AE441

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LEED for Homes: Explanation of the Landscape Irrigation Budget Calculation for Florida[1]

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New ratings systems are being developed for "green building." Green buildings aim to use less energy, water, and other natural resources than typical buildings. These rating systems are becoming popular within the sustainability movement. One such rating system is the "Leadership in Energy and Environmental Design" (LEED) rating system developed by the U.S. Green Building Council http://www.usgbc.org/Default.aspx. The LEED system is a scoring system that aims to rate buildings in categories such as water efficiency, energy efficiency, and use of natural resources. In this document, the landscape irrigation budget calculations will be explained for the LEED for Homes Rating System http://www.usgbc.org/DisplayPage.aspx?CMSPageID=147.

This document explains the landscape irrigation budget found under "Landscaping" in section SS2 beginning on page 37 under "Method for Calculating Reduction in Irrigation Demand."

Step 1. Calculate the baseline irrigation water usage:

$$\text{Baseline Usage} = \text{Landscaped Area} * ET_o * 0.62 \qquad \text{Eqn. [1]}$$

Where ET_o is defined as the "Baseline Evapotranspiration Rate" in units of inches/month and Landscaped Area is in square feet. The 0.62 factor is a conversion factor to result in Baseline Usage of gallons/month.

In the scientific and engineering community, ET_o is known as the "reference evapotranspiration" and is defined as the evapotranspiration rate from a hypothetical well watered green grass maintained at 0.12 m (5 inches) tall. The reference ET_o concept is briefly explained in the EDIS publication *Evapotranspiration: Potential or Reference?* http://edis.ifas.ufl.edu/AE256. In general, once ET_o is calculated, then it must be adjusted to represent a plant type of interest. In agricultural terms, this adjustment factor is known as a crop coefficient, K_c. The ET_o and K_c concepts and detailed calculations can be found in "Crop evapotranspiration – Guidelines for computing crop water requirements" also known as "FAO Irrigation and Drainage Paper No. 56" http://www.fao.org/docrep/X0490E/X0490E00.htm. More recently, the American Society of Civil Engineers, Environmental Water Resources Institute

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(ASCE-EWRI) has developed a standardized ET_o methodology that is being adopted by the scientific community because many approaches to calculating ET have been used in the past. These different approaches tend to lead to different answers depending on local weather variables. The ASCE-EWRI committee task report on this method can be found at, http://www.kimberly.uidaho.edu/water/asceewri/, along with links to purchase the manual for the full method.

The daily grass reference ET_o calculation is identical for both FAO-56 and the ASCE-EWRI Standardized Method and is appropriate for Florida conditions. ET_o can be calculated from weather data that may be found from sources such as the National Climatic Data Center http://www.ncdc.noaa.gov/oa/ncdc.html, which includes public weather stations in Florida. Data can also be downloaded from the Florida Automated Weather Network (FAWN) http://fawn.ifas.ufl.edu/ or FAWN. The FAWN system reports daily ET_o; however, this ET_o data is often limited historically and is not available for all locations in the state. Finally, FAWN does not use the ASCE-EWRI Standardized Method. The USGS has recently posted ET_o data calculated using the ASCE-EWRI Standardized Method at, http://hdwp.er.usgs.gov/et.asp. This data set includes calculated ET_o for a 2 km grid over the entire state on a daily basis. Thus, ET_o values can be used for specific sites or for entire counties. According to the LEED for Homes Reference Guide (can be purchased at, http://www.usgbc.org/Store/PublicationsList.aspx?CMSPageID=1518, the July ET_o should be used in the calculations. Although not specified by LEED, it is recommended that the 10-year average be computed from the USGS dataset. A longer dataset would be preferred if available.

In landscape terms, the crop coefficient adjustment factor is a landscape coefficient, KL as shown in the next step.

