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From: Chorneau, Charlotte [cchorneau@ccp.csus.edu]
Sent: Thursday, June 03, 2010 12:52 PM
To: Water Use Efficiency
Subject: FW: comments on method 6
Attachments: SB7_USC_DraftU3Methodology_Updated Landscape Area Water Use_v7dwr_05.28.10 LRO.doc

From: Loren Oki [mailto:lroki@ucdavis.edu]
Sent: Monday, May 31, 2010 11:34 PM
To: Chorneau, Charlotte
Cc: Ceppos, David M
Subject: comments on method 6

Charlotte,

Here are my comments for Methodology 6. See you tomorrow!

Loren

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Methodology 6: Landscaped Area Water Use

Draft Methodology

May 28, 2010

The calculation of landscaped area water use requires a measurement (or estimate) of both landscaped area and of the landscape water use per unit area (based on reference evapotranspiration). Like other urban water use measures, SBx7-7 defines landscaped area water use as a per capita rate of use. Service area population estimation is the subject of a separate methodology.

Definition of Landscaped Area Water Use

For the landscaped area water use component of target Method 2, subdivision 10608.20 (b) (2) (B) states:

For landscape irrigated through dedicated or residential meters or connections, water efficiency equivalent to the standards of the Model Water Efficient Landscape Ordinance set forth in Chapter 2.7 (commencing with Section 490) of Division 2 of Title 23 of the California Code of Regulations, as in effect the later of the year of the landscape's installation or 1992. An urban retail water supplier using the approach specified in this subparagraph shall use satellite imagery, site visits, or other best available technology to develop an accurate estimate of landscaped areas.

Definitions and calculations contained in the Model Water Efficient Landscape Ordinance are provided in the next section. These calculations give the landscaped area water use as a function of landscaped area and reference evapotranspiration. Whereas the Model Water Efficient Landscape Ordinance defines landscaped area in terms of developed planted area and water features, the provision quoted above clearly intends the calculation to be applied only to irrigated landscape for purposes of setting the target water use for Method 2 under SBx7-7.

Landscaped area for purposes of calculating the Method 2 target shall mean the water supplier's estimate or measurement of 2020 landscaped areas. Water suppliers shall develop a preliminary estimate (forecast) of 2020 landscaped areas for purposes of setting urban water use targets and interim urban water use targets under subdivision 10608.20 (a) (1). For final compliance year calculations, water suppliers shall measure or update 2020 landscaped areas, using one of the techniques described below.

Calculation of Landscaped Area Water Use

Landscaped area water use for each parcel shall be calculated using Maximum Applied Water Allowance (MAWA) computation from the applicable Model Water Efficient Landscape Ordinance. For landscaped areas that are installed on or after January 1, 2010, the MAWA equation from the 2010 version of the ordinance shall be used:

Maximum Applied Water Allowance (MAWA) = (ET_o) (0.62) [(0.7 x LA) + (0.3 x SLA)]

Maximum Applied Water Allowance (MAWA) is in gallons per year

ETo = Reference Evapotranspiration (inches per year), which is "a standard measurement of environmental parameters which affect the water use of plants. . . . Reference evapotranspiration is used as the basis of determining the Maximum Applied Water Allowance so that regional differences in climate can be accommodated." Reference Evapotranspiration values for each location can be found in Appendix A of the 2010 Model Water Efficient Landscape Ordinance.

0.62 = Conversion Factor (from inches/year to gallons/sqft/year)

0.7 = ET Adjustment Factor (ETAF). When applied to reference evapotranspiration, the ETAF "adjusts for plant factors and irrigation efficiency, two major influences upon the amount of water that needs to be applied to the landscape."

LA = Landscaped Area including SLA (square feet), which includes "all the planting areas, turf areas, and water features in a landscape design plan subject to the Maximum Applied Water Allowance calculation. The landscaped area does not include footprints of buildings or structures, sidewalks, driveways, parking lots, decks, patios, gravel or stone walks, other pervious or non-pervious hardscapes, and other non-irrigated areas designated for non-development (e.g., open spaces and existing native vegetation)." (For SBx7-7 compliance, only irrigated landscaped area should be included.)

Comment [LRO1]: Are pools included here?

0.3 = Additional Water Allowance for Special Landscape Area (SLA), resulting in an effective ETAF for SLA of 1.0.

SLA = Special Landscaped Area (square feet), which is defined as "an area of the landscape dedicated solely to edible plants, areas irrigated with recycled water, water features using recycled water and areas dedicated to active play such as parks, sports fields, golf courses, and where turf provides a playing surface."

For landscaped areas that are installed before January 1, 2010, the MAWA equation from the 1992 version of the ordinance shall be used:

Maximum Applied Water Allowance (MAWA) = (ETo) (0.62) (0.8 x LA)

Maximum Applied Water Allowance (MAWA) is in gallons per year

ETo = Reference Evapotranspiration (inches per year), which is "a standard measurement of environmental parameters which affect the water use of plants. . . . Reference evapotranspiration is used as the basis of determining the Maximum Applied Water Allowance so that regional differences in climate can be accommodated." Reference Evapotranspiration values for each location can be found on page 38.10 of the Model Water Efficient Landscape Ordinance.

