Recommendations for Outdoor Residential Water Use Efficiency Standard

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Prepared Pursuant to California Water Code
Section 10609.6(a)(1)

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California Department of Water Resources
Water Use Efficiency Branch

Note: This report is part of the package of reports developed by the California Department of Water Resources to meet the requirements of Senate Bill 606 and Assembly Bill 1668 of 2018 for urban water use efficiency.

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Table of Contents

Executive Summary I

1.0 Introduction 1-1

1.1 Legislative Directives 1-1

2.0 Scope 2-1

2.1 Analytical Approach in Setting the Outdoor Residential Water Use Efficiency Standard 2-1

2.2 Methodological Challenges 2-3

2.3 Data and Workflow Overview 2-4

3.0 Key Data Inputs 3-1

3.1 Electronic Annual Report 3-1

Data Acceptance Criteria 3-1

3.2 Indoor Residential Per-Capita Water Demand 3-2

3.3 Corrections to Population Data 3-3

3.4 Corrections for Unmetered Connections 3-4

3.5 Landscape Area Measurement 3-4

3.6 Reference Evapotranspiration and Effective Precipitation 3-6

4.0 Representativeness of Urban Retail Water Suppliers Used for Evaluating the Outdoor Residential Water Use Efficiency Standard 4-1

5.0 Analytic Results 5-1

5.1 Evapotranspiration Factor Distributions Based on Irrigable and Irrigated Landscape Areas 5-1

5.2 Impact of Effective Precipitation on Estimated Evapotranspiration Factors 5-3

5.3 Comparison of Evapotranspiration Factor Distributions Between Total Residential and Single-Family Sector 5-5

5.4 Impact of Relative Proportions of Irrigable-Irrigated and Irrigable-Not Irrigated Landscape Areas on Outdoor Residential Water Use 5-6

6.0 Alternative Outdoor Residential Water Use Efficiency Standard Options: Pros and Cons 6-1

6.1 Option 1: A Single Outdoor Standard Based on Irrigable Landscape Area 6-1

6.2 Option 2: A Single Outdoor Standard Based on Irrigated Area 6-1

6.3 Option 3: An Outdoor Standard Based on a Sliding Scale 6-2

6.4 Option 4: Two Outdoor Standards Based on Irrigated Area and Irrigable-Not Irrigated Landscape Areas 6-2

6.5 Option 5: A Single Outdoor Standard Applied to Irrigated Area, Landscape Area, and a Buffer Based on Irrigable-Not Irrigated Landscape Area 6-2

7.0 Detailed Evaluation of Option 5 (Recommended Option) 7-1

7.1 Impact of the Buffer on Urban Retail Water Suppliers 7-1

7.2 Effect of Capping the Buffer on Statewide Water Savings 7-3

8.0 Evaluating the Outdoor Residential Water Use Efficiency Standard's Consistency with Model Water Efficient Landscape Ordinance Principles 8-1

8.1 Mean of Trimmed or Top-and Bottom-Coded Empirical Evapotranspiration Factor Distribution 8-1

8.2 Theoretical Evapotranspiration Factor Derived from Evaluation of Canopied Versus Non-Canopied Landscape Area 8-3

8.3 Theoretical Evapotranspiration Factor Derived from Housing Age Distribution 8-4

9.0 Factors Considered During Development of the Outdoor Residential Water Use Efficiency Standard 9-1

9.1 Provisional Outdoor Residential Water Use Efficiency Standard 9-1

9.2 Stakeholder Feedback on the Provisional Outdoor Residential Water Use Efficiency Standard 9-2

10.0 Assessment of Urban Water Use Standards in Relation to Senate Bill X7-7 Statewide Target 10-1

10.1 Legislative Directive 10-1

10.2 Legislative Test of Water Code Section 10609.2(d) 10-3

10.3 Urban Water Use Objective Analyzer 10-4

Water Use Definitions 10-5

10.4 Standards Evaluated in the Legislative Test 10-7

10.5 Legislative Test Results 10-9

10.6 Sensitivity of the Legislative Test Results to Variances and Potable Reuse Bonus Incentive 10-10

11.0 Impact on Urban Retail Water Suppliers of Alternative Indoor Residential and Recommended Outdoor Residential Standards 11-1

11.1 Exceedance Assessment Results: Objective-Based Total Water Use 11-2

11.2 Exceedance Assessment Results: Urban Water Use Objective 11-4

11.3 Impact of the Proposed Long-Term Standards on Urban Trees 11-6

11.4 Exceedance Assessment Summary 11-7

12.0 Recommendation 12-1

12.1 Recommendation for the Outdoor Residential Water Use Efficiency Standard 12-1

12.2 Stakeholder Suggestions and Recommendations 12-2

13.0 Guidelines for Assessing Compliance 13-1

13.1 Calculation of Efficient Outdoor Residential Water Use 13-1

13.2 Comparison of Water Use Objective to Actual Water Use 13-2

14.0 Glossary 14-1

15.0 References 15-1

Figures

Figure 2-1 Data and Workflow Overview 2-5

Figure 4-1 Distribution of Urban Retail Water Supplier Population by Hydrologic Region 4-2

Figure 4-2 Distribution of Urban Retail Water Supplier Population by Climate Zone 4-2

Figure 4-3 Relative Proportion of the Three-Class Landscape Areas 4-3

Figure 4-4 Effective Precipitation as a Proportion of Total Precipitation 4-4

Figure 5-1 Distribution of Evapotranspiration Factor: Total Residential (N=259) 5-2

Figure 5-2 Distribution of Evapotranspiration Factor Without Outliers: Total Residential (N=249) 5-3

Figure 5-3 Comparison of Evapotranspiration Factor Distributions Between Total Residential Sector and Only Single-Family 5-5

Figure 5-4 Evapotranspiration Factor Versus Ratio of Irrigated to Irrigable Area 5-7

Figure 5-5 Sensitivity of Best Fit Line to Years of Water Use Data Used in the Analyses 5-8

Figure 7-1 Effect of Three Alternative Buffer Caps on the Outdoor Standard 7-4

Figure 8-1 Distribution of Housing Units by Model Water Efficient Landscape Ordinance Age Bands 8-5

Figure 10-1 California Water Code Section 10609.2(d) Legislative Test 10-3

Tables

Table 3-1 Landscape Area Measurement Project: Key Summary Statistics 3-5

Table 5-1 Impact of Alternative Approaches for Handling Effective Precipitation 5-4

Table 7-1 Effect of the Buffer on Different Urban Retail Water Suppliers 7-2

Table 7-2 Effect of Buffer Cap on Statewide Urban Water Savings 7-6

Table 8-1 Estimated Statewide Evapotranspiration Factor Means Under Alternative MWELO Considerations and Landscape Areas 8-2

Table 10-1 Recommended Outdoor Standard with Indoor Residential Standard in the Water Code 10-8

Table 10-2 Recommended Outdoor Standard with Indoor Residential Standard Recommended by California Department of Water Resources and State Water Resources Control Board to the Legislature 10-8

Table 10-3 Legislative Test Results (Indoor Standards in the Water Code)............... 10-9

Table 10-4 Legislative Test Results (Indoor Standards Recommended by the California Department of Water Resources and State Water Resources Control Board to the Legislature).. 10-9

Table 11-1 2030 Objective-Based Total Water Use Exceedance Distribution, Excluding the Potable Reuse Bonus Incentive (Indoor Standard of 50 Gallons Per Capita Per Day in the Water Code)... 11-2

Table 11-2 2030 Objective-Based Total Water Use Exceedance Distribution, Including the Potable Reuse Bonus Incentive (Indoor Standard of 50 Gallons Per Capita Per Day in the Water Code)... 11-3

Table 11-3 2030 Objective-Based Total Water Use Exceedance Distribution, Excluding the Potable Reuse Bonus Incentive (Indoor Standard of 42 Gallons Per Capita Per Day, Recommended by the California Department of Water Resources and State Water Resources Control Board) 11-3

Table 11-4 2030 Objective-Based Total Water Use Exceedance Distribution, Including the Potable Reuse Bonus Incentive (Indoor Standard of 42 Gallons Per Capita Per Day, Recommended by the California Department of Water Resources and State Water Resources Control Board) 11-4

Table 11-5 2030 Water Use Objective Exceedance Distribution, Excluding the Potable Reuse Bonus Incentive (Indoor Standards in the Water Code) 11-5

Table 11-6 2030 Water Use Objective Exceedance Distribution, Including the Potable Reuse Bonus Incentive (Indoor Standards in the Water Code) 11-5

Table 11-7 2030 Water Use Objective Exceedance Distribution, Excluding the Potable Reuse Bonus Incentive (Indoor Standards Recommended by the California Department of Water Resources and State Water Resources Control Board) 11-6

Table 11-8 2030 Water Use Objective Exceedance Distribution, Including the Potable Reuse Bonus Incentive (Indoor Standards Recommended by the California Department of Water Resources and State Water Resources Control Board) 11-6

Appendices

Appendix A - Urban Water Use Efficiency Recommendation Package Reports Incorporated by Reference A-1

Abbreviations and Acronyms

2018 Legislation	2018 Legislation on Water Conservation and Drought Planning (Senate Bill 606 [Hertzberg] and Assembly Bill1668 [Friedman], as amended)
AB	Assembly Bill
ACS	American Community Survey
ASABE S623	American Society of Agricultural and Biological Engineering Standard 623
Cal-SIMETAW	California Simulation of Evapotranspiration of Applied Water
CII	commercial, industrial, and institutional
CII-DIM	commercial, industrial, and institutional dedicated irrigation meter
CII-DIMWUS	Commercial, Industrial, and Institutional Outdoor Irrigation of Landscape Areas with Dedicated Irrigation Meters Water Use Efficiency Standard
CIMIS	California Irrigation Management Information System
DAC	disadvantaged community
DIM	dedicated irrigation meter
DOF	California Department of Finance
DWR	California Department of Water Resources
eAR	electronic annual report
EIR	Environmental Impact Report
EIRWU	efficient indoor residential water use
EORWU	efficient outdoor residential water use
ET	evapotranspiration
ETAF	evapotranspiration factor in Model Water Efficient Landscape Ordinance design standard (on parcel level)
ETF	evapotranspiration factor (on urban retail water supplier level)
ETo	reference evapotranspiration