Step 2. Calculate the design case irrigation water usage:

$$\text{Design Case Usage} = (\text{Landscaped Area} * \text{ETL/IE}) * \text{CF} * 0.62 \quad \text{Eqn. [2]}$$

$$\text{Where ETL} = ET_o * KL \quad \text{Eqn. [3]}$$

$$= ET_o * K_S * K_{MC} \quad \text{Eqn. [4]}$$

Where ETL is defined as the landscape evapotranspiration rate (inches/month). IE represents irrigation efficiency and ultimately adjusts the amount of allowed water for non-uniform irrigation system coverage or minor losses that occur in all irrigation systems and can be found in Table 8 (page 37 of the LEED Homes Rating System, http://www.usgbc.org/DisplayPage.aspx?CMSPageID=147) for various types of irrigation equipment. Photos of several of these types of equipment can be found in *Operation of Residential Irrigation Controllers* http://edis.ifas.ufl.edu/ae220.

The CF, or "control factor" represents conservation potential from an irrigation controller such as an ET controller, rain sensor or soil moisture based controller. Under Florida conditions a CF value of 0.6 (40% average savings) is recommended as a conservative value for soil moisture sensor controllers and ET controllers. The ET controller must have a rain sensor to bypass irrigation due to on-site rainfall measurement. If an ET controller does not have an on-site rainfall sensor, then a CF value of 0.80 should be used. If a rain sensor is used alone, a CF factor of 0.85 (15% average savings) should be used. These numbers are based on published and ongoing Smart Controller testing at the University of Florida (see *What Makes an Irrigation Controller Smart?* http://edis.ifas.ufl.edu/AE442, for more information on Smart Controllers). For detailed information on this testing and on current results go to, http://irrigation.ifas.ufl.edu/.

As seen above, ETL is computed from ET_o and a "species factor", K_S, as well a "microclimate" factor, K_{MC}. The species factor is meant to represent the inherent water demand of a given species category. Values are given for low water using plants to high water using plants in Table 6 (page 37). Use an average value if low or high water need for a particular plant type is unknown. Ideally, plants with similar water requirements are grouped together in the landscape within individual irrigation zones to allow separate application of water to those plants. If this is not done in the landscape and irrigation design and installation, the adjustment factors should correspond to the plant type with the highest water requirement within an irrigation zone.

It is important to understand that for both the Baseline Usage and the Design Case Usage, the usage is calculated by a weighted average across plant types depending on the given amount of area they comprise in the overall landscape. As an example, consider a site as follows: 5,000 ft^2 turfgrass, 2,000 ft^2 shrubs, 2,500% ft^2 groundcover, and 3,000 ft^2 trees. The site is in Alachua County, Florida. From FAWN, the July ET_o is 5.27 inches/month averaged from 2000 through 2008. Note that a longer period of record and use of the ASCE-EWRI ET_o estimation method is also preferred.

Table 1 shows a summary of the calculations for the Design Case Usage. The Baseline Usage for this scenario is as follows:

Baseline Usage (from Eqn. 1) = 12,500 ft^2 * 5.27 inches/month * 0.62

= 40,843 gal/month

Next, the Percent Reduction needs to be calculated,

Step 3. Calculate percentage reduction

Percentage Reduction = (1-(Design Case Usage/Baseline Usage)) * 100

For this example based on Table 1,

Percentage Reduction = (1 – (41,833/40,843)) * 100 = -2%

Since the Design Case Usage was higher than the Baseline Usage, the Percentage Reduction is negative. This result is largely due to the inefficient irrigation used for the turfgrass area. If an irrigation system consisting of rotary sprinklers with average efficiency were used on the turfgrass area, IE would become 0.7 and would change the calculations according to Table 2. Now the Percent Reduction becomes,

Percentage Reduction = (1-(33,501/40,843)) * 100 = 18%

This example highlights the importance, not only of plant material needs, but also of a well designed and installed irrigation system. Replacing the rain sensor with a proven soil moisture sensor irrigation controller should increase the Percentage Reduction to 42% due to this type of controller being more than twice as efficient as a rain sensor and time clock at efficiently scheduling irrigation (i.e. CF changes from 0.85 to 0.60).