Urban CII Landscape Water Use and Efficiency in California

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Project Objective

The objectives of this project are to estimate for California municipal (urban) commercial, industrial, and institutional (CII)[1] water users:

1. current landscape water use,
2. current landscape water use efficiency as a factor of ETo (evapotranspiration),
3. potential water savings if landscapes irrigated at a maximum ETo level.

Current Landscape Water Use

The California Department of Water Resources (DWR) estimates that all urban customers use about 8.8 million acre-feet (MAF) per year (DWR, Bulletin 160-98, The California Water Plan Update, draft).

Of this amount, Table 1 shows the percentage breakout associated with CII landscape water use.

Table 1. CII Landscape Water Use Percentages

User Category	% of Urban Water Use	Million Acre-Feet per Year
Dedicated Landscape Meters	7.3%	0.64
Mixed Meter Commercial	3.8%	0.33
Mixed Meter Industrial	0.5%	0.04
Mixed Meter Multiple Family	1.6%	0.14
Total	13.3%	1.17

These percentages come from results of the DWR Urban Water Production Survey (see Appendix A). The Water Use Unit of Statewide Water Planning conducts a yearly survey of public water agencies in the state of California to generate regional and statewide urban water use estimates. The data are used by the DWR to update the California Water Plan (Bulletin 160) as well as Bulletin 166, Urban Water Use in California. The data shown in Table 1 are for 2001, the most recent year with published data, and include data from 192 water agencies serving approximately 16 million people. Hence, the reported data come from a survey of agencies serving about half the population in California.[2]

Results show 7.3% of total urban water use is associated with dedicated landscape meter water use. We note some additional water use associated with commercial, industrial, and

[1] CII customers include homeowner's associations and multiple-family (apartment) residential sites. Single-family sites are not included.

[2] Monique Wilber from DWR provided the database. More on the survey can be found at http://www.waterplan.water.ca.gov/landwateruse/wateruse/Urban/wuurban.htm. Note only water agencies with complete records in the calculation were used.

multiple family categories may also to related to landscape irrigation via mixed-use meters. Mixed-use meters record water use used for both indoor and outdoor purposes.[3] It is difficult to know exactly how much landscape water use is associated with mixed-use meters, but we can approximate by assuming it equals all water use over average winter water use (December through March). By doing this, landscape water use is increased by 6.0% to a total of 13.3%.

Current Landscape Water Use Efficiency

The second objective of the project is to estimate landscape water use as a percentage of ETo. To do this we collected water use and landscape area information from 449 large sites in California. Data on 424 sites came from a database maintained by Chris Willig, an experienced landscape auditor. He conducted landscape water audits (surveys) at these sites as part of agency programs for the Santa Clara Valley Water District and the San Diego County Water Authority, among others.[4] Data from another 25 sites came from the Contra Costa Water District. The average site size is 5.7 acres and the total landscape area over all sites is 4.0 square miles. Of the total landscape area, 48% is in turfgrass and 52% in other (e.g., shrubs, trees, water features).

The data included a variety of sites by location and customer type. About 31% of the sites come Northern California and 69% of the sites from Southern California. Sites are categorized into commercial, homeowner's associations (HOA), and public (e.g., parks). Summary results are shown in Table 2.

