



# Landscape Drip Irrigation Scheduling Calculator Users Guide

The screenshot shows the homepage of the Landscape Irrigation Scheduling Calculator. The background is a photograph of a golf course with several sprinklers watering the grass. The IIABC logo is in the top right corner. The main heading reads "Landscape Irrigation SCHEDULING CALCULATOR".

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**Is this your first visit to the Calculator?**

This Irrigation Scheduling Calculator uses real-time daily evapotranspiration (ET) rates determined from climate stations that are linked to [www.Farmwest.com](http://www.Farmwest.com). All Farmwest stations are located within British Columbia.

For case studies outside BC, the Calculator allows users to input local ET data that reflects the climate conditions at their specific location.

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Prepared and Published by

**Irrigation Industry Association of British Columbia (IIABC)**

Editor

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**February 2010**

**[www.irrigationbc.com](http://www.irrigationbc.com)**

# TABLE OF CONTENTS

|   |           |
|---|-----------|
| INTRODUCTION .....  | 5         |
| <b>1 INDIVIDUAL PLANTS.....</b>                             | <b>6</b>  |
| <b>1.1 LANDSCAPE TYPE .....</b>                             | <b>6</b>  |
| Plant Diameter .....  | 7         |
| Effective Rooting Depth .....                               | 7         |
| Species Factor ( $K_s$ ).....                               | 7         |
| Availability Coefficient (AC).....                          | 8         |
| <b>1.2 SOIL CROSS-SECTION .....</b>                         | <b>8</b>  |
| Soil Texture and Structure.....                             | 8         |
| Soil Infiltration Rate.....                                 | 9         |
| Entering Soil Data .....                                    | 9         |
| Total Available Water Storage Capacity (AWSC).....          | 11        |
| Maximum Soil Water Deficit (MSWD) .....                     | 11        |
| Management Allowable Depletion (MAD).....                   | 11        |
| Root Zone Depletion .....                                   | 12        |
| <b>1.3 IRRIGATION SYSTEM DESIGN .....</b>                   | <b>12</b> |
| Application Efficiency ( $A_e$ ) .....                      | 13        |
| <b>1.4 IRRIGATION SCHEDULING .....</b>                      | <b>13</b> |
| Irrigation Schedule Worksheet – Drip Individual Plant ..... | 15        |
| <b>1.5 FORMULAS USED FOR INDIVIDUAL PLANTS .....</b>        | <b>16</b> |
| <b>2 BED AREA.....</b>                                      | <b>17</b> |
| <b>2.1 LANDSCAPE TYPE .....</b>                             | <b>17</b> |
| Vegetation Water Use.....                                   | 18        |
| Density Factory ( $K_d$ ) .....                             | 18        |

# TABLE OF CONTENTS

Continued

|  |           |
|--|-----------|
| Area Microclimate.....                                       | 19        |
| Landscape Coefficient.....                                   | 19        |
| Availability Coefficient (AC).....                           | 19        |
| <br>   |           |
| <b>2.2 SOIL CROSS-SECTION .....</b>                          | <b>20</b> |
| <br>   |           |
| <b>2.3 IRRIGATION SYSTEM DESIGN .....</b>                    | <b>20</b> |
| Application Efficiency (Ae).....                             | 20        |
| Application Rate.....  | 21        |
| <br>   |           |
| <b>2.4 IRRIGATION SCHEDULING.....</b>                        | <b>21</b> |
| Irrigation Schedule Worksheet – Bed Area in Drip System..... | 23        |
| <br>   |           |
| <b>2.5 FORMULAS USED FOR BED AREAS.....</b>                  | <b>25</b> |

## LIST OF FIGURES

|            |  |    |
|------------|--|----|
| Figure 1.  | New Area Information.....  | 6  |
| Figure 2.  | New Zone Information.....  | 6  |
| Figure 3.  | Landscape Type Tab.....  | 7  |
| Figure 4.  | Soil Texture Chart.....  | 8  |
| Figure 5.  | Soil Cross-Section Tab.....  | 9  |
| Figure 6.  | Soil Triangle Tool.....  | 10 |
| Figure 7.  | Irrigation System Design Tab.....  | 12 |
| Figure 8.  | Irrigation System Scheduling Tab Inputs.....                               | 13 |
| Figure 9.  | Irrigation System Scheduling Tab Outputs Individual Plant – Green Bar..... | 14 |
| Figure 10. | Irrigation system Scheduling Tab Outputs – Orange Bar.....                 | 14 |
| Figure 11. | Defining A Bed Area.....   | 17 |
| Figure 12. | Landscape Type Tab.....  | 17 |
| Figure 13. | Irrigation System Design Tab for Bed Area Design.....                      | 20 |
| Figure 14. | Irrigation System Scheduling Tab Inputs.....                               | 21 |
| Figure 15. | Irrigation System Scheduling Tab Outputs Bed Area – Green Bar.....         | 22 |

## LIST OF TABLES

|          |  |    |
|----------|--|----|
| Table 1. | Species Factor ( $K_s$ ) for Different Plants.....         | 7  |
| Table 2. | Soil Properties.....                                       | 10 |
| Table 3. | Management Allowable Depletion.....                        | 12 |
| Table 4. | Application Efficiency ( $A_e$ ).....                      | 13 |
| Table 5. | Species Factor.....  | 18 |
| Table 6. | Density Factor.....  | 18 |
| Table 7. | Microclimate Factor ( $K_{mc}$ ) for Different Plants..... | 19 |

# Landscape Drip Irrigation Scheduling Calculator User's Guide

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Information from the BC Trickle Irrigation Manual produced by the **Irrigation Industry Association of British Columbia** has been used as a guide in the preparation of this document. The Irrigation Scheduling Calculator was developed solely by the Ministry of Agriculture and Lands and the Irrigation Industry Association of British Columbia with funding from the Canada British Columbia Water Supply Expansion Program.

## INTRODUCTION

The Irrigation Scheduling Calculator found at [www.irrigationbc.com](http://www.irrigationbc.com) has been developed specifically for use in British Columbia although other regions can use the calculator by entering their own Reference Evapotranspiration (ET<sub>o</sub>) data. This guide provides background information on the parameters and calculations used to schedule drip systems in the Landscape Irrigation Scheduling Calculator. While there is on line help available on the calculator often not enough detail is provided to make a good determination on which value to use.

Irrigation systems should be designed and operated to supply the turf and landscape water requirement while minimizing runoff and leaching. To ensure peak irrigation system performance the system design should take into account evapotranspiration, landscape coefficients, soil type and irrigation system efficiencies. High frequency irrigation leads to increased surface evaporation and usually a higher rate of transpiration by the plants. The landscape irrigation scheduling calculator minimizes the frequency of irrigation but maximizes duration of application that is allowed by the soil and plants. It is better to have an irrigation schedule where irrigation occurs less frequently but fully utilizes water stored in the plants' root zone.

