs, groundcover and turf. It takes the place of the crop coefficient used in Equation 3.1. Equation 15.1 must be calculated for each plant species. The base plant scheduling system explained later can then be used to determine emitter size and number per plant.

The application efficiency (E) can be obtained from Table 3.8.

The climate efficiency (CE) takes into consideration micro climates that may occur in the landscape. See Table 15.1. The climate efficiency is shown for a range of reference evapotranspiration rates (ET_o). If the landscape site being irrigated is representative of the general area the Peak ET values in Table 2.1 can be used as the ET_o values in Table 15.1. However micro climates may require that an adjusted ET_o be selected. Table 15.1 provides temperature and humidity criteria that can be used to determine an ET_o rate.

For example a flower bed up against the south side of a brick building could be considered a hot dry micro climate, even if located in the Fraser Valley. The lower climate efficiency should then be used.

Figure 15.3 *Potted Plant*

Figure 15.4 *Planting Bed with a Single Lateral Line*

Table 15.1 Climate Efficiency Based on ET_o for Landscape Systems

Climate	Definition (mid summer)	Peak ET_o in/day	Peak ET_o mm/day	Climate Efficiency
Cool Humid	< 21 °C > 50% humidity	.10 - .15	2.5 - 3.8	100%
Cool Dry	< 21 °C < 50% humidity	.15 - .20	3.8 - 5.0	95%
Warm Humid	21 - 32 °C > 50% humidity	.15 - .20	3.8 - 5.0	95%
Warm dry	21 - 32 °C < 50% humidity	.20 - .25	5.0 - 6.4	95%
Hot Humid	> 32 °C > 50% humidity	.20 - .30	5.0 - 7.6	90%
Hot Dry	> 32 °C > 50% humidity	.30 - .45	7.6 - 11.4	90%

Example 15.1 Gallons per Plant per Day Calculation for Landscape Drip System

A boulevard in Kamloops with high water use trees spaced 30 ft apart is to be irrigated with a drip system. The tree canopy is 14 ft in diameter. See Figure 15.8. What is the plant water requirement?

From Equation 15.1:

$$G/P/D = \frac{0.623 \text{ x } A \text{ x } K_s \text{ x } ET_o}{E \text{ x } CE}$$

Plant Area (A) = p r^2 The radius (r) of the canopy is 7 ft

= p x (7 ft)^2 = 154 ft^2

From Table 15.2 Crop Species Factor (K_s) = 0.90

From Table 2.1 Reference Evapotranspiration (ET_o) = 0.28 in/day

From Table 3.8 Application efficiency (E) = 90% = 0.90

From Table 15.1 Climate Efficiency (CE) for an ET_o of 0.28 = 90% = 0.90

$$G/P/D = \frac{0.623 \text{ x } 154 \text{ ft}^2 \text{ x } 0.90 \text{ x } 0.28 \text{ in/day}}{0.90 \text{ x } 0.90} = 30 \text{ gallons per plant per day}$$

15.2 Landscape Coefficient Method

The landscape coefficient method should be used to determine water requirements when it is not possible to determine the individual plant water requirement. Some examples of this application method are:

- Areas with a mixture of vegetation. See Figure 15.5.
- Long narrow flower beds. See Figure 15.6.
- Areas that are to be planted in groundcover. See Figure 15.7.

These applications are usually irrigated by more than one lateral line or a linear tape system with orifices closely spaced. Emitters are therefore irrigating more than one plant making the gallon per plant per day method difficult to use. Figure 15.7 also shows the distribution pattern that is achieved from a drip system irrigating a small landscape area.

This method uses reference evapotranspiration and a landscape coefficient to determine the evapotranspiration from the area to be irrigated.

Table 2.1 provides peak evapotranspiration rates (ET) for various locations in the province. The peak ET rates shown are developed for agricultural crops and can be used as reference evapotranspiration (ET_o) for landscape systems. A reference evapotranspiration rate can also be determined from Table 15.1.

ET_o can be converted to an ET for landscape plant material (ET_L) in Equation 15.2 by using a number of crop factors to calculate the landscape coefficient. The landscape coefficient (K_L) is determined from a number of factors selected from Table 15.2, 15.3 and 15.4.

