BEST PRACTICE 7: Landscape Water Budgets, Information, and Customer Feedback

- Foundational, Programmatic, Understanding, Informational, Support, and Control best practice.
- Utility operations - implemented by water utilities.
- Customer participation – potentially impacts all customers depending upon implementation

Overview

In Colorado, urban landscape irrigation typically accounts for 50 percent or more of the total annual water demand for a utility (Mayer 1999). Landscape water budgets are a powerful conservation tool for addressing landscape water use and encouraging efficiency. A landscape water budget compares actual metered consumption against the legitimate outdoor water needs of the customer based on landscape area, plant materials, and climate conditions.[11]

Why a Best Practice?

Information is power. Landscape water budgets provide essential information to help customers manage their water use:

- How much water was used?
- How much water was required?
- What is the efficiency of use at this site?

Because many landscapes, particularly turf, can accept excess irrigation without damage many irrigators are not aware of whether they are using water efficiently or grossly over-irrigating. A landscape water budget provides a reasonable target level of water use that is customized for each customer and landscape. Water budgets help water users better understand their consumption patterns and make sound decisions about how to best manage irrigation properly. Water budgets provide utilities with a powerful tool for identifying which customers are over-irrigating and could most benefit from efficiency improvements. Water budgets can be incorporated into a utility rate structure as has been done in Castle Rock, Centennial Water and Sanitation District, and Boulder, but they are also useful in their own right outside of a rate structure as a tool for assessing water use.

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, one of the water saving measures and programs that must be considered in a conservation plan is, "Low water use landscapes… and efficient

[11] Some utilities link the water budget with an increasing block rate structure to provide financial incentive for keeping usage within the calculated budget. More details about water budget-based rate structures can be found in the Metering and Rates best practice.

irrigation," [CRS 37-60-126 (4) (a) (II)]. Another water conservation measure to be considered is, "Water rate structures and billing systems designed to encourage water use efficiency in a fiscally responsible manner," [CRS 37-60-126 (4) (a) (VII)].

Applicability

This best practice is geared towards utilities seeking to reduce outdoor demands and it applies specifically to customer accounts with significant irrigation demand. There are two fundamental methods for reducing irrigation demands: (1) Improving the efficiency of irrigation at the site (i.e. reducing over spray and runoff, improving distribution and uniformity, improving scheduling); and (2) Reducing irrigation demands by changing and improving landscape and plant materials (i.e. waterwise planting, soil improvement, mulch, etc.).

Although the focus of this best practice is on outdoor use, water budgets can be developed for all accounts in a utility's system including all commercial, institutional and industrial (CII) water users and can be established for both indoor and outdoor demands.

Implementation

A landscape water budget is typically a volume of water that is calculated from two fundamental parameters: the landscape size (usually in square feet) and the water requirement of the plants in that landscape which is often represented by the ET rate (Mayer et. al. 2008). Developing landscape water budgets is a process that has been accomplished by water utilities both small and large.

For large irrigators, an informational water budget is only effective when the information is shared by the part of the organization paying the bill as well as the landscape manager. For example, with a condo's HOA, the board, the property manager and the landscape company all need feedback from the bill. Creating financial feedback for overwatering can prompt the parties responsible for finances to share information with on-the-ground landscapers.

Landscape Area Measurement Options

Option 1 – GIS

Landscape water budgets are often calculated using a utility's geographical information system (GIS), aerial imagery, and data from local weather stations. Good GIS coverage with linkage to the utility billing database allows for the irrigated area of each customer to be determined with reasonable accuracy as shown in Figure 4-16. Many utilities have high-resolution aerial imagery available. If not, free lower resolution imagery is usually available through Google Earth and/or other sources. The analysis does not need to be as detailed as shown in Figure 4-16 and could be limited to something as simple as permeable and non-permeable area.