ETWU	expected total water use
gpcd	gallons per capita per day
II	irrigable-irrigated
INI	irrigable-not irrigated
IRWU	indoor residential water use
LA	landscape area
LAM	landscape area measurement
Legislature	California State Legislature
MAWA	maximum applied water allowance
MWELO	Model Water Efficient Landscape Ordinance
N/A	not applicable
NI	not irrigable
ORWU	outdoor residential water use
ORWUS	Outdoor Residential Water Use Efficiency Standard
OTWU	objective-based total water use
Peff	effective precipitation
PRISM	Parameter-elevation Relationships on Independent Slopes Model
PWS	public water system
SB	Senate Bill
SLA	Special Landscaped Area
State	State of California
State Water Board	State Water Resources Control Board
UWMP	Urban Water Management Plan
UWUO	urban water use objective
WC	California Water Code
WLS	Water Loss Standard

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Executive Summary

Study Goal and Stakeholder Engagement

The California State Legislature (Legislature) passed the 2018 Legislation on Water Conservation and Drought Planning (Senate Bill [SB] 606 [Hertzberg] and Assembly Bill [AB] 1668 [Friedman], as amended; hereinafter referred to as the "2018 Legislation"), which directed the California Department of Water Resources (DWR), in coordination with the State Water Resources Control Board (State Water Board), to conduct necessary studies and investigations and recommend standards for efficient outdoor residential water use (EORWU) for adoption by the State Water Board. It further specified that the standards incorporate the principles of the Model Water Efficient Landscape Ordinance (MWELO) adopted by DWR pursuant to the 1990 Water Conservation and Landscaping Act, most recently updated in 2015 (Article 10.8 [commencing with Section 65591] of Chapter 3 of Division 1 of Title 7 of the Government Code).

As directed by the 2018 Legislation, DWR conducted empirical studies and investigations, coordinated with the State Water Board, and established a Standards, Methodologies, and Performance Measures Working Group consisting of diverse stakeholders. DWR held seven workshops between October 2020 and November 2021 to inform and obtain feedback from working group members as well as any other interested public parties about development of the Outdoor Residential Water Use Efficiency Standard (ORWUS). Documents presented and feedback received at these workshops are publicly available.

This report describes all the analyses undertaken to develop the ORWUS and is consistent with the elements added to the California Water Code (WC) by the 2018 Legislation mentioned above. These relevant elements are:

> *The department, in coordination with the board, shall conduct necessary studies and investigations and recommend, no later than October 1, 2021, standards for outdoor residential use for adoption by the board in accordance with this chapter* (WC Section 10609.6(a)(1)).
>
> *The standards shall incorporate the principles of the model water efficient landscape ordinance adopted by the department pursuant to the Water Conservation in Landscaping Act* (WC Section 10609.6(2)(A)).
>
> *The standards shall apply to irrigable lands* (WC Section 10609.6(2)(B)).
>
> *For purposes of Sections 10609.6 and 10609.8, "principles of the model water efficient landscape ordinance" means those provisions of the model water efficient landscape ordinance applicable to the establishment or*

determination of the amount of water necessary to efficiently irrigate both new and existing landscapes. These provisions include, but are not limited to, all of the following (WC Section *10609.9*)*:*

> *(a) Evapotranspiration factors, as applicable.*
>
> *(b) Landscape area.*
>
> *(c) Maximum applied water allowance.*
>
> *(d) Reference evapotranspiration.*
>
> *(e) Special landscape areas, including provisions governing evapotranspiration factors for different types of water used for irrigating the landscape.*

Incorporating precipitation data and climate data into estimates of a urban retail water supplier's outdoor irrigation budget for its urban water use objective (WC Section 10609.16(d))*.*

ORWUS Development Process

The ORWUS development process followed a four-pronged approach starting with developing an understanding of current patterns in outdoor residential water use (ORWU) at an urban retail water supplier level and statewide.

- Data were first compiled for a geographically and climatologically representative set of 249 urban retail water suppliers to document current level of ORWU as a proportion of net reference evapotranspiration.
- Next, ORWU efficiency that can be achieved in the long term was identified by applying principles of MWELO to these real-world data.
- Then, literature review and feedback from stakeholders were incorporated into the decision-making process.
- Finally, DWR made its final recommendation on the standards. Each step is briefly described below.

Step 1: Understanding Current Patterns in Outdoor Residential Water Use

To understand the current patterns in ORWU at an urban retail water supplier level and statewide, DWR first estimated each urban retail water supplier's current level of outdoor water use as a percentage of net reference evapotranspiration. This section describes the key variables, data, and results of this analysis. Each urban retail water supplier's current level of ORWU is expressed in the form of an urban retail water supplier-level evapotranspiration factor (ETF) to remove the effects of known sources of variation in outdoor residential use, namely due to landscape area and weather across urban retail water suppliers. Calculation of EORWU, one of the key components of the water use objective per the abovementioned 2018 Legislation, must fully account for these two known sources of variation in ORWU. The ETF is a factor that, when multiplied by net reference evapotranspiration and landscape area (LA), produces an estimate of urban retail water supplier's outdoor water use (see Equation ES1). Net reference evapotranspiration is reference evapotranspiration (ETo) minus effective precipitation (Peff). Only ETF is unknown in this equation and can be back calculated.

$$ORWU = (ETo - Peff) \times (0.62) \times (ETF) \times (LAs) \qquad \text{(Eq. ES1)}$$

where,

- ORWU is an urban retail water supplier's annual outdoor residential water use in gallons.
- ETo is the annual reference evapotranspiration in inches.
- Peff is the annual effective precipitation in inches.
- ETF is the evapotranspiration factor (on urban retail water supplier level).
- LAs are the residential landscape areas within an urban retail water supplier's service area in square feet.
- 0.62 is a unit conversion factor.

Data for the variables in Equation ES1 come from the following sources:

- **Urban Retail Water Supplier's Annual Outdoor Residential Water Use**. Annual ORWU is obtained from the Annual Water Use Report that urban retail water suppliers submit to the State Water Board through the electronic annual report (eAR).[2] These data were subject to stringent quality control processes yielding a subset of 249 urban retail water suppliers that are geographically and climatically representative of the full set of 398 urban retail water suppliers in the State of California (State). Total residential use is disaggregated into indoor and outdoor components using estimates of indoor use derived from DWR's *Results of the Indoor Residential Water Use Study* (DWR, 2021). ORWU was developed for three consecutive years (2017 to 2019).

[2] https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/ear.html

- **Annual Reference Evapotranspiration**. ETo is obtained from California Irrigation Management Information System (CIMIS). Spatial CIMIS model provides ETo values at 2-kilometer grid for the entire State on a daily time step. Urban retail water suppliers' service area boundaries were overlaid on the Spatial CIMIS grid to obtain their specific ETo estimates.

- **Annual Effective Precipitation**. Peff represents the portion of total precipitation that becomes available for plant growth. It is affected by soil type, slope, land cover type, and rainfall frequency, intensity, and duration, among other factors. DWR uses a soil water balance model at a daily time step, known as California Simulation of Evapotranspiration of Applied Water, to estimate Peff. Daily Peff estimates are aggregated to yield an annual estimate. To be consistent with MWELO, Peff was capped at 25 percent of total annual precipitation, a decision also supported by sensitivity analyses. Including Peff in the estimation of ETF is necessary to account for the considerable variation in precipitation across urban retail water suppliers. This variation also requires that Peff be accounted for while calculating EORWU to maintain equity across urban retail water suppliers.

- **Residential Landscape Area Within an Urban Retail Water Supplier's Service Area**. LAs are the product of DWR's landscape area measurement (LAM) project. DWR contracted with Quantum Spatial, Inc. to produce irrigable landscape area estimates for all urban retail water suppliers as directed by the 2018 Legislation. Using the object-based classification system of high resolution remotely sensed data, each object (feature) in a parcel is assigned to a predetermined class using an imputation model and aggregated into three irrigation classes for each urban retail water supplier. The three irrigation status classes are irrigable-irrigated (II), irrigable-not irrigated (INI), and not irrigable (NI).

  - <u>Irrigable-Irrigated</u>. The II class represents landscape areas of healthy vegetation where the vegetation appears to be in growth, not senesced, and is foliated. The area is presumed to be maintained and managed through active irrigation, comprising irrigated hydro-zones.

  - <u>Irrigable-Not Irrigated</u>. The INI class represents areas of planted and previously maintained vegetation that appears water stressed (brown or leafless plants). These are areas that likely were not irrigated when the imagery was taken, but possibly were irrigated in the past, and may be irrigated again during the year after the imagery was taken.

  - <u>Not Irrigable</u>. The NI class represents native or undeveloped areas within, or adjacent to, a developed lot that shows no signs of active or previous irrigation, are not adjacent to irrigated vegetation, and are generally not located adjacent to structures. Impervious, solid, or compacted materials are ‘not irrigable’ because they cannot directly support growing vegetation or hold water.

To summarize, Figure ES-1 shows key data sources used for development of the ORWUS.