Equation 15.2

$$ET_L = K_L \times ET_o \text{ (in/day)}$$

Where:

ET_L = Evapotranspiration landscape (in/day)

K_L = Landscape coefficient

ET_o = Reference evapotranspiration (in/day)

The ET for landscape (ET_L) varies as a function of the mix of plant species used, the density of planting and the affects of a microclimate. By evaluating each factor and assigning it a numeric value, an estimate can be made of the overall landscape coefficient (K_L) by using Equation 15.3.

Figure 15.5
Landscape with Mixed Vegetation

Figure 15.6
Long Narrow Flower Bed

Figure 15.7
Drip Irrigation for a Groundcover Area

Equation 15.3 $$K_L = K_s \times K_d \times K_{mc}$$

Where:

K_L = Landscape Coefficient
K_S = Species factor (Table 15.2)
K_d = Density factor (Table 15.3)
K_{mc} = Microclimate factor (Table 15.4)

The landscape coefficient (K_L) is approximated for a known period of time (annual average, monthly, daily or stage of growth). Once determined it is then applied to the reference evapotranspiration (ET_o) to establish the landscape evapotranspiration rate used to calculate plant water requirements using the landscape coefficient method.

Species Factor (K_s)

Plant species can vary considerably in their rates of evapotranspiration. Some species transpire large amounts of water, while others use relatively little. Since there is such a wide range of water needs among landscape plants, the species factor (K_s) is divided into three groups: high, medium, and low, as shown in Table 15.2.

Table 15.2 Species Factor (K_s) for Different Plants

Vegetation	Plant Water Use		
	High	Medium	Low
Trees	0.9	0.50	0.2
Shrubs	0.7	0.50	0.2
Ground Cover	0.9	0.50	0.2
Mixed	0.9	0.50	0.2
Turfgrass	0.8	0.75	0.6

Density Factor (K_d)

Landscapes can also vary considerably in vegetation density. Newly planted and sparsely planted landscapes often have less leaf surface area than mature, dense landscape and typically would use less water. Even though individual plants in a sparsely planted landscape may lose more water for a given leaf area, the total water loss from a dense planting will be higher due to the greater total leaf surface area for the site. A density factor is needed in order to account for these differences in water loss. The density factor, K_d, is assigned a value between 0.5 and 1.3, as shown in Table 15.3.

Table 15.3 Density Factor (K_d) for Different Plants

Vegetation	High	Medium	Low
Trees	1.3	1.0	0.5
Shrubs	1.1	1.0	0.5
Ground Cover	1.1	1.0	0.5
Mixed	1.3	1.1	0.6
Turfgrass	1.0	1.0	1.0

Microclimate Factor (K_{mc})

Environmental conditions may also vary significantly within a single landscape. Structures and paved areas typical of urban landscapes can greatly affect these conditions.

The microclimate factor (K_{mc}) is relatively easy to establish. An *average* microclimate condition is one in which buildings, pavement, slopes, shade and reflection do not influence the site, and therefore $K_{mc} = 1$. A "high" microclimate condition is one in which the landscape is surrounded by heat absorbing surfaces, heat-reflecting surfaces or high wind conditions, so the K_{mc} might be up to 1.4 for a certain situation. A "low" microclimate is one in which plantings are shaded or protected from the wind. A K_{mc} value of 0.5 may be used if plantings are located on the north side of a building and protected from the wind. Ranges of K_{mc} values are shown in Table 15.4.

Table 15.4 Microclimate Factor (K_{mc}) for Different Plants

Vegetation	High	Medium	Low
Trees	1.4	1.0	0.5
Shrubs	1.3	1.0	0.5
Ground Cover	1.2	1.0	0.5
Mixed	1.4	1.0	0.5
Turfgrass	1.2	1.0	0.8

Example 15.2 Determining Water Requirements Using the Landscape Coefficient Method

An area on the north side of a building is to be landscaped with shrubs in Kamloops. The shrubs are average water users and are planted so that they will grow together. What is water requirement of the area?

From Table 15.2 – The species factor (K_s) selected = 0.50

From Table 15.3 – The density factor (K_d) selected = 1.0
Average density is used as there is no vegetation growing above or below the planted shrubs. Multi-vegetation levels would increase the density factor.

From Table 15.4 – The microclimate factor (K_{mc}) selected = 1.0
Since the shrubs are on the north side of a building but in a dry climate the average factor is selected.