The Landscape Irrigation Scheduling Calculator assumes that the irrigation system has been properly designed to match the location, soil type and plant water requirements and maintained in good operating condition. It is recommended that a Certified Irrigation Designer be used to design an irrigation system and a Certified Irrigation Technician be used to ensure that the irrigation system is installed as per plan.

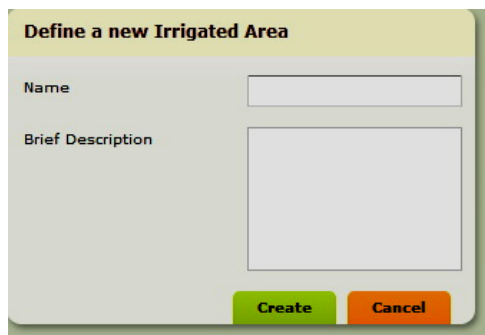
The calculator takes the following information into account in the development of an irrigation schedule:

- How much water the landscape requires.
- How much water can be stored in the soil that is readily available to the plant.
- The amount of effective rainfall that is useable by the plant.
- How much water the irrigation system needs to apply to make up the moisture deficit that has occurred.

This User's Guide provides direction on the calculations that are made by the calculator and how to select the information that populates the entry boxes in the calculator. There are four sections in the calculator that must be completed in order for a schedule to be developed. These are:

- Landscape Type
- Soil Cross-section
- Irrigation System Design
- Irrigation Scheduling

The Landscape Irrigation Calculator does both drip and sprinkler irrigation systems. To start click on the new area tab and the screen shown in Figure 1 will be provided. The area for which the calculator is to be used must be given a name so that the scenario can be saved for future reference. A brief description should also be provided.



**Figure 1 – New Area Information**



**Figure 2 – New Zone Information**

Once this information is entered the ‘Define a New Zone’ box will open. It is in this box that the selection of the type of system to be scheduled is made by clicking on the area adjacent to ‘Irrigation Type’. In Figure 2 Irrigation Type currently shows Sprinkler – Rotor. Clicking on the arrow will allow other options. There are two types of drip scenarios that the calculator can use, Drip Individual Plant and Drip Area. Drip Individual Plant should be used when emitters are installed to irrigate an individual plant like larger trees or shrubs. Drip Area should be used if drip systems are installed in a flower bed, turf area, or other type of landscape bed. The scheduling calculation for an individual plant is different than for a bed area so the correct choice should be made here. Once selected it cannot be changed later as you go through the tabs. This guide has two sections; section 1 will cover Individual Plants and section 2 Bed Areas.

## **1 INDIVIDUAL PLANTS**

### **1.1 LANDSCAPE TYPE**

The landscape tab as shown in Figure 3 is where information on the plant species to be irrigated is entered. For the Vegetation Type selected the calculator will select a number of factors that are used to adjust the Reference Evapotranspiration Rate that is imported from the climate station later on in the calculator. Once the vegetation type is selected a decision must be made on the vegetation water use factor, the plant diameter and the plant rooting depth.

Depending on the choices made the value will be populated in the table under default values. By clicking on the default tab these values can be changed if desired. The options for vegetation type are limited to individual plants.

Table 1 provides the values that will be used by calculator depending on the vegetation type and vegetation water use that are chosen.

**Figure 3 – Landscape Type Tab**

### Plant Diameter

The plant diameter is used in the calculation to determine the area that must be irrigated by the drip system. The plant diameter can be estimated by the width of the canopy.

### Effective Rooting Depth

The plant’s active **rooting depth (RD)** is the soil depth from which the crop extracts most of its water needs. It is determined by digging a soil pit to observe the actual rooting depth or using plant rooting depth information from other sources. A deeper rooting depth creates a larger reservoir of water for the plant to draw upon between irrigation. An estimate of the plant rooting depth must be added into the calculator. For trees and shrubs the values can range from 18 inches to more than 48 inches depending on the tree type and size.

### Species Factor ( $K_s$ )

Different plant species can vary considerably in their rates of evapotranspiration. Some species transpire large amounts of water, while others use relatively little.

Because there is such a wide range of water needs among different landscape plants, the water use is divided into three use groups: high, medium, and low, as shown in Table 1.

| <b>TABLE 1 SPECIES FACTOR (<math>K_s</math>) FOR DIFFERENT PLANTS</b> |             |                |            |
|---|-------------|----------------|------------|
| <b>VEGETATION</b>   | <b>HIGH</b> | <b>AVERAGE</b> | <b>LOW</b> |
| 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        |

## Availability Coefficient (AC)

Plants can only extract a portion of the soil water storage without being stressed. An **availability coefficient (AC)** is used to determine the portion of water stored in the soil that is readily available to the plant. The availability coefficient is expressed as a percentage and is used to calculate the Maximum Soil Water Deficit (MSWD) in the soil cross – section tab. The MSWD is the maximum amount of water that may be removed from the soil before irrigation is again required.

The availability coefficient varies with plant species. The calculator enters an availability coefficient default value of 50% for landscape species which represents a reasonable value.

## 1.2 SOIL CROSS-SECTION

Knowledge about the soil and landscape are important to ensure that water is applied when required by the plant at the rates and intervals that can be accepted by the soil and topography. The basic soil information required and calculated in the calculator is described below. The soil tab is where the soil type and depth is entered and the calculator selects the parameters described below.

## Soil Texture and Structure

**Soil texture** is a term used to describe the size of individual soil particles such as sand, silt, or clay. Soil texture class is a name given to a soil to describe the relative amounts of sand, silt, or clay in that particular soil. The class name may be sandy loam, loamy clay, silty clay loam, etc. See Figure 4.

Soil texture has a major influence on the amount of water that can be stored in the soil against the pull of gravity. It also has a major influence on soil infiltration rate and the permeability of a soil, these terms are described in more detail later in this section.