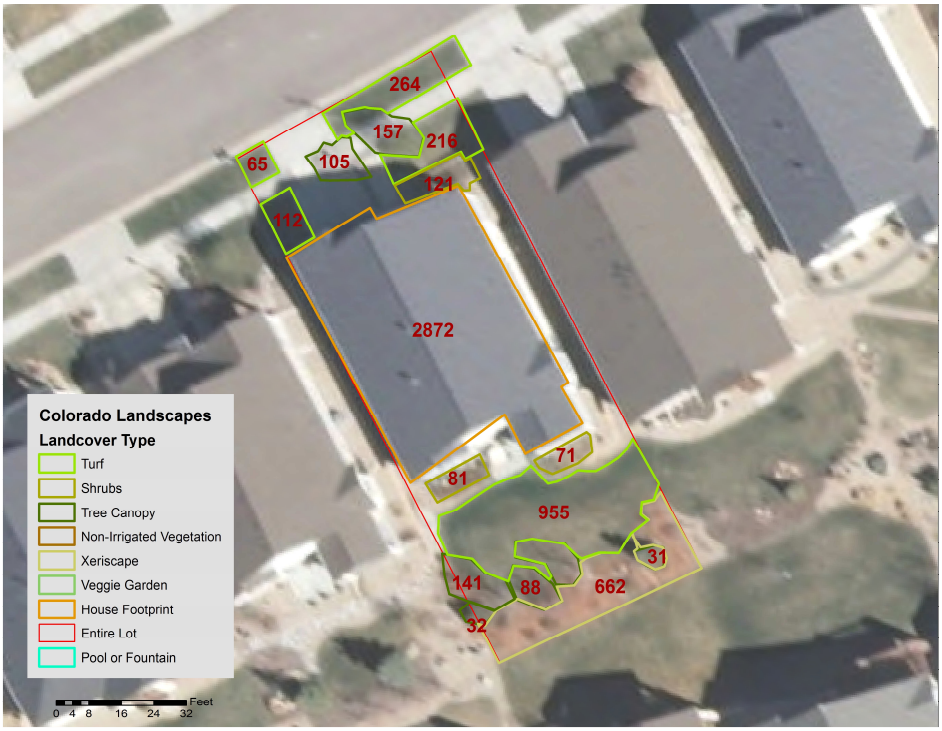

Figure 4-16: Landscape area calculation using GIS and available aerial imagery

Option 2 – Tax Assessor Records

Another option for estimating the irrigable area at a site or set of sites is to use county tax assessor records, which usually include a measurement of lot size and occasionally include measurements of the building footprint. Linkage between tax assessor records and utility billing accounts can be a complicating factor in this method as address matching (especially in large cities) is problematic. Tax assessor records typically only provide the total lot size area, so under this method estimated measurements of impermeable areas (roofs, pavements, etc) must be made. Since tax assessor records often include information about the buildings at each site including number of floors, total square footage, and presence of a garage, these data can also be used to estimate impermeable areas. However, this methodology will be more prone to systematic errors than any of the other proposed methods.

Option 3 – Physical Measurement

A third option is to hire a survey crew to physically measure the landscape area at selected sites. This is a reasonable option for a small utility or limited scale water budget program, but may not be practical when seeking to develop water budgets for an entire service area.

Option 4 – Sampling

Agencies with a reasonably homogeneous customer base can measure (via GIS or physical measurement) the irrigable area at a carefully selected sample of sites in the service area. This allows for a ratio between pervious and impervious areas to be established for each site in the sample. Once the range of areas is better understood, landscape area "bins" can be created and each property in the service area can be placed into the appropriate bin – usually based on tax

assessed lot size. All sites within a bin would have the same water budget each month. Centennial Water and Sanitation District in Douglas County used this method for establishing landscape water budgets for their budget-based rate structure. Based on the sampling effort, Centennial assumes 45 percent of the total lot size is irrigable.

Option 5 – Existing Impervious Area Measurements from Storm Water Programs

Colorado water providers that have calculated pervious and impervious area as part of a storm water management program may already have the data necessary to establish basic landscape water budgets. Since landscape water budgets are based on the irrigable (or pervious) area at a site, the storm water data by itself or in concert with tax assessor records may be sufficient to make the necessary calculations. Utilities seeking a low cost methodology for establishing landscape water budgets should consider this approach first as much of the work may already have been done on a site by site basis.