Data Sources for Setting Outdoor Standard

Data	Source	Years
Outdoor Residential Water Use (ORWU)	Water Resources Control Board, eAR	2017, 2018, 2019
Reference Evapotranspiration (ETo)	Department of Water Resources, California Irrigation Management Information System (CIMIS)	2017, 2018, 2019
Effective Precipitation (Peff)	Department of Water Resources, Cal-SIMETAW Model	2017, 2018, 2019
Supplier Landscape Area (LAs)	Department of Water Resources, Landscape Area Measurement (LAM)	2016, 2018

CALIFORNIA DEPARTMENT OF WATER RESOURCES

Figure ES-1 Key Data Sources for Setting the ORWUS

Key Findings from Step 1

Using the subset of 249 urban retail water suppliers described above, DWR developed a statistical model to evaluate irrigation received by INI landscaped areas relative to II landscape areas. Aerial imagery used in the classification represents the irrigation status of landscape areas at a single snapshot in time. Although the 2018 Legislation directs DWR to incorporate “irrigable” area into the ORWUS, which in theory is the sum of II and INI landscape areas, the empirical ETF data suggest that some INI areas do receive irrigation, albeit at a much lesser rate. This is to be expected given how aerial imagery is collected and interpreted. Green, healthy vegetation in the imagery is assigned to the II category and brown, stressed vegetation to the INI category, but the imagery only tells the story of one day, not the whole year, and images from other periods could show different results. A statistical model was used to evaluate how total annual irrigation of II and INI areas scale relative to one another. This model indicates that landscaped areas identified as INI in the imagery analysis receive roughly one-fifth of the irrigation of II landscaped areas of equivalent size (this finding is statistically significant). For calculation of annual EORWU, the landscape area to be used thus must be adjusted to become II plus 20 percent of INI landscape area.

Step 2: Identify Long Term Achievable Outdoor Water Use Efficiency by Applying Principles of MWELO to Urban Retail Water Supplier ETF Data and Other Related Analyses

DWR used three approaches to develop a provisional outdoor standard: (1) calculated average ETF for urban retail water suppliers with ETF values within the range of MWELO's evapotranspiration factor (ETAF) values; (2) adjusted ETF values of the 249 subset of urban retail water suppliers so that they are within MWELO's ETAF guidelines and then calculated an average ETF; and (3) used horticultural and irrigation sciences to calculate statewide average ETF from plant factors published in scientific journals, with an irrigation efficiency of 80 percent derived from MWELO's guidelines. DWR also calculated an average ETF using age distributions of housing stocks and the corresponding MWELO ETAFs to inform the decision-making process, but this was not used in the calculation of the initial ORWUS proposal. These approaches are discussed below in details.

MWELO's design guidelines allow landscape designers to choose from plant palettes that range from very low water using plants to high water using plants or special landscapes. The assumption that urban retail water suppliers with ETF estimates between 0.1 to 1.0 are consistent with MWELO principles, allows for estimation of a statewide average ETF against which a proposed outdoor standard can be compared for reasonableness. In other words, average statewide ETF under this approach is developed using data only from those urban retail water suppliers whose ETF falls within the 0.1-1.0 range.

A problem with this trimming approach is that water used by urban retail water suppliers that fall outside of the ETF range of 0.1-1.0 are entirely excluded from the statewide mean estimation. However, it can be argued that only their out-of-range use should be excluded, not their entire outdoor use. This can be remedied by replacing estimated ETFs that fall below 0.1, with 0.1; and those that exceed 1.0, with 1.0, respectively. This way, only the portion of outdoor use that falls outside the bound of MWELO-consistent use is removed but not the portion that is potentially consistent with MWELO.

Another theoretical analysis of achievable outdoor water use efficiency relied on landscape area measurements from 168 urban retail water suppliers (which were representative of all urban retail water suppliers), where these data were developed with additional granularity for validation purposes. Two broad categories of land cover types were identified: canopied and non-canopied. Canopy in this context is defined as the landscape feature that casts a shadow on the ground surface, such as trees, shrubs, and vegetation that are not turf or low-lying vegetation. The non-canopied areas include mostly cool season and warm season turf.

Key Findings from Step 2

1. Average statewide ETF during the 2017 to 2019 period works out to 0.62 using the first, trimming approach, and 0.70 using the second, top- and bottom-coding approach.

2. Using average plant factors from the American Society of Agricultural and Biological Engineering Standard 623 (ASABE S623) with irrigation efficiency of 0.80, average ETF for this horticultural and irrigation science approach was estimated to be 0.76.

3. Additional analyses, unrelated to urban retail water supplier-level ETFs, were also undertaken to evaluate the ORWUS's consistency with MWELO principles. The distribution of housing stock by its age provides one way to evaluate a statewide ETAF based on MWELO standards in effect at the time a housing unit was constructed. The housing age bands used in this analysis are pre-1992 (no ETAF but assumed 0.80 per 2015 amendment to MWELO for existing landscapes), 1993 to 2009 (ETAF of 0.80), 2010 to 2015 (ETAF of 0.70), 2015 to 2020 (ETAF of 0.55), and 2021 to 2030 (ETAF of 0.55). The statewide average ETAF for current (through 2020) and projected (through 2030) housing stocks are calculated to be 0.79 and 0.77, respectively. These theoretical averages only are indicative of design efficiencies possible should all landscapes be installed and maintained according to MWELO's principles.

4. Based on empirical and theoretical findings described above, DWR initially proposed a provisional ORWUS of 0.70.

Step 3: Incorporate Stakeholder Feedback About Implementation Feasibility

In response to this proposal, stakeholders offered two critiques. Some stakeholders expressed concerns that an outdoor standard of 0.70 renders cost-effective implementation infeasible because urban retail water suppliers lack authority to force residential customers, most of whom live in homes predating MWELO design criteria, to cut back their water use or make significant alterations to their landscapes. They also argued that the irrigation efficiency of 0.80 that DWR used in the horticultural and irrigation-sciences method for the derivation of the outdoor standard is too high and does not reflect actual field conditions.

Other stakeholders recommended the outdoor water use standard ramp down over time, placing implementation on a more realistic "glide path" without losing sight of the long-term imperative to continue to conserve. They argued that the State is experiencing more frequent and severe drought conditions and reduced runoff than ever before due to climate change, hence the need for more stringent long-term ORWUS.

Key Decision Made in Step 3

In response to this feedback, DWR revised its provisional recommendation to include a phase-in approach with ORWUS of 0.80 between 2023 and 2029, ramping it down to 0.65 in 2030 and beyond. DWR also recommends an ORWUS of 0.55, or MWELO's ETAF value as amended, for all new landscapes installed after 2018 (the year of imagery processed in the LAM project) to stay consistent with post-2015 MWELO guidelines.

Step 4: Incorporate Additional Stakeholder Feedback and Climate Resiliency

The final stakeholder meeting was held on January 25, 2022. At that meeting, the stakeholders were asked to submit by February 8, 2022, written comments on the proposed phase-in approach and the draft recommendation. DWR received and thoroughly reviewed the written stakeholder comments.

Key Decision Made in Step 4

Taking into consideration DWR's legislative mandate and the imperative to achieve reasonably greater long-term water use efficiency for climate resilience, DWR recommends an ORWUS of 0.8 for 2023, and 0.63 for 2030 and beyond. For new landscapes installed after the year the LAM imagery was obtained, DWR recommends an ORWUS of 0.55, or MWELO's ETAF value as amended, to stay consistent with post-2015 MWELO guidelines.

Senate Bill X7-7 Legislative Test

Efficient indoor residential water use and EORWU constitute two of the most important components of an urban retail water supplier's urban water use objective (UWUO). The 2018 Legislation requires that long-term efficiency standards be set in a way such that water conservation in the future exceeds what would have occurred under the SB X7-7 approach.

Even though final standards that DWR is recommending in response to the 2018 Legislation have yet to undergo the State Water Board's rulemaking process, and the indoor residential standards currently in the WC may be revised downward by the Legislature based on the new indoor standards recommended by DWR and the State Water Board, it is necessary to assess whether DWR's recommended ORWUS is likely to be on track to meet the SB X7-7 legislative test. The test requirement is stated as follows (WC Section 10609.2(d)):

> *The long-term standards shall be set at a level designed so that the water use objectives, together with other demands excluded from the long-term standards such as CII* [commercial, industrial, and institutional] *indoor water use and CII outdoor water use not connected to a dedicated*

> *landscape meter, would exceed the statewide conservation targets required pursuant to Chapter 3 (commencing with Section 10608.16).*

DWR determined statewide SB X7-7 baseline water use to be 199 gallons per capita per day (gpcd) and the 2020 statewide target (80 percent of baseline) to be 159 gpcd.[3] The SB X7-7 legislative test amounts to demonstrating that a statewide aggregation of an urban retail water supplier's UWUO and other demands excluded from long-term standards remain below 159 gpcd. Urban retail water supplier-level UWUO and other demands are estimated from the sum of the following components:

- Efficient indoor residential use.
- Efficient outdoor residential use.
- Efficient real water loss.
- Current commercial, industrial, and institutional dedicated irrigation meter (CII-DIM) use.
- CII and other miscellaneous use.
- Authorized unbilled use.
- Apparent water loss.

Variances remain unaccounted for in this legislative test. These cannot be incorporated until final standards are adopted and urban retail water suppliers begin requesting variances in response.

Since final standards for efficient indoor and outdoor residential use and efficient real water loss are yet to be adopted, DWR evaluated two alternative sets of provisional standards with and without the potable reuse bonus incentive. These sets differ only in terms of the indoor residential standards. In all other respects, they are identical. The first set uses the indoor residential standards that are in the WC. These are 55 gpcd until 2025, 52.5 gpcd from 2025 to 2029, and 50 gpcd from 2030 onward. The second set uses the indoor residential standards recommended by DWR and the State Water Board in their report to the Legislature on IRWU. These are 55 gpcd until 2025, 47 gpcd from 2025 to 2029, and 42 gpcd from 2030 onward.