(Continued)

Example 15.2 Determining Water Requirements Using the Landscape Coefficient Method *(Continued)*

Equation 15.3 $K_L = K_s \times K_d \times K_{mc}$

$= 0.50 \times 1.0 \times 1.0$

$= 0.50$

From Table 2.1 - The reference ET_o for Kamloops is 0.28 in / day.

Equation 15.2 $ET_L = K_L \times ET_o$ (in./day)

$= 0.50 \times 0.28$ in /day

$= 0.14$ in / day

The water use for the area will be 0.14 in / day during the peak of the summer.

15.3 Determining the System Application Rate and Operating Time

Once the plant or area water requirement has been determined the system application rate is calculated to establish an irrigation schedule. The application rate can be determined on a plant basis if the gallon per plant per day method is used or for an area if the landscape coefficient method is used.

Information about the emitter is required to determine the application rate. Manufacturer's provide a flow rate in L/hr or gal/hr for point source emitters. The flows for linear tape systems are given in Lph / m or gpm / 100 ft. Appendix B provides information on several linear tape systems. Chapters 4 and 5 provide further information on emitter selection.

Number of Emitters per Plant

The number of emitters per plant or area must also be determined. The area that must be irrigated and the lateral movement of water from each emitter often determine how many emitters are required. Table 5.3 provides information on the lateral movement of water in various soils for drip systems. Sufficient emitters should be used so that a minimum of 50 -60 % of the plant's rooting area is irrigated.

Table 15.5 can be used to determine the area wetted by an emitter for point source landscape drip systems. The wetted area is dependent on the soil type and emitter flow rate. Equation 15.4 can be used to determine the number of emitters to ensure that at least 50% of the plant root zone is irrigated.

Equation 15.4

$$\text{Number of Emitters} = \frac{\text{Plant root zone area} \times 0.50}{\text{Area wetted by one Emitter}}$$

The plant root zone area is determined from the plant canopy area. The area wetted from one emitter is determined from Table 15.5.

Equation 15.4 will give the minimum amount that is required. When in doubt always use more emitters.

Table 15.5 Wetted Area by an Emitter

Soil Type	Emitter Flow Rate gph	Wetted Area ft^2 Shallow Rooted < 2 ft	Wetted Area ft^2 Deep Rooted > 2 ft
Sandy	0.5	3	7
	1.0	7	10
	2.0	10	13
Sandy Loam	0.5	7	16
	1.0	16	20
	2.0	20	24
Loam	0.5	10	20
	1.0	20	28
	2.0	28	38
Clay Loam	0.5	15	28
	1.0	28	38
	2.0	38	50
Clay	0.5	20	38
	1.0	38	50
	2.0	50	64

Point Source Emitter

For point source systems the application rate is measured in gallons per hour and is determined by the emitter flow rate and number of emitters used per plant. The minimum number of emitters per plant can be determined by using Table 15.5. See Example 15.3.

