

## **Water Budgeting**

### **Description**

Calculate the water needs of irrigated landscapes based on plant types, land area and irrigation system efficiency. Use the calculated water budget to apply water according to the needs of the plants and manage irrigation. Overall property water budgets can be developed to include both indoor and outdoor water requirements.

### **Basic Practice Guidelines**

1. The landscape design process should incorporate a general outdoor annual water budget to be used as a guideline for irrigation design and long-term landscape management. The water budget should be developed by the landscape architect or designer as part of the plant selection and grouping process (turf, trees, shrubs, ground covers, etc.).
2. The irrigation maintenance process should be based on calculation of a monthly and annual water budget for existing sites.
3. Calculate the site landscape water budget by summing the water requirements calculated for each hydrozone of the landscape using either of these general formulas:

#### **Approach #1, when Reference ET is known:**

$$\text{Water Budget} = \frac{(ET_o)(K_c)(LA)(0.623)}{IE}$$

Where:

Water Budget = Water Needed for Plants (gallons per year)  
 ET<sub>o</sub> = Reference evapotranspiration (inches per year) for bluegrass in your area  
 K<sub>c</sub> = Crop coefficient for plant type (See Appendix E for more information.)  
 LA = Landscaped Area (square feet)  
 0.623 = Conversion Factor (to gallons per square foot)  
 IE = Irrigation Efficiency (varies based on irrigation system)

<b>BMP Type</b>			
Design			X
Installation			
Maintenance/Operation			X
<b>Green Industry Relevance</b>			
ASLA	X	GCC	X
ALCC	X	ISA	X
CALCP	X	RMSGGA	X
CGGA	X	WFC	
CNA	X		

**Approach #2, when Reference ET is not known:**

$$\text{Water Budget} = \text{Land Area (sq. ft.)} \times \text{Estimated Plant Water Use (gallons/sq. ft.)}$$

Where:

Estimated Plant Water Use = Estimated Water Use in gallons/sq. ft. for the metro-Denver Front Range area, as contained in Appendix D. For other areas, water use estimates may need to be increased or decreased based on climate and location characteristics. Water use estimates may also be reduced when more efficient irrigation systems such as drip irrigation are used.

**Example Using Both Water Budgeting Approaches:**

For purposes of a simple example, assume that 70% of a 5,000 sq. ft. of a northern Front Range landscape is Kentucky bluegrass irrigated with a properly designed automatic irrigation system with an 80% irrigation efficiency reported by the irrigation contractor. The remaining 30% of the landscape is "low to very low" water use plants irrigated with a drip irrigation system with a 90% irrigation efficiency reported by the irrigation contractor. The seasonal reference ET value for this northern Front Range location is 26.69 inches for cool season grass mowed at 5 inches. For the turf area, a crop coefficient (Kc) of 0.9 is applied to represent a nice quality Kentucky bluegrass lawn mowed at a 3-inch height. The "low to very low" water use plants require about 25% of reference ET, so the resulting water budget for the landscape would be:

$$\begin{aligned} \text{Water for Turf Area} &= [(26.69" \times 0.9) \times 3500 \text{ sq. ft.} \times 0.623] / 0.8 = 65,472 \text{ gal/yr} \\ + \text{Water for Other Area} &= [(26.69" \times 0.25) \times 1500 \text{ sq. ft.} \times 0.623] / 0.9 = 6,928 \text{ gal/yr} \\ \text{Total Landscape Water Requirement} &= 72,400 \text{ gal/yr} \end{aligned}$$

This example results in an average water requirement of about 14.5 gallons/sq. ft. of irrigated area.

Using Approach #2, one would assume the 3,500 sq. ft. of bluegrass would use about 18-20 gal/sq. ft./yr and the 1,500 sq. ft. of low water plants would require about 5 gal/sq. ft., resulting in the following calculation:

$$\begin{aligned} 19 \text{ gal/sq. ft.} \times 3,500 \text{ sq. ft.} &= 66,500 \text{ gal/yr} \\ + 5 \text{ gal/sq. ft.} \times 1,500 \text{ sq. ft.} &= 7,500 \text{ gal/yr} \end{aligned}$$

Total Landscape Water Requirement = 74,000 gal/yr, or about 14.8 gallons/sq. ft. of irrigated area.