[3] Page 3-3 of DWR and State Water Board, 2018.

The evaluated outdoor residential standard is 0.80 until 2029, after which time the standard steps down to 0.63.[4] The standard is applied to 100 percent of II plus 20 percent of INI residential landscape area. The 20 percent INI buffer may change based on the outcome of further studies and investigations to be conducted jointly by DWR and the State Water Board (see Section 5.4). The outdoor standard is multiplied by net reference evapotranspiration and irrigable landscape area to produce efficient outdoor water use. Net reference evapotranspiration is equal to reference evapotranspiration minus effective precipitation (ETo - Peff). Effective precipitation is capped at 25 percent of annual rainfall.

The evaluated Water Loss Standard (WLS) is set to the draft standard for real water loss posted on the State Water Board's website.[5] If an urban retail water supplier's baseline real water loss is less than 16 gallons per connection per day, it is assumed that they will pursue the State Water Board's proposed alternative compliance pathway. This sets the urban retail water supplier's WLS at 16 gallons per connection per day, provided the urban retail water supplier maintains real water loss at or below this level and satisfies several reporting requirements. The WLS takes effect January 1, 2028.[6] Prior to this date, urban retail water suppliers' UWUOs are calculated using their baseline water loss.

The other demands excluded from long-term efficiency standards are taken either from the eAR data (average of 2017 to 2019 data) or from Urban Water Management Plans.

All the evaluated scenarios meet the SB X7-7 legislative test by a significant margin, suggesting that DWR's recommended ORWUS will likely meet this requirement in the future when a full accounting, including variances, becomes feasible.

Distributional Impacts of Efficiency Standards

Residential per-capita water use varies significantly across urban retail water suppliers. Several analyses were undertaken to evaluate the gap between current water use and water use objectives to evaluate the differential impacts of long-term efficiency standards on urban retail water suppliers. Under the most aggressive 2030 IRWU Standard of 42 gpcd, these analyses indicate that roughly 70 to 80 urban retail water

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[4] The provisional standard for new residential landscape is 55 percent of net reference evapotranspiration. However, the legislative test is based only on existing residential landscape area and, thus, the provisional standard for new landscape area does not factor into it.

[5] https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/docs/standards-to-release.xlsx

[6] The deadline may be extended to January 1, 2031, for disadvantaged community (DAC)-designated urban retail water suppliers meeting certain conditions. Additionally, urban retail water suppliers with standards that require at least a 30 percent reduction from baseline real loss may be eligible for the same deadline extension, provided they demonstrate progress in lowering their water losses and satisfy other reporting and verification requirements.

suppliers (or 18 to 20 percent of the 398 urban retail water suppliers) may have to reduce their demands subject to efficiency standards by more than 30 percent of their water use objective over the next 10 years. The average exceedance for these urban retail water suppliers is greater than 50 percent, which raises the question of whether such large reductions would be technically or economically feasible. At the other end of the spectrum, 125 to 138 urban retail water suppliers (31 to 35 percent of the 398 urban retail water suppliers) would have UWUOs that exceed their current water use and, thus, would likely have no reduction requirements.[7] The remainder of the urban retail water suppliers (roughly 48 percent of the 398 urban retail water suppliers) fall between these two extremes. Whether intended or not, the standards will result in widely varying reduction requirements for urban retail water suppliers, which may raise questions of both feasibility and fairness.

California Department of Water Resources' Recommended ORWUS

In summary, DWR evaluated several factors while developing its ORWUS recommendation for adoption by the State Water Board. These include:

- Urban retail water suppliers' current ORWU patterns.
- Efficiency guidelines codified in MWELO.
- SB X7-7 legislative test.
- Balancing long-term outdoor water use efficiency with equity across urban retail water suppliers.
- Implementation feasibility, stakeholder views, and acceptance.
- Distributional impacts of long-term efficiency standards.

Based on these considerations, DWR recommends an ORWUS that includes the following requirements and specifications:

1. **Phase-In Approach**. For existing residential landscapes (homes built before the imagery that was used in the LAM project was taken), start with an ORWUS of 0.80 in 2023, and transition to a lower ORWUS of 0.63 in 2030 and beyond. This phase-in refinement is meant to reduce the impact that the stakeholders anticipated from a fixed provisional ORWUS of 0.70 that DWR initially proposed, which could be significant for some urban retail water suppliers in the early

[7] The latter group also includes a small group of eight urban retail water suppliers that do not seem to be on track to meet their 2020 targets under SB X7-7 at the time that the 2017 to 2019 data was analyzed.

compliance years, allowing for a more realistic implementation glide path without compromising on long-term water conservation goals.

2. **New Residential Construction**. New residential construction's efficient outdoor water use should use an ORWUS of 0.55, or MWELO's ETAF value as amended, to stay consistent with MWELO's guidelines. New residential construction refers to landscapes installed after the year of imagery processed in the LAM project (2018 for most urban retail water suppliers).

3. **Special Landscape Areas in Residential Parcels**. Many urban retail water suppliers have Special Landscape Areas (SLA) in residential parcels. Urban retail water suppliers need to report their residential SLAs with CII-DIMs and subtract the SLA from the aggregate II landscape area estimates provided by DWR to avoid double counting. When applied with the CII-DIM, an outdoor water use standard for SLAs will be 1.0. If an urban retail water supplier chooses to include the residential SLAs in the ORWU report for internal record keeping purposes or other issues, however, the current ORWUS standard (0.80 in 2023 to 2029, and 0.63 in 2030 and thereafter) shall be used to calculate efficient outdoor water use for SLA.

4. **Include 20 Percent of INI and All of II Landscape Area**. For calculating EORWU, urban retail water suppliers should apply ORWUS to the sum of II and 20 percent of INI landscape areas, with the former adjusted for residential SLAs evaluated according to the methodology in the Commercial, Industrial, and Institutional Outdoor Irrigation of Landscape Areas with Dedicated Irrigation Meters Water Use Efficiency Standard. The 20 percent INI buffer may change based on the outcome of further studies and investigations to be conducted jointly by DWR and the State Water Board (see Section 5.4).

5. **Capping the Severity of Demand Reductions Required by the UWUO, Variances, and Bonus Incentive**. DWR recommends to the State Water Board that it consider placing a cap for a limited time on how large a reduction urban retail water suppliers should be expected to make per year, in case their actual water use that is subject to efficiency standards exceeds their UWUO plus variances and bonus incentive.

6. **Compliance with 2020 SB X7-7 Targets**. Most urban retail water suppliers are on track to comply with their SB X7-7 targets based on the 2017 to 2019 data that was analyzed. They must maintain their water use below these targets in the future as the State transitions to efficiency-standard based UWUOs. Urban retail water suppliers that are not on track to meeting their 2020 SB X7-7 targets must come into compliance with these targets as well as their water use objective. DWR recommends that for urban retail water suppliers whose calculated

UWUOs exceed their 2020 targets, the State Water Board adjust components of their UWUOs to prevent backsliding from their 2020 targets.

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1.0 Introduction

1.1 Legislative Directives

In 2018, the California State Legislature (Legislature) enacted two policy bills (Senate Bill [SB] 606 [Hertzberg] and Assembly Bill [AB] 1668 [Friedman], as amended; hereinafter referred to as the "2018 Legislation") to establish a new foundation for long-term improvements in water conservation and drought planning to adapt to climate change and the resulting longer and more intense droughts in the State of California (State) (DWR and State Water Board, 2018). These two bills amend existing law to provide expanded and new authorities and requirements to enable permanent changes and actions for those purposes, improving the State's water future for generations to come. SB 606 and AB 1668 are direct outcomes of Governor Edmund G. Brown Jr.'s Executive Order B-37-16 issued in May 2016. The recommendations in the April 2017 report, *Making Water Conservation a California Way of Life, Implementing Executive Order B-37-16* (2017 Framework), and subsequent extensive legislative outreach efforts informed the development of SB 606 and AB 1668.

According to the 2018 Legislation, an urban retail water supplier's ***urban water use objective (UWUO) is composed of the following***:

1. Aggregate estimated efficient indoor residential water use (EIRWU).
2. Aggregate estimated efficient outdoor residential water use (EORWU).
3. Aggregate estimated efficient outdoor irrigation of landscape areas with dedicated irrigation meters (or equivalent technologies) in connection with commercial, industrial, and institutional (CII) water use.
4. Aggregate estimated efficient water loss.
5. Aggregate estimated water use in accordance with variances, as appropriate.

Additionally, an urban retail water supplier that delivers water from a groundwater basin, reservoir, or other source that is augmented by potable reuse may adjust its UWUO by a bonus incentive based on the volume of its potable reuse delivered to residential water users and to landscape areas with dedicated irrigation meters in connection with CII water use. The bonus incentive is limited to 15 percent of the urban retail water supplier's UWUO when the potable reuse water comes from a facility that has a certified Environmental Impact Report, mitigated negative declaration, or negative declaration on or before January 1, 2019, began producing and delivering water on or before January 1, 2022, and uses microfiltration and reverse osmosis technologies. The bonus incentive is limited to 10 percent of the urban retail water supplier's UWUO when the potable reuse water comes from a facility not meeting these conditions.