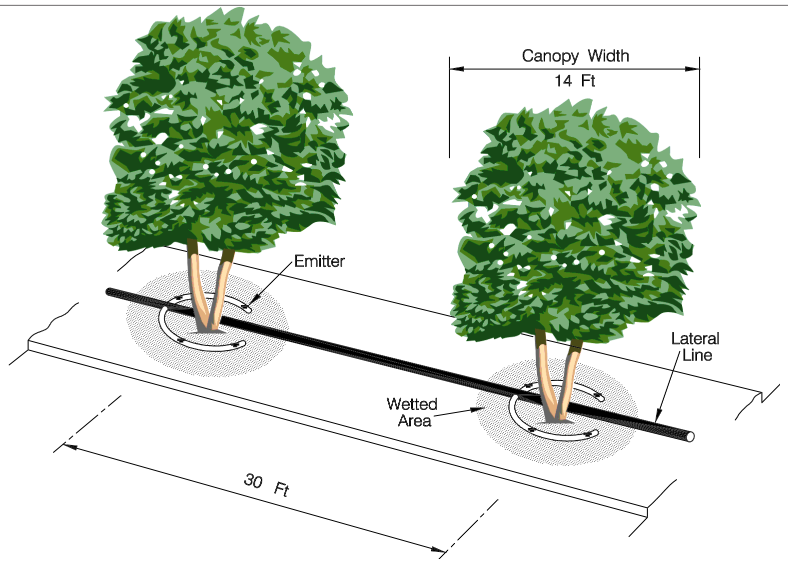

Figure 15.8 Point Source System Layout for Examples 15.1, 15.3 and 15.8

Example 15.3 Point Source System Application Rate Calculation

A boulevard in Kamloops with high water use trees spaced 30 ft apart is to be irrigated with a drip system. The trees are deep rooted and have a canopy that is 14 ft in diameter. The soil type is a sandy loam. Point source emitters with a flow rate of 4 L/hr (1.0 gph) are to be used. The plant water requirement was previously calculated to be 30 gallons per plant per day. How many emitters are required and what is the system operating time?

From Table 15.5
The area wetted by a 1.0 gph emitter in a sandy loam soil on a deep rooted crop is 20 ft^2.

The root area of the tree is $= \pi r^2 = \pi\,(7\text{ ft})^2 = 154\text{ ft}^2$

From Equation 15.5:

$$\text{Minimum Number of Emitters} = \frac{\text{Plant root zone area x 0.50}}{\text{Area wetted by one Emitter}}$$

$$= \frac{154\text{ ft}^2 \text{ x } 0.50}{20\text{ ft}^2} = 3.85 \text{ or 4 emitters}$$

Figure 15.8 shows a layout of the point source system for this example.

$$\text{Flow Rate to each Plant} = \text{Number of Emitters x Flow Rate per Emitter}$$
$$= 4 \text{ x } 1.0 \text{ gph}$$
$$= 4.0 \text{ gph}$$

$$\text{System Operating Time} = \frac{\text{Plant Water Requirement}}{\text{Flow Rate to the Plant}} = \frac{30 \text{ GPD}}{4.0 \text{ gph}}$$

$$= 7.5 \text{ hrs / day}$$

Base Plant Scheduling

Point source systems may also be used in bed areas that have more than one size of plant and therefore more than one water requirement. In these situations the emitter flow rate or the number of emitters selected can be adjusted to accommodate the different water needs. An operating time for the lowest plant water requirement should be calculated first. The size and number of emitters for the other plants will then be chosen based on this operating time. This method allows for different size plants to be irrigated on the same zone. See Example 15.4.

Example 15.4 **Determining Operating Times for Beds with Various Plant Sizes**

A bed area has three different types of plants. The water requirements for each plant and the minimum number of emitters required based on the root zone area are as follows:

Plant 1	6 gpd	2 emitters / plant
Plant 2	12 gpd	3 emitters / plant
Plant 3	15 gpd	3 emitters / plant

Two 0.5 gph emitters are chosen for plant 1. What size and number of emitters should be chosen for plant 2 and plant 3?

Flow rate to plant 1 $= 2 \times 0.50 \text{ gph} = 1.0 \text{ gph}$

System Operating Time $= \dfrac{\text{Plant Water Requirement}}{\text{Flow Rate to the Plant}} = \dfrac{6 \text{ GPD}}{1.0 \text{ gph}} = 6 \text{ hours}$

Flow rate to plant 2 $= \dfrac{12 \text{ gpd}}{6 \text{ hours}} = 2 \text{ gph}$

While the minimum number of emitters is three for this plant, four emitters would allow a flow rate of 0.5 gph per emitter to achieve the flow rate of 2 gph desired.

Flow rate to plant 3 $= \dfrac{15 \text{ gpd}}{6 \text{ hours}} = 3 \text{ gph}$

Three 1.0 gph emitters can be used for this plant to achieve the desired flow rate of 3 gph.

Line Source Systems

Line source systems have the emitter inserted in the lateral during the extrusion process. The emitter can be inserted at almost any spacing. Installation is just a matter of laying the laterals in the area to be irrigated at the appropriate spacing. These systems are often used where plants are spaced very close together in a row or area. The lateral movement of water from an emitter will determine the lateral spacing as 100% of the area should be covered by these systems.

Equation 15.5 can be used to determine the application rate for line source drip systems.

Equation 15.5

$$AR = \frac{1.6 \times Q}{A}$$

where:

AR	=	Application Rate of the drip system (in/hr)
Q	=	Flow Rate supplied by the drip system (gph)
A	=	Area to be irrigated (ft^2)

Example 15.5 shows how Equation 15.5 is used.