Table 2. Landscape Water Use as Function of ETo

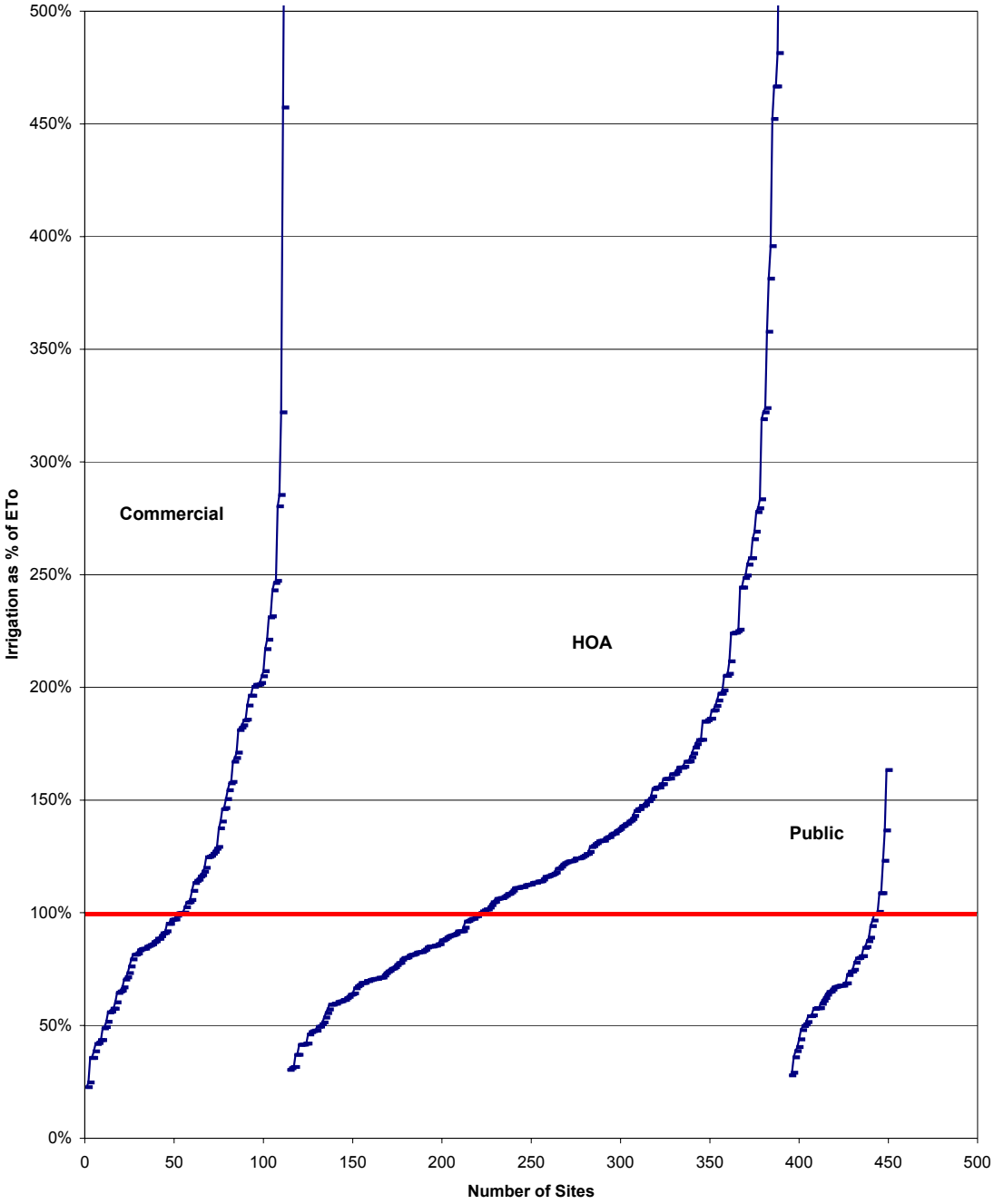
Customer Type	Site Count	% of ETo	% over 100% of ETo
Commercial	113	102%	51%
HOA	281	102%	62%
Public	55	68%	9%
Total	449	93%	50%

On average, these customers applied 93 percent of ETo over their landscaped areas. Large variations, however, occur. Looking at customer type, commercial and HOA sites average 102% of ETo, much higher than the 68% average seen with public sites. But, even within customer type groups, a large variation still occurs as shown in Figure 1.

[3] Note that water agencies have different policies and histories regarding the use of dedicated irrigation meters. The main motivation for using irrigation meters is that customers are not assessed a sewer charge on this water use. When irrigation is not a main end-use, mixed-use water meters are more common, especially in older communities.

[4] These landscape sites volunteered to participate in the survey programs for a variety of reasons, and hence, have not been randomly selected. These sites are used in this study because we have readily available landscape area measurements and water use histories.