This report describes all the analyses undertaken to develop the Outdoor Residential Water Use Efficiency Standard (ORWUS) consistent with elements added to the WC by abovementioned 2018 Legislation. The relevant elements are:

> *The department, in coordination with the board, shall conduct necessary studies and investigations and recommend, no later than October 1, 2021, standards for outdoor residential use for adoption by the board in accordance with this chapter* (WC Section 10609.6(a)(1))*.*
>
> *The standards shall incorporate the principles of the model water efficient landscape ordinance adopted by the department pursuant to the Water Conservation in Landscaping Act* (WC Section 10609.6(2)(A))*.*
>
> *The standards shall apply to irrigable lands* (WC Section 10609.6(2)(B)).
>
> *For purposes of Sections 10609.6 and 10609.8, "principles of the model water efficient landscape ordinance" means those provisions of the model water efficient landscape ordinance applicable to the establishment or determination of the amount of water necessary to efficiently irrigate both new and existing landscapes. These provisions include, but are not limited to, all of the following* (WC Section 10609.9*):*
>
> > *(a) Evapotranspiration factors, as applicable.*
> >
> > *(b) Landscape area.*
> >
> > *(c) Maximum applied water allowance.*
> >
> > *(d) Reference evapotranspiration.*
> >
> > *(e) Special landscape areas, including provisions governing evapotranspiration factors for different types of water used for irrigating the landscape.*
>
> *Incorporating precipitation data and climate data into estimates of a urban retail water supplier's outdoor irrigation budget for its urban water use objective (WC Section 10609.16(d)).*

2.0 Scope

2.1 Analytical Approach in Setting the Outdoor Residential Water Use Efficiency Standard

The Model Water Efficient Landscape Ordinance (MWELO), first adopted in 1993 and updated several times, most recently in 2015, was designed to raise outdoor water use efficiency in new and rehabilitated landscapes by promoting more efficient irrigation systems, graywater usage, onsite stormwater capture, and limiting the portion of landscape that can be covered with turf (EO B-29-15), and by promoting landscape designs that zone together plant species with similar irrigation needs to improve irrigation efficiency. With the latest 2015 amendment, existing landscapes have also been brought under MWELO's purview, requiring urban retail water suppliers to undertake programs to eliminate irrigation runoff from existing landscapes under 1 acre, including establishing and monitoring water budgets not to exceed 80 percent of reference evapotranspiration (ETo) for metered landscapes over 1 acre, or implementing irrigation surveys and audits to identify and eliminate water waste in landscapes greater than 1 acre without individual meters.

Although MWELO applies at a parcel level, its conceptual framework can be extended to the urban retail water supplier level to assess and quantify an ORWUS.

To be MWELO-compliant a parcel's theoretical irrigation requirement must remain below the maximum applied water allowance (MAWA), which is defined as follows:

$$MAWA = (ETo - Peff) \times (0.62) \times ETAF \times LA \quad \text{(Eq. 1)}$$

where,

- MAWA is the maximum applied water allowance at a parcel level in gallons.
- ETo is the reference evapotranspiration in inches.
- Peff is the effective precipitation in inches.
- 0.62 is a unit conversion factor.
- ETAF is the evapotranspiration factor in the MWELO design standard (on parcel level).
- LA is the parcel landscape area in square feet.

Parcel level ETAF is codified in MWELO and has undergone several iterations over time. For new or rehabilitated residential landscapes, ETAF was 0.80 between 1993 and 2009, 0.70 between 2010 and 2015, and 0.55 thereafter. A landscape architect's challenge is to design a landscape using an appropriate mix of plant species such that expected theoretical irrigation remains below MAWA. For new and rehabilitated landscapes, the lowering of ETAF over time has encouraged more efficient irrigation systems and greater use of climate-appropriate plant species.

The ETAF for Special Landscape Areas (SLA) can be higher, up to 1.0. SLAs are defined in MWELO as areas of landscape dedicated solely to edible plants, recreational areas, areas irrigated with recycled water, or water features using recycled water. The same definition is used for SLAs in the current outdoor water use efficiency development process. Most SLAs exist in CII settings and are covered by Commercial, Industrial, and Institutional Outdoor Irrigation of Landscape Areas with Dedicated Irrigation Meters Water Use Efficiency Standard (CII-DIMWUS). There are, however, some SLAs in residential settings. Examples of SLAs in residential settings include common areas in homeowner associations, areas dedicated to edible plants, and other areas that are on dedicated irrigation meters (DIM). SLAs were not identified in the residential landscape area measurement (LAM) data that DWR provided to urban retail water suppliers due to lack of sufficient input data. Therefore, urban retail water suppliers need to identify and quantify their respective residential SLAs.

The 2015 amendment to MWELO sets the ETAF for existing landscapes at 0.80, a goal expected to be met through urban retail water supplier programs such as water budgets, irrigation surveys and audits, irrigation runoff prevention, all designed to raise outdoor water use efficiency over time.

The framework for parcel-level MAWA can be extended to an urban retail water supplier level as follows:

$$ORWU = (ETo - Peff) \times (0.62) \times (ETF) \times (LAs) \quad \text{(Eq. 2)}$$

where,

- ORWU is the urban retail water supplier's outdoor residential water use in gallons.
- ETo is the reference evapotranspiration in inches.
- Peff is the effective precipitation in inches.
- 0.62 is a unit conversion factor.
- ETF is the evapotranspiration factor (on urban retail water supplier level).

- LAs are the residential landscape areas within an urban retail water supplier's service area in square feet.

Rearranging terms in Eq. 2, ETF can be back calculated at the urban retail water supplier level as follows:

ETF = ORWU ÷ ((ETo - Peff) x 0.62 x LAs)..(Eq. 3)

The purpose of Equation 3 is to estimate urban retail water supplier-level ETFs, assess the level and causes of variation in these ETF values, and select a threshold from the distribution of ETFs to serve as the ORWUS that results in EORWU. Although the units in Equation 3 cancel each other giving the appearance that ORWUS is unitless, it actually represents gallons of water needed to irrigate a square foot of landscape area per inch of net reference evapotranspiration (ETo - Peff).

Treating the distribution of ETFs as the foundation for the ORWUS is to provide for any variation in outdoor water demand caused by variation in landscape area or weather in an urban retail water supplier's service area. Remaining variation in ETFs across urban retail water suppliers reflects the combined effect of factors other than landscape area and weather on ORWU. Such factors may include, but are not limited to, retail water costs, household income levels, and community norms and preferences for residential landscapes.

2.2 Methodological Challenges

DWR initiated a project for LAM to provide irrigable landscape area to urban retail water suppliers as directed by the 2018 Legislation. It also manages the California Irrigation Management Information System (CIMIS) for calculating ETo and has the California Simulation of Evapotranspiration of Applied Water (Cal-SIMETAW) model for estimating effective precipitation at the urban retail water supplier level. These are critical inputs for estimating urban retail water supplier-level ETFs. Estimation of residential outdoor water use at the urban retail water supplier level, however, remains a challenge.

Urban retail water suppliers report water consumption data (electronic annual report, eAR) to the State Water Resources Control Board (State Water Board) with varying levels of accuracy. For a variety of reasons, listed below, inferring residential outdoor water use at an urban retail water supplier-level from these data requires considerable care:

- Single-family and multifamily definitions are not uniform across urban retail water suppliers. Some urban retail water suppliers group multifamily customers along with their commercial customers.

- Not all residential customers are metered. Although a rapidly diminishing problem in the State, it is nonetheless still a problem in a handful of urban retail water suppliers.

- Even when total residential water use is captured with high levels of accuracy, no urban retail water supplier reports residential water use separated into indoor and outdoor categories. Residential outdoor water use must be analytically inferred requiring reliable estimates of per-capita residential indoor use as well as good estimates of the residential population. The *Results of the Indoor Residential Water Use Study* (DWR, 2021), recently completed by DWR, yields urban retail water supplier‑specific estimates of per-capita residential indoor use.

- Service area population estimates may overstate the residential population when group quarters settings are significantly represented in a service area (e.g., prisons, colleges and universities, military bases, or nursing homes). Water used indoors by people residing in these group quarters settings is generally captured by meters classified as institutional accounts, not residential. Seasonal population, not captured by the census, can also create a mismatch between a service area’s official and actual population counts.

While the details are covered in later sections, to overcome the abovementioned problems, the analytic framework followed here includes the following key steps:

1. Urban retail water suppliers with missing multifamily data are screened out of the analysis dataset.

2. Reported water use is adjusted for unmetered accounts.

3. Population estimates are adjusted for group quarter population using U.S. Census Bureau data.

4. Per-capita residential indoor water use estimates are developed using the methodology developed in DWR's indoor water use study (DWR, 2021).

Because of data exclusions, only a subset of 249 urban retail water suppliers (that are required to submit an Urban Water Management Plan [UWMP] to DWR) were used for evaluating the ORWUS. This subset represents roughly 76 percent of the State’s total UWMP-supplier population. Extensive analyses were undertaken to test for the climatic representativeness of this subset of urban retail water suppliers with respect to the full set of UWMP suppliers.

2.3 Data and Workflow Overview

Figure 2-1 provides an overview of the analytic framework followed in this study. Additional details are covered in subsequent chapters.