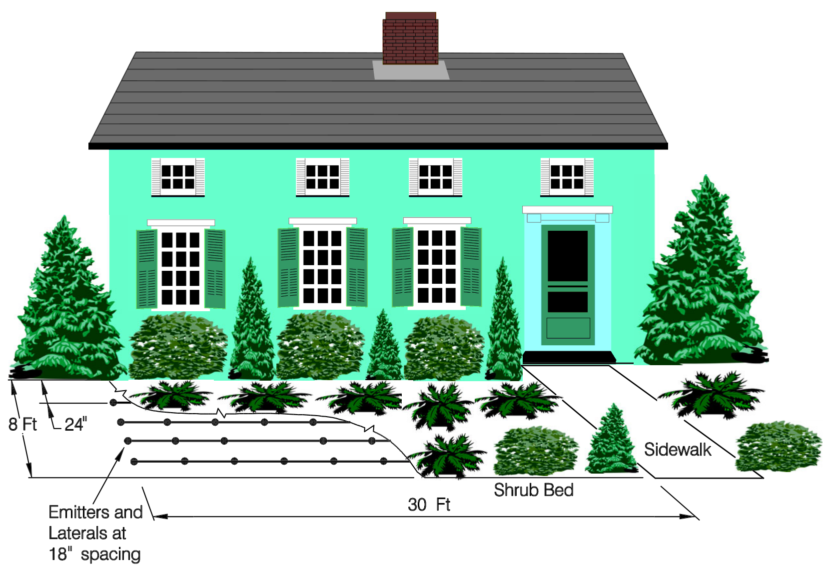

Figure 15.9 *Line Source System Layout for Examples 15.5, 15.6 and 15.7*

Example 15.5 Line Source Application Rate

An area 8 ft x 30 ft on the north side of a building is to be landscaped with shrubs in Kamloops. The water requirement for the area was calculated as 0.14 in /day in Example 15.2. The shrubs have a rooting depth of 1.5 ft and are growing in a sandy soil. A line source system with an irrigation efficiency of 90% is to be used with 2 l/hr (0.5 gph) emitters. See Figure 15.9. Determine the application rate and operating time for this area?

In this case it is easier to use the information provided in Table 5.3 to determine emitter and lateral spacing.

From Table 5.3
The lateral movement of water from each emitter is 0.75 ft for a shallow rooted crop in a sandy soil. The emitters should therefore not be spaced any further than twice this distance, preferably closer. An emitter spacing of 1.5 ft is selected for this soil and crop type. The lateral spacing should be the same as the emitter spacing. The area is 8 ft wide so the minimum number of laterals required to cover the area is four spaced 1.5 ft apart. See Figure 15.9.

$$\text{Number of emitters per lateral} = \frac{\text{lateral length}}{\text{emitter spacing}} = \frac{30\text{ ft}}{1.5\text{ ft / emitter}} = 20\text{ emitters}$$

The system flow rate can be determined by:

System Flow Rate (Q) = number of laterals x emitters per lateral x emitter flow rate

= 4 laterals x 20 emitters / lateral x 0.50 gph /emitter
= 40 gph

Area = 8 ft x 30 ft = 240 ft^2

From Equation 15.5:

$$\text{Application rate (AR)} = \frac{1.6 \times Q}{A}$$

$$= \frac{1.6 \times 40\text{ gph}}{240\text{ ft}^2} = 0.27\text{ in/hr}$$

$$\text{System Operating Time} = \frac{\text{Area Water Requirement}}{\text{Application Rate x Efficiency}} = \frac{0.14\text{ inches / day}}{0.27\text{ in/hr} \times 0.90}$$

= 0.57 hrs / day
= 34 minutes /day

Linear Tape System

Linear tape systems are normally an agricultural product and are not usually used in landscape systems. If used the design procedure would be similar to line source systems. The difference is that the flow rate for these products is often given in a gpm / 100 ft. Example 15.6 uses the same parameters as Example 15.5 but uses a linear tape product as the drip irrigation system.

Example 15.6 Linear Tape Application Rate

This example uses the landscaped shrub area on the north side of a building in Kamloops. See Figure 15.9.

Area to be irrigated	8 ft x 30 ft	Lateral spacing	1.5 ft
Area water requirement	0.14 in /day	Emission spacing	1.5 ft
Shrub rooting depth	1.5 ft		

Determine the application rate and operating time for this area using a linear tape product?