4. The water budget provides the total gallons per year that the site needs to thrive in addition to natural precipitation. The annual water budget assumes a normal year of natural precipitation (14 inches of annual precipitation for the Front Range area). In either wetter or drier years, the water budget will need to be adjusted.
5. The rate at which plants use water is called evapotranspiration (ET). Temperature, humidity, wind and light all influence the ET rate. When watering, it is only necessary to replace the amount of water that has been lost due to ET.
6. In order for water budgets to be accurate, it is necessary to provide accurate information on factors such as crop coefficients. See the GreenCO web site ([www.greenco.org](http://www.greenco.org)) and Appendix E for recommended crop coefficients to be used in calculating water budgets.
7. It should be noted that the  $ET_0$  (reference ET) in the water budget equation does not reflect the fact that Kentucky bluegrass can be attractive and viable at much lower ET rates and can be very drought tolerant. For properly established turf, the actual irrigation water needs of turf can vary, depending on desired appearance.
8. The water budget does not apply to the initial establishment period of plantings, which can vary from a 2-4 weeks for annuals to several growing seasons, depending on plant type and the timing of planting. One year is typical for many perennials and shrubs to become established.
9. Water features, outdoor pool(s), and/or any other outdoor water uses should be included in the water budget.
10. If a property manager/landscaper knows the water budget for each month, he/she can compare actual use to the site water budget and adjust irrigation practices accordingly. Excessive water use may also be attributed to irrigation system deficiencies, which should be corrected.
11. Evapotranspiration (ET) or "smart" irrigation controllers are one tool that can facilitate landscape irrigation according to the needs of the plants (and therefore the water budget).
  - a. Low water use plants don't automatically save water (they are easily and most likely over-watered). Using a "smart" controller can insure the proper irrigation is applied to low water use plants.
  - b. High water use plants (such as turf) don't automatically waste water. They are often over-watered. Using a "smart" controller can insure the proper irrigation is applied to higher water use plants.
12. Often the retrofitting of poor irrigation systems and the use of "smart" controllers will provide a payback in saved water. In order to calculate the payback time, use the water budget to measure how much water is actually needed, versus how much has historically been used.

13. GreenCO provides a simple water budget calculator on its website at [www.greenco.org](http://www.greenco.org) and as shown in Appendix D. Green Industry professionals can use this calculator with customers to demonstrate that water budgeting is a manageable approach to understanding water needs for a given property and adjusting watering practices accordingly.

### **Regional or Industry Considerations/Adaptations**

1. Water budgets can be incorporated into development project financial models and incorporated into projected budget and fees for Homeowners Associations, office parks, etc.
2. Water budgets can be used by water utilities to determine how much water they need versus how much they sell or have. The difference is how much water could be saved, or how much more water needs to be purchased.
3. Water budgeting approaches adopted by utilities typically include ET-based irrigation scheduling combined with tiered pricing for increasing water usage. Tiered pricing provides incentive to conserve because it gradually increases the price of larger quantities of water. At the time of this manual's publication, this approach had been adopted in other water-limited states such as California and Arizona. See Centennial Water and Sanitation District in Highlands Ranch, Colorado, for information on their program <http://www.highlandsranch.org/6/6-1a.html>.
4. Colorado's *Water Efficient Landscape Design Model Ordinance* (see [www.dola.state.co.us/smartgrowth/](http://www.dola.state.co.us/smartgrowth/)) is based on water-budgeting with a goal of 15 gallons/square foot/year of water required for the landscaped area.
5. Check the GreenCO website ([www.greenco.org](http://www.greenco.org)) for more information on water budgeting techniques.

### **Key References**

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