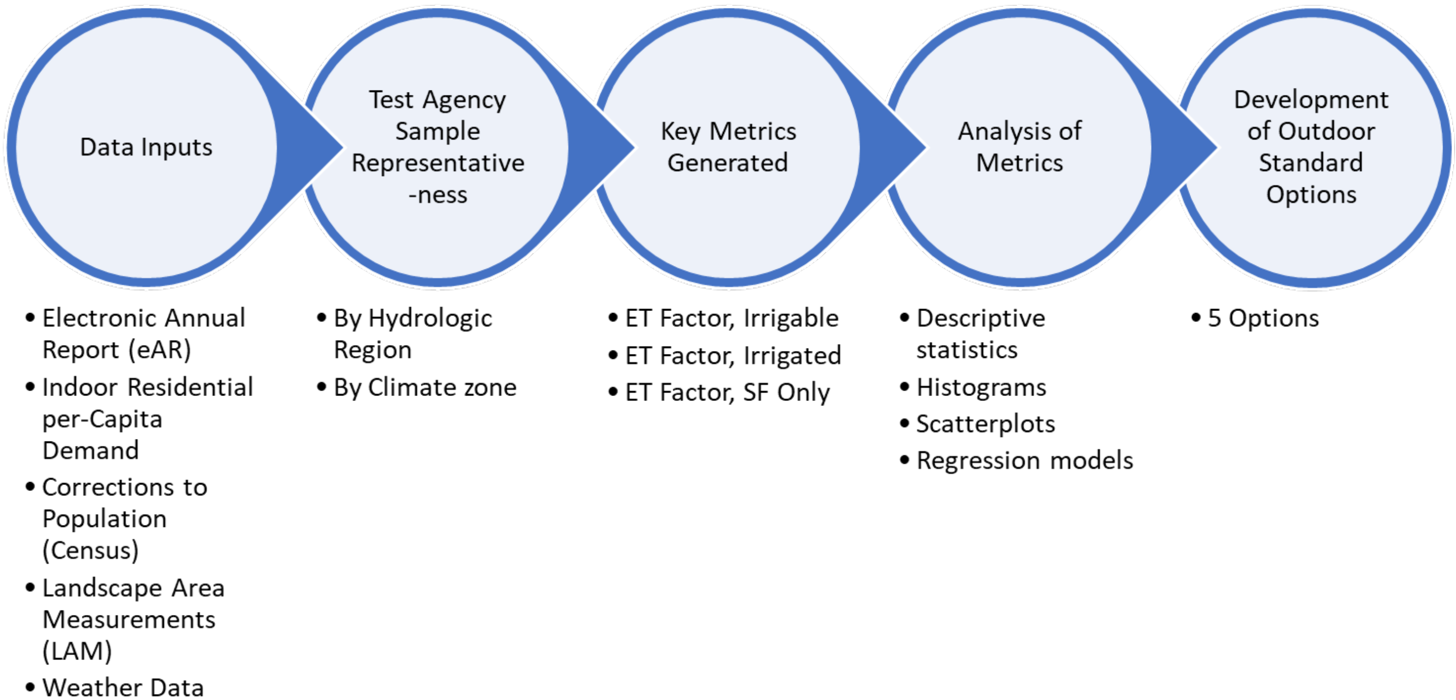

Figure 2-1 Data and Workflow Overview

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3.0 Key Data Inputs

3.1 Electronic Annual Report

Urban retail water suppliers submit annual reports to the State Water Board using an electronic portal. These reports contain detailed information about many aspects of utility operations, such as production, consumption, population, connections, and water rates. For the analyses undertaken here, consumption data by customer class, number of metered and unmetered connections by customer class, and service area population are particularly relevant. These data were obtained for calendar years 2017 to 2019 for all public water systems (PWS). An urban retail water supplier's service area may consist of multiple PWSs. Data were first screened at the PWS level, then aggregated to reflect an urban retail water supplier's service area because regulatory compliance with UWUO is required of urban retail water suppliers.

Data Acceptance Criteria

A PWS was considered acceptable for inclusion in the analyses if its eAR data exhibited the following properties:

1. Water delivery data were reported for both single-family and multifamily customer classes for all three years.

2. The water delivery data were free of extreme values or large year-over-year changes, often a result of data errors such as misstatement in the units associated with these data. Several such instances could be resolved through manual examination of the data; where they could not be resolved, the PWS was excluded.

3. Seasonal patterns exhibited by residential per-capita water use within the reporting year were free of unusual peaks and troughs.

Of the above three criteria, the first removed those PWSs where multifamily is not reported as a separate customer class. This was treated as evidence of multifamily customers being captured in another class, such as, commercial, although in a handful of cases a PWS's service area may truly not have any multifamily housing. Nonetheless, out of an abundance of caution and to ensure that residential water use remains properly aligned with residential landscape area, missing multifamily data was treated as a strong reason for exclusion.

At the time of aggregation of PWS data to the level of an urban retail water supplier, additional criteria were applied, namely that clean data should be available for all PWSs in an urban retail water supplier's service area for all three years.

In a few cases where detailed customer level data had been provided to DWR’s indoor water use study team, or an urban retail water supplier showed willingness to crosscheck eAR data with their own records, data directly obtained from the urban retail water supplier were substituted in place of problematic data identified in the eAR.

3.2 Indoor Residential Per-Capita Water Demand

To estimate the outdoor water use from total residential water use (from eAR), it is necessary to estimate indoor water use. This is estimated as the product of per-capita indoor residential demand and total residential population. The former was developed using the methodology in DWR's *Results of the Indoor Residential Water Use* Study (DWR, 2021); the latter is covered in the next section.

Only a brief overview about how the indoor residential water use study's results have been incorporated in the outdoor standard analyses is covered here. For detailed technical methods and findings see *Results of the Indoor Residential Water Use* Study (DWR, 2021).

The indoor water use study development process followed two broad tracks for estimating per-capita indoor residential use. Under the first track, 18 geographically dispersed urban retail water suppliers located throughout the State were recruited for the study. A detailed statistical-modeling analysis was undertaken, using billing histories of all residential customers in these 18 urban retail water suppliers to estimate per-capita indoor residential use. The statistical modeling techniques isolated indoor use from total billed use. These techniques generate two sets of estimates: (1) average estimates of per-capita indoor use for each of the 18 participating urban retail water suppliers; and (2) average estimates of per-capita indoor use by census tracts located in their service areas. Each residential customer’s account was geocoded to a census tract as part of the research effort. Working with 18 urban retail water suppliers resulted in per-capita IRWU estimates for roughly 450 census tracts with diverse housing, demographic, and economic characteristics. During the design phase of the study, DWR overlaid urban retail water supplier boundaries on a census tract map to link census tracts to urban retail water suppliers. Tract housing demographic and economic characteristics were also obtained from the census. With this information, it was possible to identify and select 18 urban retail water suppliers that would, by design, capture a diverse mix of census tracts and be geographically dispersed.

Next, a tract-level regression model was estimated to explain the variation in per-capita IRWU, with the tract’s housing, demographic and economic characteristics serving as the explanatory variables. The resulting regression model was used to predict per-capita indoor residential use for the remaining census tracts in the State. Finally, tract-level estimates were rolled up to the urban retail water supplier−level since linkage between tracts and urban retail water suppliers was known. This approach generated estimates of per-capita indoor residential use for almost all urban retail water suppliers.

Apart from the census tract approach, a second approach using aggregate customer data sourced from the eAR was also used to estimate per-capita IRWU. Under this approach minimum-month residential usage is down-corrected for winter irrigation, which is estimated by bringing in information about the maximum-to-minimum peak observed in the case of dedicated irrigation accounts. This aggregate method works only for urban retail water suppliers that report consumption data for dedicated irrigation accounts. Because of this limitation and other data issues, this method yielded estimates of indoor use only for 157 urban retail water suppliers.

For the outdoor standard evaluation, indoor use estimates based on an urban retail water supplier's own data were favored over alternative estimates produced by other methods. For example, for the 18 participating urban retail water suppliers where indoor estimates are based on bill history analysis of all of their residential customers, these estimates are favored over the aggregate eAR-data based estimates. For the 157 urban retail water suppliers, excluding the 18 participants in the indoor water use study (DWR, 2021), the aggregate eAR-data based estimates are favored over the census tract-based rolled up estimates, with the latter being used only for the remainder set of urban retail water suppliers.

3.3 Corrections to Population Data

Population data for single-family and multifamily housing units versus group quarters settings are available from the U.S. Census Bureau. These data were obtained at the census tract level, and then rolled up to the urban retail water supplier level using information about the linkage between tracts and urban retail water suppliers. For tracts split across urban retail water supplier boundaries, the share of a tract's geographic area that fell within an urban retail water supplier's service area was used to apportion the population estimates to respective urban retail water suppliers.

The U.S. Census Bureau data were used to estimate the fraction of total population that resides in group quarters settings, and this fraction was subtracted from the population reported by urban retail water suppliers in the eAR. In other words, the eAR remains the source of population information, albeit with corrections applied to it. In a handful of cases, urban retail water suppliers noted in the data they provide to the eAR that their reported data excludes group quarters population. Where such notes were found, a group quarters population correction was not applied.

These corrections are negligible for most urban retail water suppliers. Only in service areas with large prisons or universities is this correction appreciable.

Another application of the U.S. Census Bureau population data was to split the group quarters corrected eAR population into single-family and multifamily components based on the single-family share of residential population derived from the census. These separated data are used later in Section 5.3 to conduct sensitivity analyses.

3.4 Corrections for Unmetered Connections

The practice of billing for water without metering usage (flat monthly rates) is rapidly dwindling in the State. Nonetheless, even as late as the 2017 to 2019 period, some unmetered residential connections could be found in the service areas of a handful of urban retail water suppliers. This potentially creates a problem because unmetered residential connections' water usage remains unaccounted for.

A simple correction was applied to reported water use in the eAR data to capture water used by unmetered connections. It was assumed that unmetered connections use 20 percent more water than metered connections based on prior research that indicates conversion of flat-rate accounts to metered accounts causes usage to fall roughly by that amount (Tanverakul and Lee, 2015). Since the eAR provides data about both the number of metered and unmetered connections, it is straightforward to estimate usage per metered connection and from this to calculate the amount of water to add back to reported usage to capture the impact of unmetered connections. These corrections were developed and applied separately for single-family and multifamily unmetered connections.