From Table B.4

T-Tape TSX 500 with an efficiency of 85% has an outlet spacing of 18 inches which matches the spacing required by the soil and crop for this area as determined in Example 15.5. The flow rate for the 18 inch emission spacing is 0.44 gpm / 100 ft.

The system flow rate can be determined by:

System Flow Rate (Q) = number of laterals x flow rate per lateral

$$= 4 \times 30 \text{ ft} \times \frac{0.44 \text{ gpm}}{100 \text{ ft}} = 0.53 \text{ gpm}$$

$$= 0.53 \text{ gph} \times 60 \text{ minutes /hr} = 32 \text{ gph}$$

From Equation 15.4:

$$\text{Application rate (AR)} = \frac{1.6 \times Q}{A}$$

$$= \frac{1.6 \times 32 \text{ gph}}{240 \text{ ft}^2} = 0.21 \text{ in/hr}$$

$$\text{System Operating Time} = \frac{\text{Area Water Requirement}}{\text{Application Rate x Efficiency}} = \frac{0.14 \text{ inches / day}}{0.21 \text{ in/hr} \times 0.85}$$

$$= 0.78 \text{ hrs / day}$$

$$= 47 \text{ minutes /day}$$

15.4 Determining Maximum Operating Time

The calculations in Section 15.3 determine a daily run time to match the peak daily site evapotranspiration conditions. Landscape irrigation systems are not usually operated daily. A longer irrigation interval can be calculated once the maximum operating time is known. See Examples 15.7 and 15.8.

The maximum operating time is the length of time the system can run before water is wasted due to deep percolation beyond the plant's rooting depth. The flow rate of the emitter must be known as well as the allowable depletion of water from the soil. Allowable depletion is the percentage of moisture the plant can extract from the soil before irrigation is again required. A lower allowable depletion will require more frequent but smaller applications. A higher allowable depletion will require fewer irrigations buy applying more water during each application. Sections 3.3 and 13.4 provides additional information on water holding capacities of various soils and allowable depletion.

For drip systems in landscape areas the allowable depletion is usually 30%. Tables 15.6, 15.7 and 15.8 provide a guide to the maximum run times and depth of application for drip systems on various soils types. Example 15.8 provides a methodology for calculating maximum operating times for situations that are not provided in the tables.

Table 15.6 Maximum Drip Irrigation Operating Time for Coarse Soils

Watering Depth	Emitter Spacing	Emitter Flow (gph)	Maximum Run Time (minutes)
3 inches 6 inches 9 inches		Use Spray Emitters	
12 inches	12 inches	0.5	40
		1.0	20
		2.0	10
18 inches	18 inches	0.5	150
		1.0	60
		2.0	30
24 inches	24 inches	0.5	300
		1.0	150
		2.0	75

Water Storage Capacity = 1.4 in/ft; Application Efficiency = 85%
Allowable Depletion = 30%

Concept taken from Irrigation Association

Table 15.7 Maximum Drip Irrigation Operating Time for Medium Soils			
Watering Depth	**Emitter Spacing**	**Emitter Flow (gph)**	**Maximum Run Time (minutes)**
3 inches		Use Spray Emitters	
6 inches	12 inches	0.5 1.0 2.0	30 15 10
9 inches	18 inches	0.5 1.0 2.0	90 45 20
12 inches	24 inches	0.5 1.0 2.0	200 100 50
18 inches	36 inches	0.5 1.0 2.0	720 360 180
24 inches	48 inches	Use individual emitters based on plant needs	
Water Storage Capacity = 2.0 in/ft; Application Efficiency = 85% Allowable Depletion = 30%			

Concept taken from Irrigation Association

Table 15.8 Maximum Drip Irrigation Operating Time for Fine Soils			
Watering Depth	**Emitter Spacing**	**Emitter Flow (gph)**	**Maximum Run Time (minutes)**
3 inches	12 inches	0.5 1.0 2.0	15 10 5
6 inches	24 inches	0.5 1.0 2.0	130 70 30
9 inches	36 inches	0.5 1.0 2.0	450 225 110
12 inches	48 inches	Use individual emitters based on plant needs	
Water Storage Capacity = 2.5 in/ft; Application Efficiency = 85% Allowable Depletion = 30%			

Concept taken from Irrigation Association

15.5 Determining an Irrigation Interval

Normally landscape drip irrigation systems are not operated on a daily basis. The daily calculated operating time should therefore be compared to the maximum operating time to determine an irrigation interval. See Equation 15.6.