Comment [LRO2]: There are several methods to calculate this value, so there is no "standard." The method used or source of the values used should be referenced here, e.g., "as reported by CIMIS."

Deleted:

0.62 = Conversion Factor (from inches/year to gallons/sqft/year)

0.8 = ET Adjustment Factor (ETAF). When applied to reference evapotranspiration, the ETAF "adjusts for plant factors and irrigation efficiency, two major influences upon the amount of water that needs to be applied to the landscape."

LA = Landscaped Area including SLA (square feet), which includes "all the planting areas, turf areas, and water features in a landscape design plan subject to the Maximum Applied Water Allowance calculation. The landscaped area does not include footprints of buildings or structures, sidewalks, driveways, parking lots, decks, patios, gravel or stone walks, other pervious or non-pervious hardscapes, and other non-irrigated areas designated for non-development (e.g., open spaces and existing native vegetation)." (For SBx7-7 compliance, only irrigated landscaped area should be included.)

Comment [LRO3]: Are pools considered "landscaped areas" or "structures", as listed below.

The above calculations will yield water use estimates in gallons per year. The total landscaped area water use for the water supplier will equal the total landscaped area water use of all parcels in the supplier's service area. Because SBx7-7 defines landscaped area water use in units of GPCD, the result of the calculation above must be divided by service area population and then converted from annual to daily use.

Methodology for Computation of Landscaped Area

The water supplier shall select a technique for estimating landscaped area that satisfies the following criteria:

- The landscaped area must be measured or estimated for each parcel served by a residential or dedicated landscape water meter or connection within the water supplier's service area.
- Only irrigated landscaped area served by residential or dedicated landscape water meter or connection shall be included in the calculation of landscaped area water use. Landscape served by CII connections and non-irrigated landscape shall be excluded.

The following sections describe techniques that may be used to estimate landscaped area.

1. Field-Based Measurement of Landscaped Area

Field-based measurement of each parcel's landscaped area may be performed through physical measurement using a total station, measuring wheel and compass, Global Positioning System (GPS), or other measuring devices having similar accuracy to these.

2. Estimate Landscaped Area Using Remote Sensing

The landscaped area may be estimated by using remote sensing (aerial or satellite imaging) to identify the landscaped areas in conjunction with a GIS representation of the parcels within the water supplier's service area. A variety of remote sensing techniques are currently available, and additional ones may become available between now and 2020. The Department will allow the water supplier to select the remote sensing technique that it prefers. However, the following conditions shall be met:

- The remote sensing information must be overlaid onto a GIS representation of each parcel's boundaries to estimate the irrigated landscaped area within each parcel.
- The remote sensing imagery must have a resolution of 1 meter or less per pixel.
- The remote sensing technique must be verified for accuracy by comparing its results to the results of field-based measurement for a subset of parcels selected using random sampling. The water supplier should report the resulting percent error between the estimates of landscaped area produced by the remote sensing technique and those produced by field-based measurements for the sampled parcels.
- The Department has not set its own standards for remote sensing verification and sampling design. The water supplier shall provide a description of its remote sensing technique, including imagery, data processing, and verification, when it reports its landscaped area for purposes of complying with provisions of SBx7-7.

Comment [LR04]: Remote sensing cannot be used if parcel features are obscured by tree canopies or other obstructions.

Congalton and Green (1999) and Stein et al. (2002) are examples of references that describe professional standards for remote sensing.

3. Estimate Landscaped Area as a Percentage of Total Land Use

The landscaped area for smaller-sized parcels may be estimated by measuring the percentage of total parcel area that is landscaped in a group of similar parcels and applying that percentage to the remaining parcels. This technique may only be used for parcels with a total land area of 24,000 square feet or less. The parcels for which this technique is used shall be divided into groups based on parcel size, in increments of 4,000 square feet or less. Field-based measurement or remote sensing should be used to estimate the landscaped area for a subset of parcels sampled at random within each parcel size group (see Sampling below). The percentage of landscaped area to total land area for the sampled parcels in each group can then be used to estimate the landscaped area for all other parcels within the group. Parcels greater than 24,000 square feet shall be measured directly.

Comment [LR05]: As there will be variability associated with this method, an acceptable level of variability should be stated and the measured variability should be reduced by increasing the number of parcels within the "group of similar parcels."

4. Other Techniques to Estimate Landscaped Area

The water supplier may select another technique to estimate landscaped area for each parcel other than the ones described above if one becomes available in the future. However, the selected technique must meet similar conditions to those described above for remote sensing:

- The landscaped area information must be overlaid onto a GIS representation of each parcel's boundaries to estimate the landscaped area within each parcel.
- The technique must be tested for accuracy by comparing its results to the results of field-based measurement for a subset of parcels. Field-based measurement should be performed for a subset of parcels selected at random (see Sampling below) from those for which the technique has been used. The water supplier should report the percent error between the estimates of landscaped area produced by the technique and those produced by field-based measurements for the sampled parcels.