3.5 Landscape Area Measurement

Residential landscape area estimates are obtained from DWR's LAM project. Only a brief overview is provided here as the LAM project's methodology has been extensively discussed and documented (see *Landscape Area Measurements Final Project, Report EA-133C-16-CQ-0044* [WUES-DWR-2021-02.T1]).

The 2018 Legislation requires that DWR provide each urban retail water supplier with data regarding the area of residential irrigable lands in a manner that can reasonably be applied to the standards. However, the 2018 Legislation did not define the meaning of irrigable landscape area. Most academic literature treats irrigable landscape area as the difference between total parcel area and impervious area. This interpretation mostly reflects practical constraints surrounding estimation of irrigable area instead of a meaningful definition of the concept. DWR and the LAM project contractor, Quantum Spatial, Inc., went beyond the above simplified definition and instead classified the landscape into three classes using the object-based classification system of high-resolution (pixel size equals 1x1 foot) aerial imagery. Each object (feature) in a parcel is assigned to a predetermined class using an imputation model and aggregated into the three irrigation classes for each urban retail water supplier. The three classes are irrigable-irrigated (II), irrigable-not irrigated (INI) and not irrigable (NI). The sum of II and INI classes generates a measure of total irrigable landscape area as called out by the 2018 Legislation. However, total irrigable area is not what DWR is recommending be used for calculating efficient outdoor use. Instead, total irrigable area should be adjusted to account for the proportion of INI that would have received irrigation during the year (see Section 5.4). Table 3-1 shows key summary statistics for the three-class measurements obtained from the LAM project.

Table 3-1 Landscape Area Measurement Project: Key Summary Statistics

Metric (Averaged Across Urban Retail Water Suppliers)‡	Average Per Urban Retail Water Supplier
Total Irrigable-Irrigated (II) Area in Acres	1361.9
Total Irrigable-Not Irrigated (INI) Area in Acres	700.9
Total Not Irrigable Area (NI) in Acres	4479.1
Total Residential Parcel Area (II + INI + NI)	6541.9
Proportion of Total Residential Parcel Area Estimated to be Irrigable	31.5 percent
Proportion of Total Irrigable Area Estimated to be Irrigated [II / (II + INI)]	66.0 percent

Note:
‡ Averaged across 395 urban retail water suppliers; data for three urban retail water suppliers under review.

- Irrigable-Irrigated. The II class represents landscape areas of healthy vegetation where the vegetation appears to be in growth, not senesced, and is foliated. The area is presumed to be maintained and managed through active irrigation, comprising irrigated hydro-zones.

- Irrigable-Not Irrigated. The INI class represents areas of planted and previously maintained vegetation that appears water stressed (brown or leafless plants). These are areas that likely were not irrigated when the imagery was taken, but possibly were irrigated in the past, and may be irrigated again during the year after the imagery was taken.

- Not Irrigable. The NI class represents native or undeveloped areas within, or adjacent to, a developed lot that shows no signs of active or previous irrigation, are not adjacent to irrigated vegetation, and are generally not located adjacent to structures. Impervious, solid, or compacted materials are 'not irrigable' because they cannot directly support growing vegetation or hold water.

An extra work product that was generated through the LAM for the outdoor standard evaluation includes estimates of single-family landscape area using county assessor codes for identification of single-family parcels. This is used to perform sensitivity analyses by comparing urban retail water supplier‑level ETF distributions for the single-family sector to that for the total residential sector (Section 5.3).

The LAM project yields several other data outputs that were not used in the development of the ORWUS but may be of assistance to urban retail water suppliers wishing to adjust their estimate of efficient outdoor water use or to apply for a variance. These include estimates of urban agricultural lands, undeveloped lands, horse corrals, and artificial turf. More details on LAM products that could be used in variances are presented in the *Recommendations for Guidelines and Methodologies for Calculating Urban Water Use Objective* (WUES-DWR-2021-01B) and *Summary of Recommendations for Variances* (WUES-DWR-2021-04).

The following LAM products are excluded from the classification provided to urban retail water suppliers for various reasons. Urban retail water suppliers can request adjustments if they believe that the excluded products have a material effect on their water use objective.

- Parkway strips are not classified because they are outside of residential parcel boundaries. The LAM model works only inside the parcel polygon. Urban retail water suppliers can request for an adjustment for parkway strips before they submit their water use objective reports to DWR. DWR will provide guidelines by December 2022 on how urban retail water suppliers can quantify and incorporate their estimates of parkway strips into their irrigable landscape areas.

- Vacant parcels were excluded because DWR's investigation revealed that most of them are truly vacant. Urban retail water suppliers can request an adjustment in their irrigable landscape area if vacant parcels are reoccupied.

- Disputed parcels are parcels that are claimed by two or more adjacent urban retail water suppliers. They were excluded because DWR needs to establish who supplies water to these parcels. Most urban retail water suppliers have addressed this issue, but a few still need to resolve the disputed-parcel issue. Adjacent urban retail water suppliers must work together to resolve the disputed parcels and contact DWR to make necessary adjustments.

- Pools, spas, and other small water features are already classified as II and no further actions are needed by urban retail water suppliers.

If there are significant changes in irrigable landscape areas during years when landscape imagery is not available, urban retail water suppliers can identify the changes and request for adjustments per WC 10609.16(e).

3.6 Reference Evapotranspiration and Effective Precipitation

DWR has well-established programs for estimation of ETo at weather station sites that are managed by the CIMIS program. ETo is evaporation plus transpiration from grass surfaces on which the weather stations stand. DWR currently manages over 155 automated CIMIS stations throughout the State. To fill spatial data gaps, DWR, in cooperation with the University of California, Davis (UCD), developed Spatial CIMIS, a model that couples remotely sensed data from the Geostationary Operational Environmental Satellite with point measurements from CIMIS stations to estimate ETo at a 2-kilometer grid. Urban retail water supplier boundaries were overlaid on the Spatial CIMIS grid, and a weighted average of each enclosed grid's ETo was derived to reflect ETo at the urban retail water supplier level.

Similarly, daily total rainfall records were obtained from the Parameter-elevation Relationships on Independent Slopes Model (PRISM) as an input to DWR's Cal-SIMETAW model to calculate Peff. PRISM is a climate mapping model developed by the PRISM Climate Group at Oregon State University, and Cal-SIMETAW is a soil water balance model that was developed by DWR and UCD. Effective precipitation represents the portion of total precipitation that becomes available for plant growth. It is affected by soil type, slope, land cover type, and rainfall frequency, intensity, and duration, among other factors. Since it is not practical to use all landscape landcover types in urban settings for estimation of Peff, Cal-SIMETAW assumes that the surface is covered with a cool season turfgrass. These models make common ground cover assumptions across different urban retail water suppliers; however, soil type is allowed to vary based on a urban retail water supplier's geographic location. Cal-SIMETAW uses the Soil Survey Geographic Database from the National Resources Conservation Service to model the soil water balance for different service areas.

Based upon sensitivity analyses presented later, annual Peff estimates generated from the soil water balance models are capped at 25 percent of total annual precipitation to stay consistent with MWELO.

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4.0 Representativeness of Urban Retail Water Suppliers Used for Evaluating the Outdoor Residential Water Use Efficiency Standard

Data screening caused several urban retail water suppliers to be excluded from the analysis dataset that was compiled for evaluating the ORWUS. The most frequent cause was missing multifamily water usage data. Initial screening of the eAR data produced acceptable data for 259 urban retail water suppliers. Ten of these, however, generated implausible ETF estimates (discussed in Section 5.1) and were dropped for that reason. The final dataset includes 249 urban retail water suppliers, compared to the full set of 398 urban retail water suppliers that are required to submit UWMPs. The subset of 249 analyzed urban retail water suppliers represents roughly 62 percent in terms of urban retail water supplier count, but 76 percent in terms of population residing in the full set of urban retail water suppliers.

Before proceeding to develop recommendations about the residential outdoor standard, the subset of urban retail water suppliers selected for analysis was assessed in terms of how well they represent the full set of urban retail water suppliers geographically and climatically. This was done by comparing the distribution of population in the subset versus the full set, by hydrologic region and climate zone (Figure 4-1 and Figure 4-2, respectively). The distribution of population looks very comparable between the subset and full set, both by hydrologic region and climate zone, indicating that the analytics presented later are a robust representation of the full set of urban retail water suppliers.[8] Another way to interpret this close correspondence is that urban retail water suppliers that fail the data screening criteria are not concentrated in one or another part of the State but are, in essence, randomly distributed.

[8] A Chi-Square test was unable to reject the null hypothesis, at 5 percent level of significance, that the distribution of urban retail water suppliers across hydrologic and climatic zones is similar between the subset of 249 and full set of 398 urban retail water suppliers.