Equation 15.6

$$\textbf{Maximum Irrigation Interval} = \frac{\textbf{Maximum Operating Time}}{\textbf{Calculated Operating Time per Day}}$$

If the calculated daily operating time is more than the maximum operating time the system must be operated more than once per day. For drip systems twice per day will usually be enough. A time span of 4 hours between irrigations for situations requiring more than one operating time per day should be sufficient.

The information in Tables 15.6, 15.7 and 15.8 cannot be used for deeper rooted crops and wide emitter spacings. For these situations the maximum operating time must be calculated by determining the amount of water stored in the root zone using Table 3.1. See Example 15.8.

Example 15.7 Determining an Irrigation Interval for Shallow Rooted Plants

An area 8 ft x 30 ft on the north side of a building is to be landscaped with shrubs in Kamloops. The system parameters were previously calculated in Example 15.5 as:

Water Requirement	0.14 in /day
Rooting Depth	1.5 ft
Soil type	Sand
Emitters used	0.5 gph emitters space 1.5 ft apart on lateral
Calculated Operating Time	42 minutes per day

From Table 15.6

For a sandy (coarse) soil, an emitter flow rate of 0.5 gph, emitter spacing of 1.5 ft and a rooting depth (watering depth) of 1.5 ft the maximum run time is shown as 150 minutes.

From Equation 15.6

$$\text{Maximum Irrigation Interval} = \frac{\text{Maximum Operating Time}}{\text{Calculated Operating Time per Day}}$$

$$= \frac{150 \text{ minutes}}{42 \text{ minutes /day}} = 3.6 \text{ days}$$

A maximum irrigation interval of 3 days can therefore be used for this area. The operating time every three days would be:

3 days x 42 minutes / day = 126 minutes
= approximately 2 hours during peak summer conditions

Example 15.8 Determining an Irrigation Interval for Deep Rooted Plants

A boulevard in Kamloops has high water use trees that are deep rooted in a sandy loam soil. The system parameters are as follows:

Plant Water Requirement	28 GPD
Root depth	3 ft
Root zone area	14 ft diameter - 154 ft^2
Soil type	Sandy Loam
Emitter	4 L/hr or 1.0 gph
Emitters per plant	4
Area wetted per emitter	20 ft^2
Calculated Daily Operating Time	7 hrs /day

The simplest method to determine the maximum operating time is to calculate the application rate for the system over the area that is wetted by the emitters. If the emitters are spaced properly the area irrigated will be:

$$4 \text{ emitters per plant} \times 20 \text{ ft}^2 \text{ per emitter} = 80 \text{ ft}^2.$$

The flow rate to the tree is 4 emitters x 1.0 gph per emitter = 4.0 gph

The application rate for this system can be determined from Equation 15.5:

$$AR = \frac{1.6 \times Q}{A} = \frac{1.6 \times 4 \text{ gph}}{80 \text{ ft}^2} = 0.08 \text{ in / hr}$$

Calculate water storage:

From Table 3.1 - The storage capacity of a sandy loam soil is 1.5 inches per foot of soil.

An allowable depletion of 30% is used for drip systems in landscape areas. The storage capacity for the root depth is therefore:

$$= \text{rooting depth} \times \text{storage capacity} \times \text{allowable depletion}$$
$$= 3 \text{ ft} \times 1.5 \text{ in /ft} \times 0.30$$
$$= 1.35 \text{ inches}$$

$$\text{The maximum operating time} = \frac{\text{root zone storage capacity}}{\text{application rate}} = \frac{1.35 \text{ inches}}{0.08 \text{ in /hr}}$$
$$= 16.9 \text{ hours}$$

From Equation 15.6

$$\text{Maximum Irrigation Interval} = \frac{\text{Maximum Operating Time}}{\text{Calculated Operating Time per Day}}$$
$$= \frac{16.9 \text{ hours}}{7 \text{ hours /day}} = 2.4 \text{ days}$$

The maximum irrigation interval for the trees in the boulevard is 2 days. The system would then need to operate for 14 hours, every other day during the peak of the season.