Appeals Process

If landscape water budgets are used as the basis for billing and are linked to the water rate structure, then inaccuracies can hit end users in their pocket book and an appeals process is required. An appeals process typically allows the customer to submit information in support of a revised landscape water budget, typically enlarging the budget from what was established by the City. Since customers are usually more knowledgeable about their landscape than anyone else, reasonable appeals are usually accepted. If landscape water budgets are used for informational purposes only, then an appeals process is probably unnecessary.

Water Requirement Options

Determining the legitimate water needs for each landscape in a service area is usually accomplished using evapotranspiration (ET) rate data obtained or calculated from local weather stations. ET, which originally comes from agronomy, is a measurement of the water requirement of plants and is typically reported in inches. Historic or real-time ET can be used to develop landscape water budgets.

There are a number of methods for calculating ET. A key difference is that many of the established methods do not include precipitation in the calculation. When seeking to improve irrigation efficiency it is essential to include effective precipitation[12] in the formulation of ET since effective rainfall can reduce the irrigation requirements of a landscape. ET is calculated for a specific reference crop (usually Kentucky bluegrass), but different plants have different water requirements and hence different ET values. Low-water use plants have a lower ET value. Utilities often establish water budgets based on the ET for bluegrass, but then reduce this by a 20 to 30% (or more) to account for different plants with a lower water requirement. Water budgets can be created with different objectives in mind. Some communities with ample water supply may wish to provide budgets that encourage lush, well irrigated landscapes while others may

> ET_o is typically a measure of ET that *does not* include precipitation. Factoring in effective precipitation is extremely important for establishing realistic water requirements.

[12] The Irrigation Association defines effective precipitation as "the portion of total precipitation which becomes available for plant growth".

wish to develop more restrictive budgets to encourage landscapes more appropriate for a drier climate (Mayer et. al. 2008).

There are several sources for ET data for Colorado. Colorado ET provides access to different ET networks around the state - www.coloradoet.org/etnetworks.html. Denver Water maintains nine weather stations in the metro area, where the historical ET for bluegrass is 27 inches. The Northern Colorado Water Conservancy District has 24 weather stations located along the northeastern part of the state. Some are located on turfgrass and others are in agricultural settings. CoAgMet is a network of over 30 weather stations located around the state primarily in rural agricultural settings. It is important to know the site factors of weather stations to determine which ones are most appropriate to use.

Calculating the Water Budget

A simple landscape water budget can be calculated using the following equation:

Water budget (gal) = Area (sf) x ET (inches) x 0.0833 (ft/inch) x 7.48 (gal/cubic foot)

or simplified to

Water budget (gal) = Area (sf) x ET (inches) x 0.623 (gal/inch/cubic foot)

For example, a 10,000 square foot (sf) turf landscape and an annual ET rate of 28 inches/year results in an annual water budget of 174,464 gallons (174.5 kgal) per year.

To determine a reasonable landscape water budget for the diverse landscapes served by a Colorado utility, an ET adjustment factor of between 0.5 and 0.8 can be used. This factor simply reduces the overall allocation to between 50% and 80% of a full bluegrass allotment to account for plants with lower water demands.

Using the example above, a 10,000 SF mixed turf and water wise landscape that only needs 70% of the 28 inch/year ET rate would have an annual water budget of 122,124 gallons (122 kgal) per year.

Water budgets can be set on an annual, quarterly, bimonthly, or monthly basis by setting the ET factor in the equation above to correspond with the desired time period (e.g. ET_{July} could be used to establish a water budget for the month of July). When incorporated into a utility billing rate structure, the budget is allocated based on the utility billing period. This may require adjusting ET rates to correspond with billing periods with differing start and end dates (a meter may be read on the 22nd of the month for example).

When implementing informational water budgets, different time periods can be considered. Monthly budgets provide regular feedback and are usually the best option. In Colorado, the irrigation season is usually only six or seven months long, so water budget updates need only be provided for half the year from April – October. Monthly budgets provide opportunity to make changes to irrigation schedules or system improvements to adapt to water budget allotments and

then to learn if these changes have had the desired effect. Annual budgets are far less immediate and informational and unless tied to the rate structure are unlikely to stimulate efficiency improvements.