Figure 1. Irrigation as % of ETo



This variation results from a variety of factors. One of the factors is site size. Figure 2 plots percentage of ETo applied against site size. As sites tend to get larger, percentage of ETo tends to become smaller. This is a partial explanation of why the public sites, that tended to be large (average site size of 12.0 acres), had a smaller percentage of ETo applied.[5]

Figure 3 plots percentage of ETo applied against percentage of landscape in turf. Our prior expectation was that sites with high percentages of turf, a more water intensive plant material, would exceed the 100% of ETo threshold more often and to a greater degree. Surprisingly, the data do not support this expectation.[6] Sites exceed the 100% threshold with similar frequency and magnitude across the spectrum of turf percentage. This evidence suggests that the conversion from turf to other irrigated plant materials (e.g., shrubs) does not necessarily convert into lower water use given current (inefficient) water management practices.

The right column of Table 2 shows the percent of sites irrigating over the 100% of ETo level. These are the sites with large potential water savings. We see 51% and 62% of commercial and HOA sites exceed the 100% ETo threshold respectively. In contrast, only 9% of public sites exceed the threshold.

[5] In discussing with Chris Willig, he also observed that the public sites tended to be large, contiguous areas where obtaining a high sprinkler application uniformity is easier (e.g., parks), some public sites tended to deficit irrigated because of financial constraints, and tended to be actively managed.

[6] I estimated a multiple linear regression model using % of ETo as the dependent variable and % turf, site size, and type of site (commercial, HOA, public) as explanatory variables. The estimate for the % turf variable is statistically insignificant with a t-statistic of 0.66. In contrast, the other two explanatory variables are significant; % of ETo decreases with site size and increases with commercial and HOA sites.