Using Sampling to Estimate Landscaped Area

Statistical sampling is a means to provide adequate information at reasonable cost. If implemented carefully, sampling allows the water supplier to develop accurate estimates of landscaped area for all relevant parcels from a subset of parcels. It is fundamental to technique 3 above, but may also be incorporated into remote sensing or other techniques. For example, statistically valid samples of landscaped area identified on aerial photographs may be used to estimate total landscaped area.¹ Sampling shall not be used to estimate landscaped area for parcels larger than 24,000 square feet.

Stratified sampling (random sampling within identified sub-groups of parcels) should be used to estimate the proportion of landscaped area within different parcel size classes. Other characteristics of parcels may be used as a basis for selecting the strata in addition to parcel size.

¹ Note that this is different from sampling required to validate remotely sensed estimates using field measurement.

The Department has not developed specific standards for sampling design. Urban water suppliers should follow standards of professional practice sufficient to demonstrate unbiased estimates of landscaped area. For example, Cochrane (1977) and Lohr (2010) provide guidance for sound sampling design.

Estimating Irrigated Landscaped Area from Total Landscaped Area

Irrigated landscaped area is defined as landscaped area served by a landscape irrigation system supplied by a dedicated or residential meter or connection.

- For field-based measurement, the irrigated portion of landscaped area may be measured for each parcel.
- For remote sensing, irrigated landscaped area may be estimated as part of the imagery interpretation and processing, but must be verified for accuracy using field-based measurement.
- For all techniques, random sampling is an acceptable approach to estimate the fraction of landscaped area that is irrigated. The sampling design should follow standards of professional practice sufficient to demonstrate unbiased estimates of irrigated fraction.

Comment [LR06]: If remote sensing has be to validated by field measurements, then what is the utility of remote sensing?

Estimating Reference Evapotranspiration

Calculations under the Model Water Efficient Landscape Ordinance require an estimate of reference evapotranspiration (ET). Each parcel served by a residential or dedicated landscape water meter or connection within the water supplier's service area shall be assigned a reference ET based on one of the following methods.

- Appendix A of the 2010 Ordinance contains tables of reference evapotranspiration. In some cases, the water supplier may choose a single reference ET value most appropriate for all parcels within its service area. For parcels in geographic areas not covered in the Appendix A table, the Ordinance provides the following direction for selecting the appropriate reference value: "For geographic areas not covered in Appendix A, use data from other cities located nearby in the same reference evapotranspiration zone, as found in the CIMIS Reference Evapotranspiration Zones Map, Department of Water Resources, 1999."
- DWR is currently enhancing its California Irrigation Management Information System (CIMIS) data capabilities. It is developing a tool that can provide estimates of reference ET for any part of California down to a 4 km-by-4 km square. When this enhanced tool becomes available, water suppliers may use it to assign reference ET to parcels. Any other CIMIS enhancements or additional stations formally adopted by DWR between 2010 and 2020 may also be used.
- Water suppliers may use local reference ET estimates that are not formally part of CIMIS, or that make adjustments to CIMIS station estimates, provided that such

estimates or adjustments are scientifically derived and of comparable reliability to CIMIS estimates.

Summary of Steps to Calculate Landscaped Area Water Use

- Step 1: Assign applicable Model Water Efficient Landscape Ordinance (MWELo, 1992 or 2010) to each parcel.
- Step 2: Estimate irrigated landscaped area for each parcel.
- Step 2.a: Select estimation technique(s) for landscaped area (e.g., field-based, remote sensing, sampling).
- Step 2.b: Apply technique(s) to estimate total landscaped area for each parcel.
- Step 2.c: Estimate irrigated fraction of total landscaped area for each parcel.
- Step 2.d: Estimate special landscape area (SLA) where applicable.
- Step 3: Use applicable MWELo to calculate landscaped area water use for all parcels.
- Step 3.a: Determine the reference evapotranspiration for each parcel.
- Step 3.b: Use the MWELo equations to calculate the Maximum Applied Water Allowance for each parcel or group of parcels (grouped according to applicable MWELo, reference evapotranspiration, and presence of SLA).
- Step 3.c: Sum the Maximum Applied Water Allowance over all parcels to calculate the total landscaped area water use portion of the Method 2 target.
- Step 3.d: Divide the total from step 3.c by service area population and then by 365 to calculate the landscaped area water use in GPCD.

References

General sampling design and statistical analysis

- Cochran, William G. *Sampling Techniques*. Wiley; 3rd edition. NY, NY. 1977.
- Lohr, Sharon. *Sampling: Design and Analysis*. Brooks/Cole Cengage, Boston, MA. 2nd edition. 2010.

Statistical techniques for remote sensing.

- Stein, A.; van der Meer, F.; and Gorte, B., Editors. *Spatial statistics for remote sensing*. Kluwer Academic Publishers, Netherlands. 2002.
- Congalton, R. G., and Green, K. *Assessing the Accuracy of Remotely Sensed Data: Principles and Practices*. CRC Press, Boca Raton, FL. 1999.