Customer Education and Communication

If landscape water budgets are to be effective, customers must understand what they are and how they are calculated. Public input in the early stages can create wider-public support for budgets. Where water budgets are established it is also important that customers be given regular feedback on their consumption. Providing customers with a remote meter reading device or instructions for reading their own water meter is an important consideration. Currently some Colorado utilities do not permit customers to read their own water meter, while others promote self-meter reading and provide instructions on the utility website.

Green Industries of Colorado (GreenCO), a consortium of trade associations representing diverse aspects of the plant and landscape industry, has a landscape water budget calculator which gives customers and utility planners an estimation of efficient water use. It can be downloaded from their website at: www.greenco.org/. This calculator (a screen shot is shown in Figure 4-17) takes water bills, local ET data and information about landscape and develops a site specific water budget.

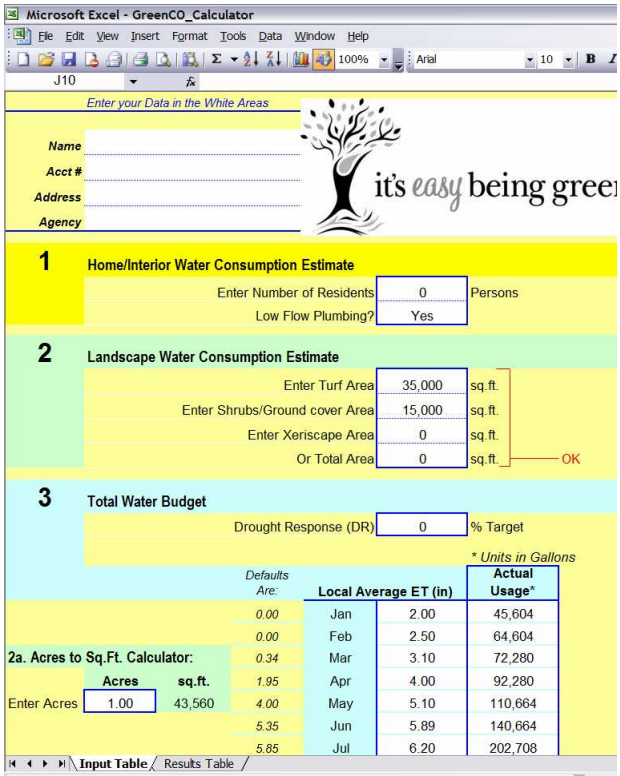

Figure 4-17: GreenCO's landscape budget calculator spreadsheet available for free download from www.greenco.org/

There are a number of web-based water budget calculator tools that may be useful as well including one from the California Urban Water Conservation Council (CUWCC) -

www.waterbudgets.com/ConserVision/CUWCC/DataInput.htm that automatically calculates a landscape water budget based on zip code.

Water Savings and Other Benefits

Range of Likely Water Savings: Significant

The savings achievable from landscape water budgets is largely based on the level of over-watering that occurred prior to implementation of the program. Customers who have historically over-irrigated have significant potential for savings, while those who have been frugal with outdoor water use will have little potential to reduce their use and may even increase their use.

Water budgets, particularly when linked with an increasing block rate structure, have lead to significant reductions in water use in Colorado. After implementing budget-based rates, the Centennial Water and Sanitation District reported a 25% reduction in demand vs. their previous inclining block rate structure. This over-all reduction can be tied to landscape reductions. Irvine Ranch Water District found that irrigation levels dropped substantially when landscape water budgets were used as part of the rate structure (Mayer 2008).

How to Determine Savings

Water savings from landscape water budgets can be calculated on a property by property basis by comparing outdoor or seasonal water use before and after implementation of the water budget program, taking care to adjust for differences in weather conditions during the pre- and post-implementation period.

Savings Assumptions and Caveats

Water savings from water budgets cannot be assumed; they should be measured and verified. Adjusting for differences in weather during the pre- and post-implementation period and accounting for other changes at the site not related to the water budget will yield more accurate results.

Goals and Benchmarks

Landscape water budgets offer utilities and customers the best available method for comparing actual water use against a reasonable efficiency benchmark.

> Utilities should set the goal of establishing landscape water budgets for all customers – even if they do not intend to take the step of linking the budget to the water rate structure.