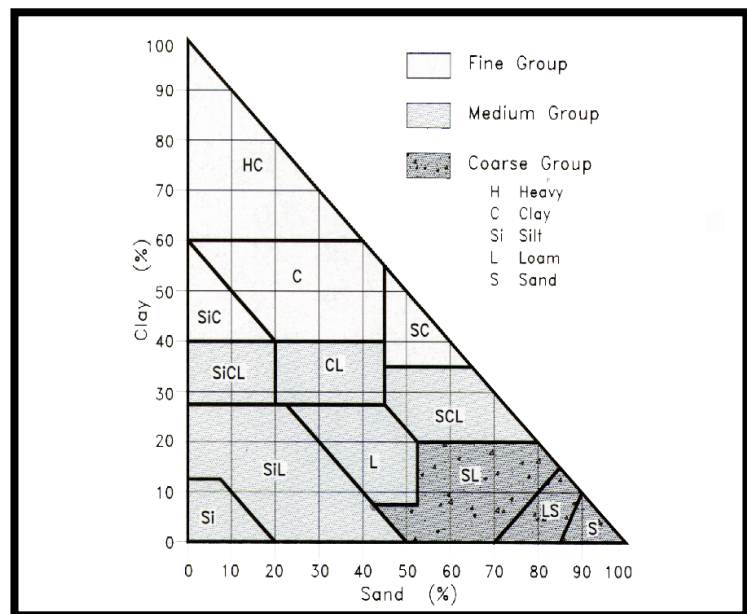


Figure 4 Soil Texture Chart

**Soil structure** is the arrangement of soil particles and soil aggregates into recognizable particles or lumps. Aggregates occur in almost all soils, but their strength, size and shape varies between soil type. Soil structure can be described in many ways such as; granular, blocky, crumb, platy, massive or granular. The structure also influences the amount soil water holding capacity and the infiltration rate. Soil with poor structure at the surface will not allow water to infiltrate easily.



## Soil Infiltration Rate

The **infiltration rate** is a measure of how quickly water enters the soil. The irrigation system application rate cannot exceed the soil's infiltration rate or ponding or runoff will occur. The calculator has built in values that determine an estimated maximum run time based on soil texture. An estimated maximum run time and suggested cycling of the irrigation system is provided by the calculator if these values are exceeded. The infiltration rate is shown in the default values. Compacted soils, thick thatch, and slopes will all reduce the infiltration rate of the soil. With the irrigation system running it is useful to physically observe and record the elapsed time at which runoff begins to occur on a site. These measurements can be used to override the calculator values.

## Entering Soil Data

In the soil cross section tab, Figure 5, the soil texture and depth for each soil layer must be entered. The soil layer information is entered by clicking on the add soil layer button. The calculator allows a user to add a soil layer by using a drop down table or the soil texture triangle a shown in Figure 6. Once a soil type is selected a soil layer depth must be added. The total depth of the soil must be greater than the rooting depth that was selected in the previous tab. The first soil depth can be less than the rooting depth if a second rooting depth is added. The total depth of the two or more soil types should be greater than the plant rooting depth.

**Soil Data**

The available water storage capacity of the soil must be determined. This soil information is used by the calculator to determine the maximum run time for one set as well as the maximum irrigation interval. The maximum irrigation interval is the maximum number of days between irrigations that the crop can sustain before becoming stressed.

**Required Values**

Soil Texture By Depth: in

| Layer Depth | Soil Type  | AWSC      |
|-------------|------------|-----------|
| 48 in       | Silty Loam | 2.3 in/ft |

**Default Values**

Override Defaults?

Total AWSC: 6.90 in

Maximum Soil Water Deficit: 3.45 in

Infiltration Rate: 0.35 in/hr

Management Allowable Depletion: 0.6

Root Zone Storage Depletion: 2.07 in

Figure 5 Soil Cross-Section Tab

**Add a new Soil Layer**

**1. Select a Soil Type from either the List or the Triangle**

- Heavy Clay
- Silty Clay
- Clay
- Sandy Clay
- Silty Clay Loam
- Clay Loam
- Sandy Clay Loam
- Silty Loam**
- Loam
- Silt
- Sandy Loam**
- Loamy Sand
- Sand

**2. Enter the Depth of this Soil Layer**

Depth  in

**Default Values**

Override Defaults?

AWSC  in/ft

**Figure 6 Soil Triangle Tool**

When the soil layer has been added the calculator will select and calculate a number of soil parameters using the information shown in Table 2. The terms shown in the calculator are shown below. Although all the values are shown as defaults only the Management Allowable Depletion should be adjusted by the user if better information is available.

| <b>TABLE 2 SOIL PROPERTIES</b> |                                   |                                   |                                |                          |                |
|--------------------------------|-----------------------------------|-----------------------------------|--------------------------------|--------------------------|----------------|
| <b>SOIL TEXTURE CLASS</b>      | <b>AWSC (in. water/ in. soil)</b> | <b>AWSC (in. water/ ft. soil)</b> | <b>AWSC (mm water/ m soil)</b> | <b>INFILTRATION RATE</b> |                |
|                                |                                   |                                   |                                | <b>(in/hr)</b>           | <b>(mm/hr)</b> |
| Clay                           | 0.20                              | 2.4                               | 200                            | 0.25                     | 6.3            |
| Silt loam                      | 0.21                              | 2.5                               | 208                            | 0.35                     | 8.9            |
| Clay loam                      | 0.20                              | 2.4                               | 200                            | 0.30                     | 7.6            |
| Loam                           | 0.18                              | 2.1                               | 175                            | 0.35                     | 8.9            |
| Fine sandy loam                | 0.14                              | 1.7                               | 142                            | 0.40                     | 10.1           |
| Sandy loam                     | 0.12                              | 1.5                               | 125                            | 0.45                     | 11.4           |
| Loamy sand                     | 0.10                              | 1.2                               | 100                            | 0.65                     | 16.5           |
| Sand                           | 0.08                              | 1.0                               | 83                             | 0.75                     | 19             |

## Total Available Water Storage Capacity (AWSC)

The soil's **available water storage capacity (AWSC)** is the amount of moisture the soil can store between field capacity and the permanent wilting point. The AWSC is related to the soil texture and the soil structure. Table 2 contains AWSC values for various soil types.

**The Total AWSC** as shown in the calculator is determined from the Available Water Storage Capacity (AWSC) and the plant's active rooting depth (RD). Knowing the soil water storage allows the calculator to determine the maximum length of time that the irrigation system should operate at one time assuming that the soil profile has been completely depleted. The maximum irrigation interval between irrigations is also estimated. Applying more water to the soil than can be stored results in a loss of water to deep percolation and leaching of nutrients beyond the root zone.

## Maximum Soil Water Deficit (MSWD)

**Maximum soil water deficit (MSWD)** is the amount of water that can be stored in the soil that is readily available to the plant. It is the maximum amount of water that should be removed from the soil before irrigation is again required. The MSWD is also the maximum amount of water that can be applied at one time before the risk of deep percolation occurs. It is calculated by multiplying the Total AWSC by the Availability Coefficient.

## Management Allowable Depletion (MAD)

In some situations the irrigator may wish to apply only a portion of the MSWD due to the soil type, irrigation system or other local conditions that may be present. The **management allowable depletion (MAD)** factor can be used to determine the percentage of the MSWD that the irrigator allows to be depleted at one time. For sprinkler systems the entire MSWD is usually depleted, but for drip systems it may be a portion of this amount.