Figure 2. % of ETo vs. Site Size

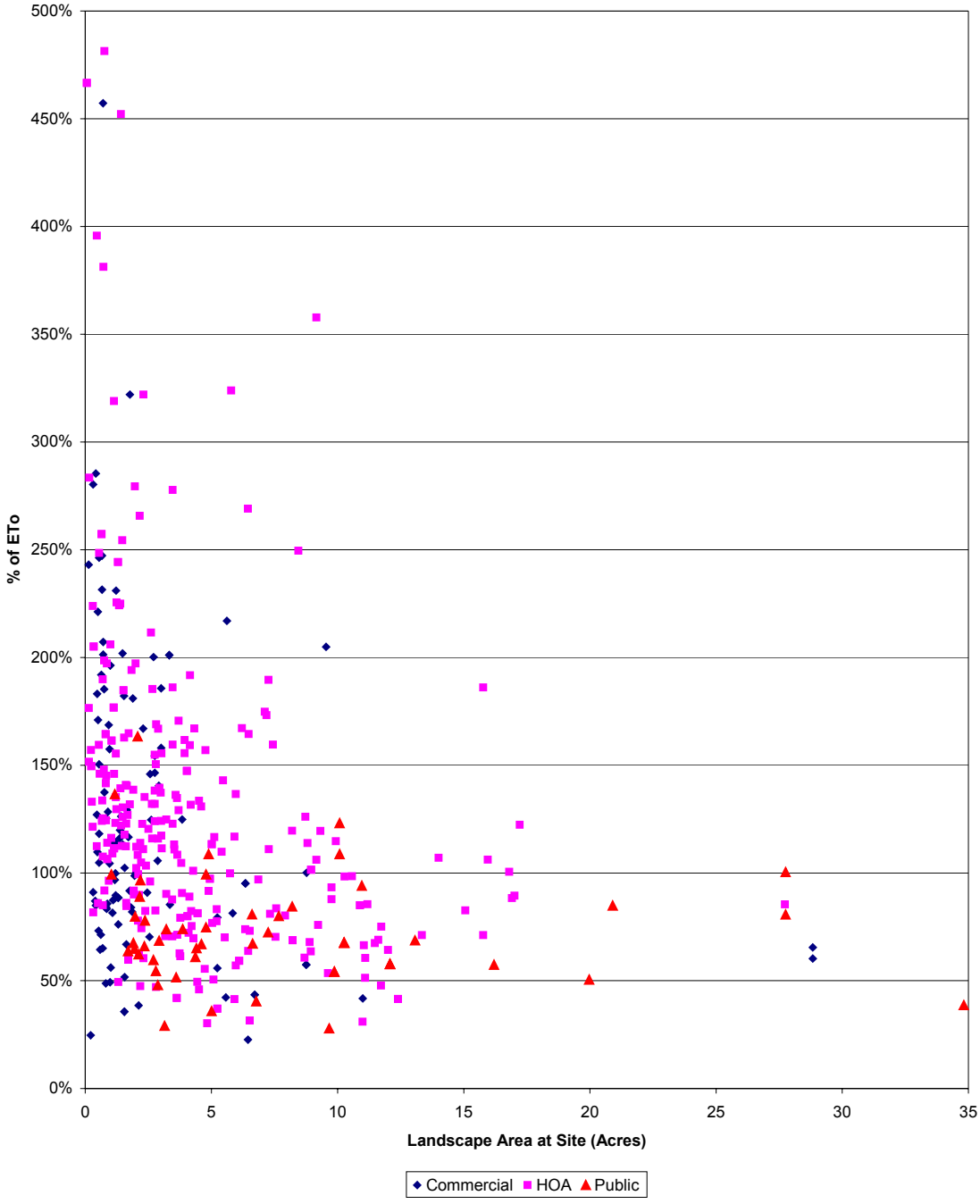
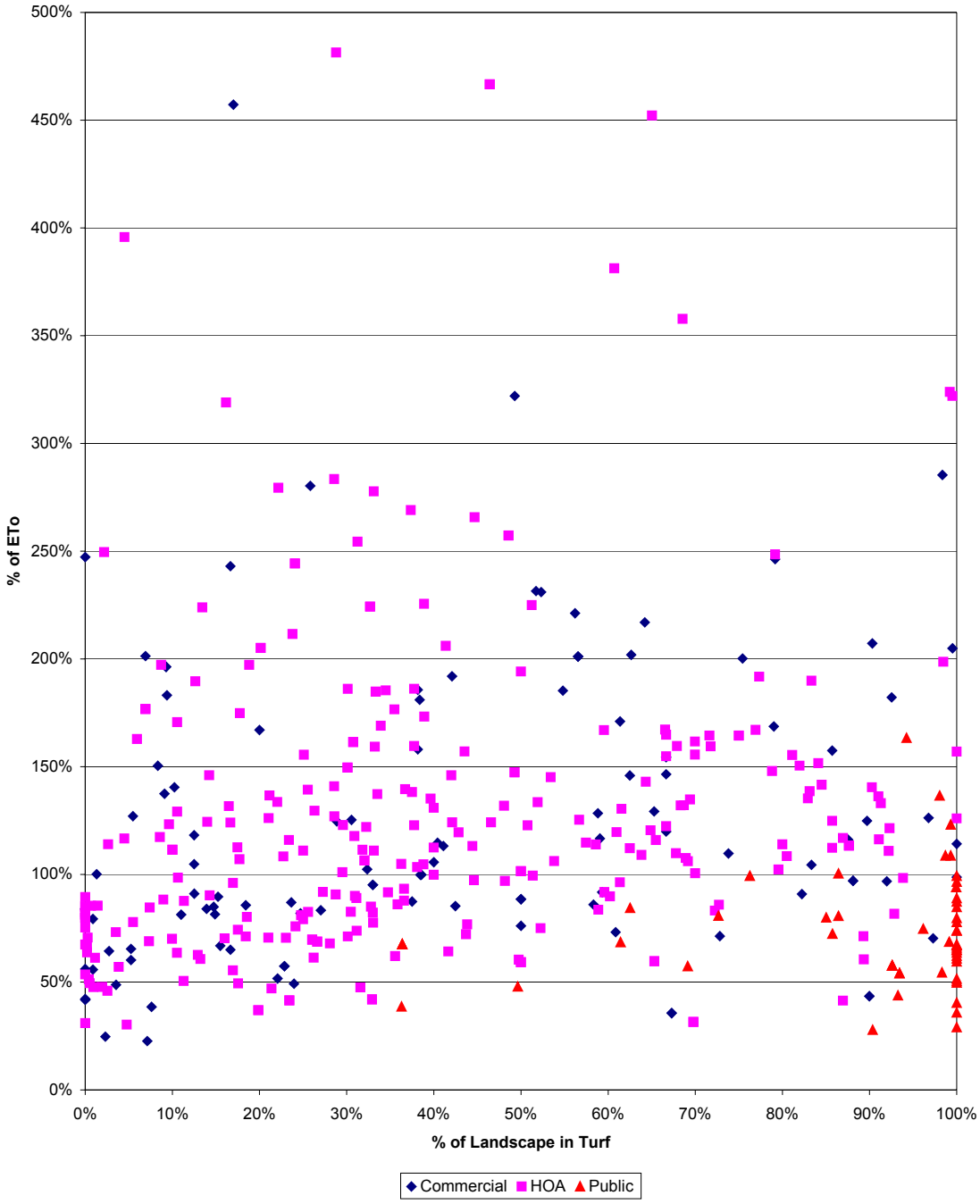