If irrigable area data are readily available from a GIS or another source, then basic landscape water budgets can be established for all customers. When landscape area data must be measured or obtained manually, the process is more time consuming and expensive.

Utilities seeking a phased approach can choose to first establish landscape water budgets for their dedicated irrigation accounts including parks, medians, open space, and large landscapes. A dedicated irrigation account with a dedicated irrigation water meter makes it much easier to compare the proposed water budget against actual outdoor use and to determine program impacts. Once this is completed, the residential sector is the next logical customer group to target

under a phased approach followed by the commercial and industrial sector. Landscape irrigation is an often under appreciated component of CII use.

Other Benefits

Landscape water budgets are not just a good conservation tool; they can also help manage demand during a drought emergency. Landscape water budgets and water budget rate structures offer water utilities powerful tools for reducing demand during drought and for monitoring customer compliance with drought restrictions.

The following comes from Mayer, et. al. May 2008 AWWA Journal and sums up the uses of water budgets and water budget-based rate structures for drought response.

"*Landscape water budgets establish an empirical and quantifiable limit to the amount of water that a customer is entitled to use at a given price from a given tap. Water budgets theoretically reserve a volume of water that is set aside for the customer to use as he sees fit. Water budgets have the potential to protect the utility from overuse and to protect the customer from having her water allocated to other uses or micromanaged by the utility. In time of shortages, water budgets allow a water provider to quickly and easily identify excess use and even penalize it if necessary. By summing all water budgets, utilities can quickly understand the amount of water likely to be required to meet customer demands in any given month. During a drought, water budgets have the potential to assist water utilities in more fairly apportioning demand reductions among customers with different needs and among different customer classes since the reference point for reductions is based on the water required by each customer in normal times. Historically, when customers are asked to reduce their use from the previous year, justified complaints arise from customers who are already conserving, and don't have as much room for additional curtailments.*

"Water budget rate structures can help with drought plan enforcement in the area of communications. The water budget rate structure, with its billing system, informs all customers on a regular basis of the required use reductions. The water bill can show each customer how much water they are allocated during the drought. This information can be developed well before the drought occurs as part of the budgeting process. This is a far more reliable and effective way to implement drought related conservation since it is pre-planned rather than improvised. The billing system is already in place and the bills can provide the public with the information needed to respond to the drought.

"Another way that water budges aid with drought plan implementation is in the enforcement of mandatory demand curtailment. A simple query can inform the utility each billing period which customers have complied with drought restrictions and remained within budget and which have not. If the higher water rates being charged are not sufficient to elicit cooperation then additional fines and penalties can be considered. This is a highly reliable system. Unlike the "water cop" approach where customers are ticketed if they happen to be observed violating the drought restrictions, a water budget drought enforcement program automatically identifies every customer who is not complying, thus enabling fair and uniform enforcement. Water enforcement patrols are costly and can only catch violators "in the act" of violating a watering restriction. A

water budget, however, provides a regular and automatic check on which customers are in or out of compliance with drought response."

Costs

Utility Costs

Utilities will face financial costs in the form of staff or contractor time needed to develop and implement budgets. Utility billing systems may need to be upgraded to accommodate water budgets. Geographical information systems (GIS) can greatly enable establishment of water budgets on a system-wide scale, but GIS is not a requirement for creating landscape water budgets. Other less expensive methods have been used and utilities that have already calculated pervious and impervious areas as part of a stormwater management program can re-use that same information to establish landscape water budgets. Data savvy utilities may find that they can create basic landscape water budgets using existing data which can reduce costs substantially. However, agencies that do not have existing data resources may need to make a more significant investment in order to establish accurate water budgets.

Customer Costs

There are no direct customer costs associated with implementing water budgets, but customers do finance the programs through water bill payments as will all utility functions and programs.

Resources and Examples

Resources

GreenCO, a consortium of trade associations representing diverse aspects of the plant and landscape industry, has a landscape water budget calculator which gives customers and utility planners an estimation of efficient water use. It can be downloaded from their website at: www.greenco.org/

There are several sources for ET data for Colorado. Colorado ET provides access to different ET networks around the state. www.coloradoet.org/etnetworks.html.