**Management allowable depletion (MAD)** is a term often used to determine the soil moisture level at which irrigation is scheduled to begin. It is a subjective decision used by the irrigator taking into consideration the irrigation system and soil type. The MAD factor adjusts the MSWD to determine how much of the soil moisture can be removed before irrigation is again required. It therefore also determines the maximum amount of water that should be applied at one time.

Sprinkler systems usually are scheduled using the entire MSWD, except for heavier soils. Drip systems are usually operated to maintain a higher soil moisture level in the soil, therefore only a portion of the MSWD is removed. The calculator selects the default MAD values shown in Table 3 based on the system type and soil type selected.

By clicking on the override defaults tab a different value can be selected. However knowledge in soil moisture and crop water used is required prior to selecting another value. It is recommended that the values selected by the calculator are not changed.

| TABLE 3 MANAGEMENT ALLOWABLE DEPLETION |                        |                   |
|--|------------------------|-------------------|
| SOIL TEXTURE CLASS                     | Sprinkler Systems<br>% | Drip Systems<br>% |
| Clay                                   | 70                     | 50                |
| Silt loam                              | 80                     | 60                |
| Clay loam                              | 80                     | 60                |
| Loam                                   | 100                    | 60                |
| Fine sandy loam                        | 100                    | 70                |
| Sandy loam                             | 100                    | 70                |
| Loamy sand                             | 100                    | 80                |
| Sand                                   | 100                    | 80                |

## Root Zone Depletion

For drip systems a root zone depletion term is used as only a portion of the MSWD may be withdrawn as explained above. The root zone depletion is determined by multiplying the MSWD by the Management Allowable Depletion.

## 1.3 IRRIGATION SYSTEM DESIGN

The Irrigation System Design tab shown in Figure 7 allows for the entry of irrigation design and operation parameters. The basic information that must be entered is the number of emitters per plant and the emitter flow rate. The value entered for the emitter flow rate can be in gph or lph. The units can be changed by clicking on the down arrow next to the units. The number of emitters per plant and the flow rate per emitter are used to determine the irrigation system run time.

The screenshot shows the 'Irrigation System Design' tab in a software application. The interface is divided into a sidebar and a main content area. The sidebar on the left contains the text 'Step 3 Irrigation System Design' and two paragraphs of explanatory text. The main content area on the right is titled 'Required Values' and contains three input fields: 'Emitters per Plant' with a value of 4, 'Flow Rate per Emitter' with a value of 1 and units set to 'gph', and 'System Efficiency' with a value of 90%. Below this is a 'Default Values' section with an 'Override Defaults?' checkbox and a 'Flow Rate per Plant' field with a value of 4 and units set to 'gph'. The interface uses a light green and grey color scheme.

Figure 7 Irrigation System Design Tab

## Application Efficiency (Ae)

The application efficiency (Ae) takes into account irrigation system losses due to wind drift from the sprinkler during application and evaporation from the plants, soil surface and system application. The application efficiency of various irrigation systems is shown in Table 4.

| TABLE 4 APPLICATION EFFICIENCY (Ae) |      |
|-------------------------------------|------|
| IRRIGATION SYSTEM                   | Ae   |
| Drip                                | 0.9  |
| Trickle                             | 0.9  |
| Microsprinkler                      | 0.80 |
| Rotor sprinkler                     | 0.72 |
| Spray heads                         | 0.70 |

### 1.4 IRRIGATION SCHEDULING

When the plant material, soil and irrigation system information has been entered into the calculator, an irrigation schedule can now be determined. The calculator will retrieve Evapotranspiration data from a weather station of your choice. The calculator operates in real time so the climate date generated by the calculator will be the current date with an estimated forecast of the next five days. Climate data for the calculator is obtained from [www.Farmwest.com](http://www.Farmwest.com)

**Note:** If accessing the calculator in the morning the climate data for the current date may not have been posted to the Farmwest web site yet. Climate data gets posted in the early afternoon of each day. For best results the calculator should be used in the evening to determine a schedule for the next few days.

To obtain irrigation scheduling information: select the climate station to be used, enter information on watering restrictions if there are any, and select the schedule start date from the calendar. The calculator can also go back in time if desired to previous weeks, months or years if desired. See Figure 8.

**Step 4 Irrigation Scheduling**

Previous Step: Add Irrigation System Design

1. Closest Weather Station ?  
Mamit Lake

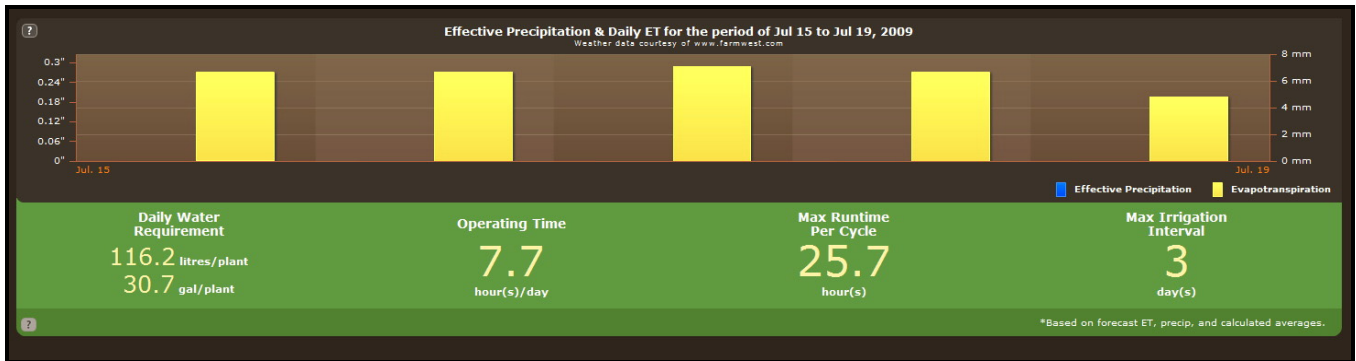
2. Irrigation Restrictions ?  
Irrigation Permitted 7 days per week.

3. Schedule Start Date ?  
Click to Select a Starting Date 07/07/2008

Irrigation Schedule Output Data. To obtain output information from the calculator, a weather station must be selected, any restriction to when irrigation may be applied should be selected, and a schedule start date chosen. The calculator will provide an operation schedule over the next 7 days by taking the average ET from the 5 days that are forecast and extending that average over 7 days. The operating time per irrigation that is shown on the bottom of the page will therefore be averaged for a weekly period. The maximum run time per cycle is the maximum run time that the system should be operated during an irrigation event. The irrigation interval is the suggested number of days between irrigations if the maximum run time is used as a schedule.