Figure 3. % ETo vs. % Turf



Potential Landscape Water Savings

Part of the scope of this project is to estimate the water savings that could be achieved if a set efficiency rate of 100% of ETo was applied to landscaped areas. Such a rule would impact about half the sites in our database.

If such a rule existed, the average percent of ETo over all sites would drop from 93% to 78%, a 15% reduction.[7]

Extrapolating a 15% reduction from our sample sites to the entire state, we would see landscape water use associated with dedicated irrigation meters drop from 0.64 MAF to 0.54 MAF per year. This equals 100,000 acre-feet per year. This does not include irrigation used by mixed-use meters.

It is difficult to extrapolate potential savings over time as trends in landscape covers and irrigation efficiencies are difficult to predict. As a baseline, we can assume that landscapes and landscape savings will grow proportionate with population. From the California Department of Finance, the latest population projections have California population growing by 33% to 45.8 million by the year 2020.[8] This extrapolates the 100,000 acre-feet per year to 133,000 acre-feet per year over the same period, holding all else constant.

Readers should note that the landscape areas measured and evaluated in this project include only "irrigated" areas at the sites. It is possible to broaden the definition of landscape area to include outdoor areas that are not irrigated (e.g., undeveloped or native vegetation areas). Doing this would increase defined landscape area at some sites and allow more water to be used below the 100% of ETo threshold. We do not have non-irrigated landscape area information in the database to evaluate the impact of this change in definition.

Also, potential landscape efficiency gains could be much greater than 15%, especially with non-turf landscape covers that require much less water than turf. Sites can inefficiently be irrigating non-turf areas and still be under the 100% of ETo threshold.

[7] Technically the percentage change from 93% to 78% is 16.1%. Also note the savings calculations are based on this sample of irrigation sites being representative of the population of all landscape sites, an unverified assertion.

[8] http://www.dof.ca.gov/HTML/DEMOGRAP/P1.doc

Appendix A
DWR Urban Water Production Survey

State of California | Department of Water Resources | The Resources Agency

PUBLIC WATER SYSTEM STATISTICS

Calendar Year

Mailing Label

1. General Information

Please follow the guidelines on the back of this form.

Contact :
Title:
Phone:
Fax:
E-mail:
Website:
Communities served:

County:
Population served

2. Active Service Connections

Customer Class	Recycled Water	Potable Water		Complete this portion if the system serves all or part of an incorporated city			
				Inside City Limits		Outside City Limits	
		Metered	Unmetered	Metered	Unmetered	Metered	Unmetered
Single Family Residential							
Multi-family Residential							
Commercial/Institutional							
Industrial							
Landscape Irrigation							
Other							
Agricultural Irrigation							
TOTAL							

3. Total Water Into the System - Units of production: ☐ acre-feet ☐ million gallons ☐ hundred cubic feet

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Potable	*Wells*													
	Surface													
	Purchased 1/													
	Total Potable													
Recycled 2/														

1/ Potable wholesale supplier(s):

2/ Recycled wholesale supplier(s):
Level of treatment:

4. Metered Water Deliveries - Units of delivery: ☐ acre-feet ☐ million gallons ☐ hundred cubic feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
A. Single Family Residential													
B. Multi-family Residential													
C. Commercial/Institutional													
D. Industrial													
E. Landscape Irrigation													
F. Other													
Total Urban Retail (A thru F)													
Agricultural Irrigation													
Wholesale(*to other agencies)*													

DWR 38 (Rev. 03/02)

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