The California Water Conservation Council offers one of the best available online water budget calculators which is capable of associating zip code with local ET data. This calculator can be found at: www.waterbudgets.com/ConserVision/CUWCC/DataInput.htm.

Examples

Centennial Water and Sanitation District

In response to the drought in 2002, and to encourage water conservation, Centennial Water and Sanitation District and the Highlands Ranch Metro District implemented an innovative water budgeting concept for residential and commercial water customers. The rate structure is detailed in the best practice on metering, conservation-oriented rates and tap fees, customer categorization within billing system. This landscape budget best practice takes a closer look at how the outdoor allocation is determined.

Lot size is the prime factor in determining the outdoor allocation. Tax assessor records were used to provide data on lot size. The basic calculation assumes 45% of the lot is irrigable. Centennial allots 27 inches of irrigation use for landscapes for a year. This is based on historic ET for the Highland's Ranch area. This means that the area of a given lot is multiplied by 27 inches to determine a volume for budgeting. Converting between various units (square footage of lot, inches of allocation and units of volume used for billing) can be tedious, but is a simple arithmetic operation. For example, a 10,000 square foot lot would be expected to have 4,500 square feet of irrigable area. Irrigating 27 inches (per season) on this 4,500 square feet would yield 75.7 kgal added to the home's budget for the irrigation season.

Determining what portion of the landscape is irrigable (the 45% factor) involved research. Detailed irrigable area was determined for a sample of 1,000 residential accounts. This analysis was done using aerial photography and geographical imaging system technology. This research found that lots had an average of 45% irrigable area and 55% impervious surfaces.

Commercial budgets are similar. However, for commercial, actual measured irrigable area is used to calculate water allotments for each site. Commercial customers are responsible for submitting this data.

Once in place these budgets were adjusted to include winter watering and extra allotments for establishing sod. Both block rates and break points were also adjusted.

Implementation took less than six months. Creating the new rate structure (including landscape budgets) was all done by utility staff. A major asset in developing the program was electronic versions of lot size data from county records. Centennial's billing system did not need to be replaced, and this too saved time and money.

Customer communication was also a prominent piece of the implementation process. Centennial conducted public meetings and workshops. Mailings were and still are used to communicate with customers about the rate structure.

City of Boulder

The City of Boulder established a water budget-based rate structure in 2007. This was also in response to the 2002 drought. This drought necessitated severe watering restrictions. These restrictions caused landscape to suffer and raised questions about drought enforcement policies.

In Boulder, budgets are established by customer type: single-family residential, multi-family residential, irrigation only and commercial/industrial accounts. For most customers, the annual water budget is the sum of the indoor and outdoor water allocations for a particular month.

Irrigable areas were measured using GIS. The outdoor budget for single family is determined by a tiered structure. The first 5,000 square feet of irrigable area is allotted 15 gallons of water per square foot. The next 9,000 square feet of irrigable area is allotted 12 gallons per square foot. Irrigable areas over 14,000 square feet are allotted 10 gallons per square foot. For reference, low-water use plants should need 10 gallons of water per square foot in Boulder's climate. For multi-

family and dedicated irrigation meters the allotment is 15 gallons per square foot over the whole irrigable area. To handle the variable water demands of CII accounts, and to keep the implementation process moving swiftly, Boulder decided to use historical consumption for each account as the basis for budgets.

Boulder's billing system had already been slated for replacement prior to the contemplation of budget-based billing. Before the new billing system was online, Boulder staff made an intensive effort to determine lot sizes and irrigable areas for each single family, multi-family and irrigation meter. Customer education was also a high priority during the interim before the new billing system was in place. Fliers explaining budget-based billing were sent to customers. A telephone hotline was set up for customer's queries. Forms were created for customers requesting an adjustment to their bill.

City of Castle Rock

The City of Castle Rock established a water budget-based rate structure in 2009 in an effort to reduce water demands in their groundwater-fed system as they transition to different water sources. In Castle Rock, the indoor portion of the water budget is based on the average winter consumption of the customer and the outdoor portion of the budget is based on the irrigated area.

Castle Rock contracted with a consulting firm to help develop the water rate structure and billing system used for implementation.