Figure 8 Irrigation System Scheduling Tab Inputs

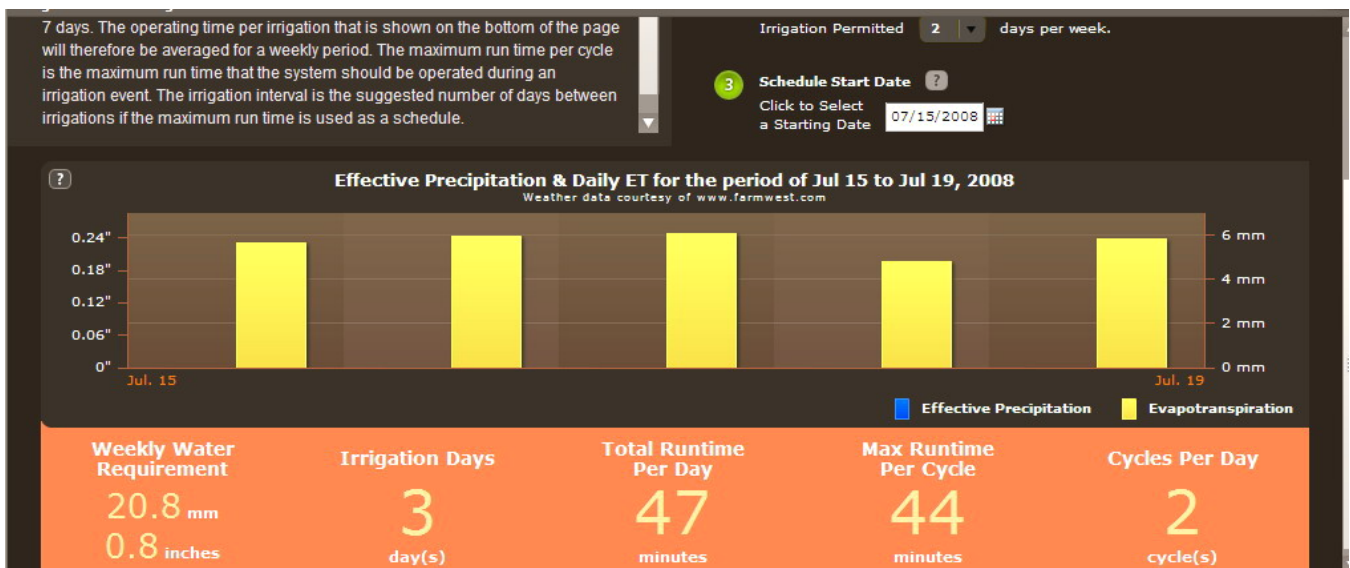
When selecting a date the calculator will also provide climate data for the next five days. This information is obtained from the closest Environment Canada weather station. For individual plants operated with a drip system the calculator provides a daily plant water requirement, the operating time to apply this daily, the maximum run time if the soil moisture has been totally depleted and the maximum irrigation interval as shown in Figure 9.



**Figure 9 Irrigation System Scheduling Tab Outputs Individual Plant – Green Bar**

**Green Bar:** If the bar containing the scheduling information is green, all of the choices made for the plant, soil crop, irrigation system design parameters can be accommodated by the irrigation system restrictions that have been selected. See Figure 9.

**Orange Bar:** In some cases the irrigation design may not match up with the soil or crop conditions or the watering restrictions that are in place. A red warning flag may then pop up on some of the input screen or an orange box on the irrigation schedule tab may appear. See Figure 10 for an example of an orange bar. Changes to the system design or operation may then be warranted.



**Figure 10 Irrigation System Scheduling Tab Outputs – Orange Bar**

A summary of the data inputs and calculations can be printed out. The format for the individual plant irrigated by a drip system will be similar to the worksheet shown below.

# Irrigation Schedule Worksheet

Landscape Irrigation  
SCHEDULING CALCULATOR



Report for

## Drip on Trees in Drip Individual Plant

Trees. Field Size: 200 x 30 ft. Irrigation Method: Drip - Individual Plant. Climate Station: Glenmore

| <b>Drip - Individual Plant System</b> |                    |
|---------------------------------------|--------------------|
| Item                                  | Value              |
| <b>Landscape Water Requirement</b>    |                    |
| Plant Material                        | Trees              |
| Reference Month                       | July               |
| Reference Period                      | 7 Days             |
| Reference Evapotranspiration          | 41.6 mm            |
| Species Factor                        | .9                 |
| Landscape Water Requirement           | 102.5 litres/plant |
| <b>Soil Properties</b>                |                    |
| Root Zone Soil Type                   | Silty Loam         |
| Soil Infiltration Rate                | 0.35 in/hr         |
| Available Water Storage Capacity      | 2.3 in/ft          |
| Rooting Depth                         | 3 in               |
| Availability Coefficient              | 0.5                |
| Maximum Soil Water Deficit            | 3.45 in            |
| Root Zone Storage Depletion           | 2.07 in            |
| <b>Irrigation System</b>              |                    |
| Flow Rate                             | 4 gal/hr           |
| System Efficiency                     | 90                 |
| Operating Time                        | 7 hrs              |
| Management Allowable Depletion        | 0.6                |
| <b>Scheduling Requirements</b>        |                    |
| Maximum Runtime Per Cycle             | 24 hours           |
| Maximum Irrigation Interval           | 3 days             |

## 1.5 FORMULAS USED FOR INDIVIDUAL PLANTS

The following formula is used in the calculator to generate a schedule of individual trees irrigated with drip systems.

### Individual Plant Water Requirement

$$G/P/D = \frac{0.623 \times A \times K_s \times ET_o}{E \times CE} \quad \text{Equation 1}$$

Where:

- GPD = Gallons per Plant per Day
- ET<sub>o</sub> = Reference Evapotranspiration Rate, in/day
- K<sub>s</sub> = Crop Species Factor
- A = Plant Root Zone Area
- E = Irrigation Application Efficiency
- CE = Climate Factor Based on the ET<sub>o</sub> rate

### Operating Time

$$OT = \frac{G/P/D}{Q_p} \quad \text{Equation 2}$$

Where:

- OT = System Operating Time, hrs
- GPD = Gallons per Plant per Day
- Q<sub>p</sub> = System flow rate to each plant, gph

### Application Rate

$$AR = \frac{Q_p \times 1.6}{0.5 \times A \times AE} \quad \text{Equation 3}$$

Where:

- AR = Application rate, in/hr
- Q<sub>p</sub> = System flow rate to each plant, gph
- A = Plant area (ft<sup>2</sup>)
- AE = Application Efficiency

### Maximum Run Time per Cycle

$$MRT = \frac{RZSD}{AR} \quad \text{Equation 4}$$

Where:

- MRT = Run time per cycle, hrs
- RZSD = Root zone storage depletion, inches
- AR = Application rate, in/hr



## 2 BED AREA

### 2.1 LANDSCAPE TYPE

Determining the run time for a drip system operating in a bed area uses a different approach than for an individual plant. In this scenario the calculation is done on the entire bed area so the dimensions of the bed must be accurately determined when entering the calculator and setting up a new zone as shown in Figure 11.



The screenshot shows a form titled "Define a New Zone" with the following fields and values:

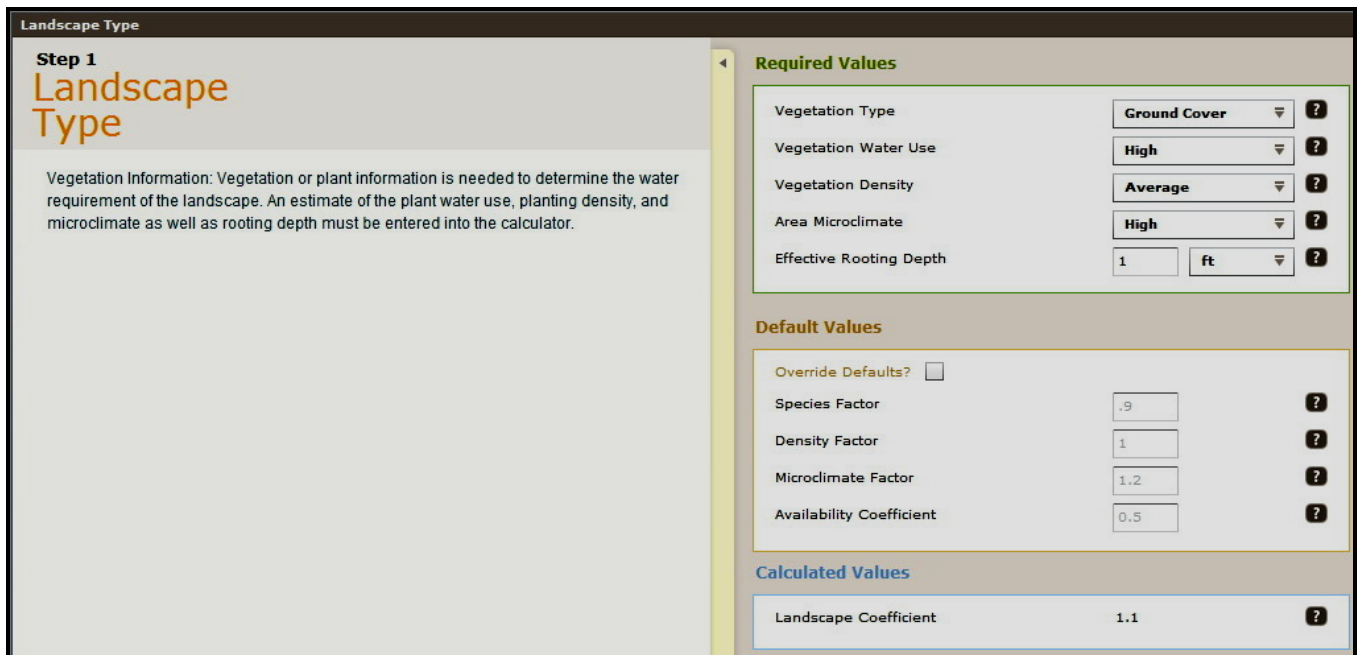
|                   |  |
|-------------------|--|
| Name              | Bed Area                                       |
| Brief Description | Drip system operated on a bed of mixed flowers |
| Irrigation Type*  | Drip - Area                                    |
| Weather Station   | Glenmore                                       |
| Zone Width        | 15 ft  |
| Zone Length       | 50 ft  |

\*Irrigation Type can't be changed after clicking Create.

Buttons: Create, Cancel

Figure 11 – Defining a Bed Area

The landscape tab as shown in Figure 12 is where information on the plant species to be irrigated is entered. For the Vegetation Type selected the calculator will select a number of factors that are used to adjust the Reference Evapotranspiration Rate that is imported from the climate station later on in the calculator.



The screenshot shows the "Landscape Type" tab with the following sections:

### Step 1 Landscape Type

Vegetation Information: Vegetation or plant information is needed to determine the water requirement of the landscape. An estimate of the plant water use, planting density, and microclimate as well as rooting depth must be entered into the calculator.

#### Required Values

|                         |              |   |
|-------------------------|--------------|---|
| Vegetation Type         | Ground Cover | ? |
| Vegetation Water Use    | High         | ? |
| Vegetation Density      | Average      | ? |
| Area Microclimate       | High         | ? |
| Effective Rooting Depth | 1 ft         | ? |

#### Default Values

Override Defaults?

|                          |     |   |
|--------------------------|-----|---|
| Species Factor           | .9  | ? |
| Density Factor           | 1   | ? |
| Microclimate Factor      | 1.2 | ? |
| Availability Coefficient | 0.5 | ? |

#### Calculated Values

|                       |     |   |
|-----------------------|-----|---|
| Landscape Coefficient | 1.1 | ? |
|-----------------------|-----|---|

Figure 12 – Landscape Type Tab

The calculator requires the user to determine the vegetation water use, vegetation density, area microclimate and the rooting depth. Table 5, 6 and 7 show the values that will be used depending on the choices made. By clicking on the default tab these values can be changed if desired.

## Vegetation Water Use

Different plant species can vary considerably in their rates of evapotranspiration. Some species transpire large amounts of water, while others use relatively little.

Because there is such a wide range of water needs among different landscape plants, the water use is divided into three use groups: high, medium, and low, as shown in Table 5.

| <b>TABLE 5 SPECIES FACTOR</b> |             |                |            |
|-------------------------------|-------------|----------------|------------|
| <b>VEGETATION</b>             | <b>HIGH</b> | <b>AVERAGE</b> | <b>LOW</b> |
| 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 likely be higher due to the greater total leaf surface area for the site. A density factor of some sort 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 within three groupings, as shown in Table 6.

| <b>TABLE 6 DENSITY FACTOR</b> |             |                |            |
|-------------------------------|-------------|----------------|------------|
| <b>VEGETATION</b>             | <b>HIGH</b> | <b>AVERAGE</b> | <b>LOW</b> |
| 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        |
| Turf grass                    | 1.0         | 1.0            | 1.0        |

## Area Microclimate

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

The **area microclimate** 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 the factor is 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 factor might equal 1.4 for a certain situation. A *low* microclimate is one in which plantings are shaded or protected from the wind, so the factor may equal 0.5 if plantings are very protected from the wind. Ranges are shown in Table 7.

| <b>TABLE 7 MICROCLIMATE FACTOR</b> |             |                |            |
|------------------------------------|-------------|----------------|------------|
| <b>VEGETATION</b>                  | <b>HIGH</b> | <b>AVERAGE</b> | <b>LOW</b> |
| 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        |
| Turf grass                         | 1.2         | 1.0            | 0.8        |

## Landscape Coefficient

The landscape coefficient is determined by multiplying Species Factor, Density Factor and Microclimate Factor together.

Equations 2 and 3 use the factors above to adjust the reference  $ET_0$  for the landscape type. This information is used to develop the schedule.

## Availability Coefficient (AC)

Plants can only extract a portion of the soil water storage without being stressed. An **availability coefficient (AC)** is used to determine the portion of water stored in the soil that is readily available to the plant. The availability coefficient is expressed as a percentage and is used to calculate the Maximum Soil Water Deficit (MSWD) in the soil cross – section tab. The MSWD is the maximum amount of water that may be removed from the soil before irrigation is again required.

The availability coefficient varies with plant species. The calculator enters an availability coefficient default value of 50% for landscape species which represents a reasonable value.

## 2.2 SOIL CROSS-SECTION

The soils information used by the calculator for a bed area is the same as for an individual plant. See Section 1.2 of this guide.

## 2.3 IRRIGATION SYSTEM DESIGN

The Irrigation System Design tab shown in Figure 13 allows for the entry of irrigation design and operation parameters. For a bed area the basic information that must be entered is the area of the bed to be irrigated, the flow rate of the irrigation system in the bed and the irrigation system efficiency. The value entered for the system flow rate can be in gph or lph. The units can be changed by clicking on the down arrow next to the units.

**Figure 13** Irrigation System Design Tab for Bed Area Design

The system flow rate in the bed area must be calculated to determine the system run time. This is done by adding up the flow rate of each emitter in the bed. If line source type systems are used then the length of the lines source product must be determined and multiplied by the flow rate per meter, 100 meters or 100 ft.

For example if there are 6 laterals in the bed and they are each 10 meters long then the total length is 125 meters. If the flow rate is 2.5 lph/m then the flow rate would be  $2.5 \text{ lph/m} \times 125 \text{ m} = 312 \text{ lph}$ .

If there were 20 point source emitters operating on each lateral operating at 2 lph each then the flow rate would be  $20 \text{ emitters per lateral} \times 6 \text{ laterals} \times 2 \text{ lph} = 240 \text{ lph}$ .

### Application Efficiency ( $A_e$ )

**The application efficiency ( $A_e$ )** takes into account irrigation system losses due to wind drift from the sprinkler during application and evaporation from the plants, soil surface and system application. The application efficiency of various irrigation systems is shown in Table 4 on page 12.

## Application Rate

The flow rate of the system in the bed area and the bed area being irrigated can be used to determine an **Application rate (AR)** for the system. It is a measure of the amount of water that is applied to an area by the irrigation system per unit of time.

The application rate (metric) for a drip system is calculated using equation 4. For English units equation 5 is used. It is important to ensure that the flow rate calculated for the system matches up with the area that is being irrigated by the flow rate calculated.

## 2.4 IRRIGATION SCHEDULING

When the plant material, soil and irrigation system information has been entered into the calculator, an irrigation schedule can now be determined. The calculator will retrieve Evapotranspiration data from a weather station of your choice. The calculator operates in real time so the climate date generated by the calculator will be the current date with an estimated forecast of the next five days. Climate data for the calculator is obtained from [www.Farmwest.com](http://www.Farmwest.com)

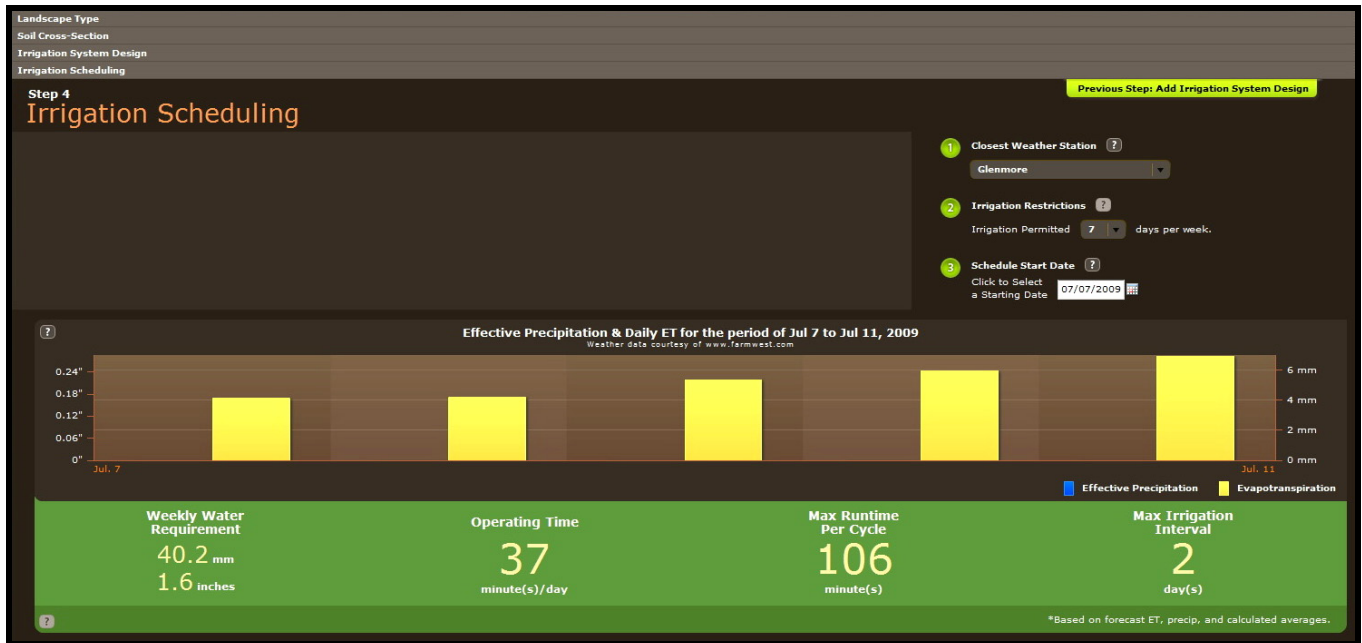
**Note:** If accessing the calculator in the morning the climate data for the current date may not have been posted to the Farmwest web site yet. Climate data gets posted in the early afternoon of each day. For best results the calculator should be used in the evening to determine a schedule for the next few days.

To obtain irrigation scheduling information: select the climate station to be used, enter information on watering restrictions if there are any, and select the schedule start date from the calendar. The calculator can also go back in time if desired to previous weeks, months or years if desired. See Figure 14.

The screenshot shows a web-based calculator interface for irrigation scheduling. The interface is dark-themed with a sidebar on the left containing navigation tabs: 'Landscape Type', 'Soil Cross-Section', 'Irrigation System Design', and 'Irrigation Scheduling'. The 'Irrigation Scheduling' tab is active. The main content area is titled 'Step 4 Irrigation Scheduling' and includes a 'Previous Step: Add Irrigation System Design' button. Below the title is a text box explaining the calculation process. To the right, there are three numbered input sections: 1. 'Closest Weather Station' with a dropdown menu set to 'Mamit Lake'. 2. 'Irrigation Restrictions' with a dropdown menu set to '7' days per week. 3. 'Schedule Start Date' with a calendar icon and the date '07/07/2008' displayed.

Figure 14 Irrigation System Scheduling Tab Inputs

When selecting a date the calculator will also provide climate data for the next five days. This information is obtained from the closest Environment Canada weather station. For bed areas irrigated with a drip system the calculator provides a weekly water requirement, the daily operating time, the maximum run time the system can be operated at any one time to stay within soil and root zone parameters identified and the maximum number of days between irrigations if the maximum run time is utilized. Figure 15 provides a screen shot of the output.



**Figure 15** Irrigation System Scheduling Tab Outputs Bed Area – Green Bar

**Green Bar:** If the bar containing the scheduling information is green, all of the choices made for the plant, soil crop, irrigation system design parameters can be accommodated by the irrigation system restrictions that have been selected. See Figure 15.

**Weekly Water Requirement** – the amount of water required for the landscape on a weekly basis in mm or inches.

**Orange Bar:** In some cases the irrigation design may not match up with the soil or crop conditions or the watering restrictions that are in place. A red warning flag may then pop up on some of the input screen or an orange box on the irrigation schedule tab may appear. See Figure 10 on page 13 for an example of the orange bar. Changes to the system design or operation may then be warranted.

A summary of the data inputs and calculations can be printed out. The format for a bed area irrigated with a drip system will be similar to the worksheet shown below.

# Irrigation Schedule Worksheet

## Landscape Irrigation SCHEDULING CALCULATOR



Report for

## Bed Area in Drip System

Ground Cover. Field Size: 15 x 50 ft. Irrigation Method: Drip - Area. Climate Station: Glenmore

| <b>Drip - Area System</b>          |              |
|------------------------------------|--------------|
| Item                               | Value        |
| <b>Landscape Water Requirement</b> |              |
| Plant Material                     | Ground Cover |
| Reference Month                    | July         |
| Reference Period                   | 7 Days       |
| Reference Evapotranspiration       | 41.6 mm      |
| Landscape Coefficient              | 1.1          |
| Landscape Water Requirement        | 44.9 mm      |
| <b>Soil Properties</b>             |              |
| Root Zone Soil Type                | Loam         |
| Soil Infiltration Rate             | 0.35 in/hr   |
| Available Water Storage Capacity   | 2 in/ft      |
| Rooting Depth                      | 1 in         |
| Availability Coefficient           | 0.5          |
| Maximum Soil Water Deficit         | 1 in         |
| Root Zone Storage Depletion        | 0.6 in       |
| <b>Irrigation System</b>           |              |
| Application Rate                   | 0.34 in/hr   |
| System Efficiency                  | 95           |
| Operating Time                     | 41 min       |
| Management Allowable Depletion     | 0.6          |
| <b>Scheduling Requirements</b>     |              |
| Maximum Runtime Per Cycle          | 106 minutes  |
| Maximum Irrigation Interval        | 2 days       |

## 2.5 FORMULAS USED FOR BED AREAS

### Landscape Evapotranspiration

The **landscape water use** ( $ET_L$ ) can be calculated for a specific plant by using a reference evapotranspiration rate ( $ET_O$ ), and applying a **landscape coefficient** ( $K_L$ ) to convert the reported  $ET_O$  to  $ET_L$ .

$$ET_L = K_L \times ET_O \quad \text{Equation 5}$$

Where:

$ET_L$  = Evapotranspiration landscape, mm

$K_L$  = Landscape coefficient

$ET_O$  = Reference evapotranspiration for a grass reference crop, mm

### Landscape Coefficient

$ET_L$  varies as a function of the mix of plant species used, the density of planting and the effects of a microclimate. These factors together parallel the crop coefficients that are used for agricultural crops. By evaluating each factor and assigning it a numeric value, an estimate can be made of the overall landscape coefficient ( $K_L$ ) as follows:

$$K_L = K_s \times K_d \times K_{mc} \quad \text{Equation 6}$$

Where:

$K_L$  = Landscape coefficient

$K_s$  = Species factor (Table 1)

$K_d$  = Density factor (Table 2)

$K_{mc}$  = Microclimate factor (Table 3)

### Application Rate

The application rate calculated in mm/hr is determined using the equation as follows:

$$AR = \frac{Q}{A} \quad \text{Equation 7}$$

Where:

AR = Application rate, mm/hr

Q = Drip system flow rate, lph

A = Area of the bed to be irrigated, m<sup>2</sup>



The application rate calculated in inches/hr is determined using the equation as follows:

$$AR = \frac{1.6 \times Q}{A} \quad \text{Equation 8}$$

Where:

AR = Application rate, in/hr

Q = Drip system flow rate, gph

A = Area of the bed to be irrigated, ft<sup>2</sup>

1.6 = factor used to convert gph and area in ft<sup>2</sup> to application rate in/hr

### Irrigation Water Requirement

The **irrigation water requirement (IR)** is determined by dividing the landscape water requirement by the application efficiency (Ae).

$$IR = \frac{ET_L}{Ae} \quad \text{Equation 9}$$

Where:

IR = Irrigation water requirement, mm

ET<sub>L</sub> = Evapotranspiration landscape, mm

Ae = Application efficiency, % (Table 6)

### Irrigation Operating Time

The landscape water requirement and the application rate determine the maximum length of time the system should operate for each irrigation event.

$$OT = \frac{ET_L \times 60}{AR} \quad \text{Equation 10}$$

Where:

OT = Operating Time, minutes

ET<sub>L</sub> = Evapotranspiration landscape, mm

AR = Application rate, mm/hr

## Maximum Run Time Per Cycle

The maximum run time per cycle provides an indicator as to how long the system can operate at one time before leaching below the root zone occurs. It is determined from the root zone depletion and the application rate as follows:

$$\text{MRT} = \frac{\text{RZSD} \times 60}{\text{AR}} \quad \text{Equation 11}$$

*Where:*

- MRT = Maximum Run Time, minutes
- RZSD = Root zone storage depletion, mm
- AR = Application rate, mm/hr

## Maximum Irrigation Interval

The maximum irrigation interval is the length of time between irrigations assuming that the system is operating close to the maximum runtime. The numbers are rounded down to the lower whole number. Maximum Irrigation Interval is calculated as follows:

$$\text{MII} = \frac{\text{MRT}}{\text{OT}} \quad \text{Equation 12}$$

*Where:*

- MII = Maximum Irrigation Interval, days
- MRT = Maximum Run Time, minutes
- OT = Daily Operating Time, minutes