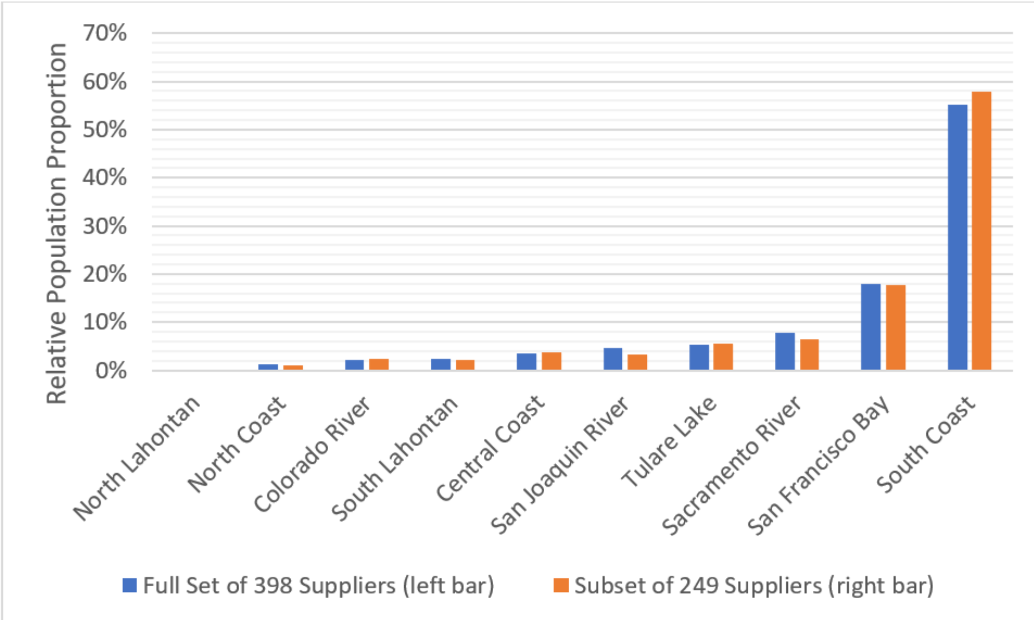

Figure 4-1 Distribution of Urban Retail Water Supplier Population by Hydrologic Region

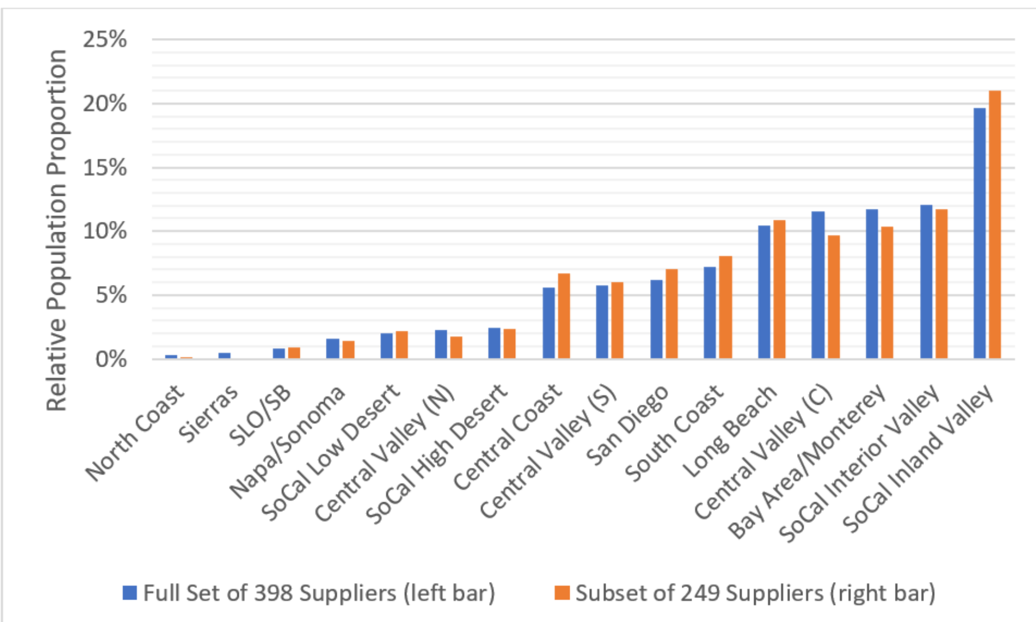

Figure 4-2 Distribution of Urban Retail Water Supplier Population by Climate Zone

Figure 4-3 shows the relative distribution of II, INI, and NI landscape areas in the full set of urban retail water suppliers compared to the analyzed subset. For example, 68.5 percent of total residential parcel area in the full set of 398 urban retail water suppliers is categorized as not irrigable, compared to 66.7 percent in the subset of analyzed urban retail water suppliers. The proportions of II and INI are also very comparable. Note, that roughly a third of total irrigable landscape area (II+INI) is estimated to be presently unirrigated (INI) across both sets of urban retail water suppliers. This close correspondence indicates that the analyzed subset is a good representation of the full set of 398 UWMP suppliers in the State.

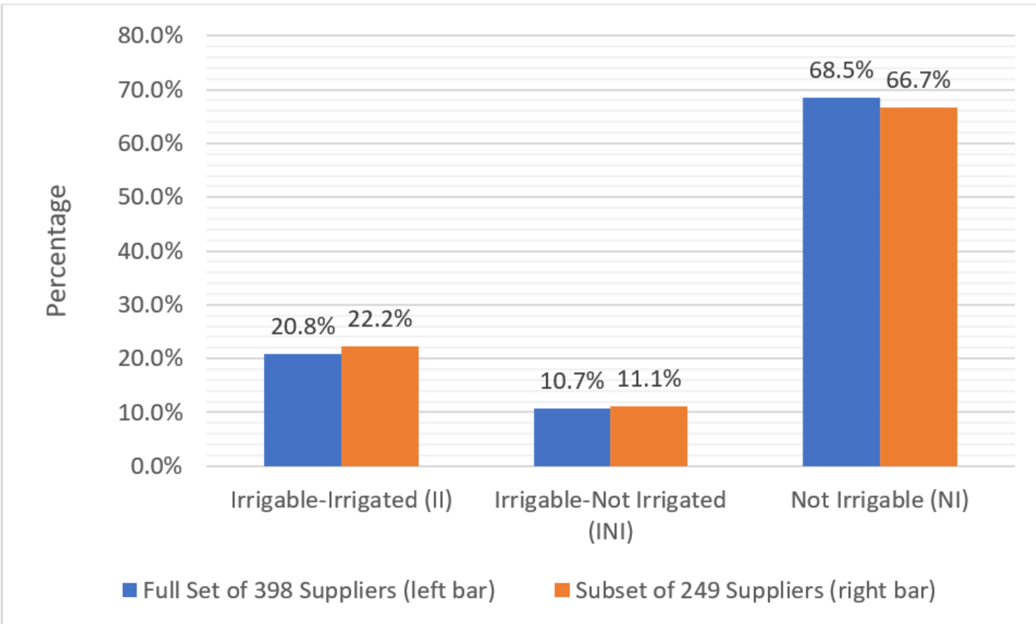

Figure 4-3 Relative Proportion of the Three-Class Landscape Areas

Figure 4-4 shows the distribution, at the urban retail water supplier level, of the proportion of total precipitation that is estimated to be effective precipitation for the full set and subset of urban retail water suppliers. Given that the subset is as geographically dispersed as the full set, these two distributions also appear very comparable, with the mean proportion having a value of roughly 37 percent and the median having a value of roughly 33 percent. The variation in the effective-precipitation proportion across urban retail water suppliers, however, is quite large, with maximum values exceeding 70 percent for a handful of urban retail water suppliers. This pattern diverges from the constant 25 percent effective-precipitation assumption embedded in MWELO. Since the outdoor standard is required to be consistent with the principles of MWELO, results of sensitivity analyses are shown later to evaluate the impact of alternative effective-precipitation assumptions on the outdoor standard. Based on these analyses, effective precipitation is capped at 25 percent of total precipitation for the development of the ORWUS.

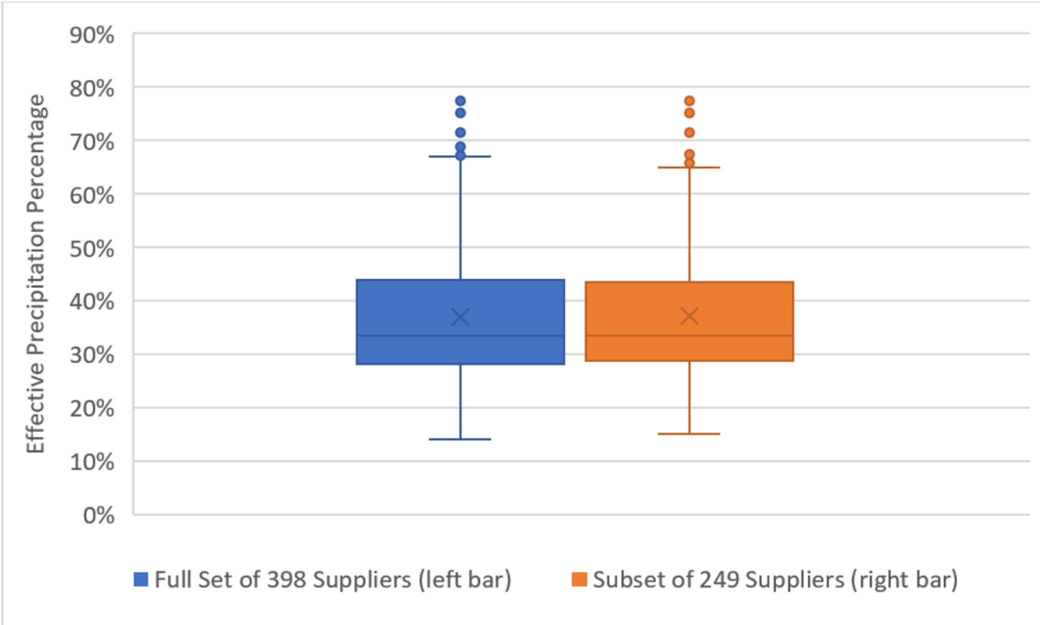

Figure 4-4 Effective Precipitation as a Proportion of Total Precipitation

5.0 Analytic Results

5.1 Evapotranspiration Factor Distributions Based on Irrigable and Irrigated Landscape Areas

As mentioned earlier, the LAM project splits total residential parcel area into three categories: (1) II; (2) INI; and (3) NI. The first category, II, represents landscape area identified as currently irrigated; the second category, INI, as landscape area not likely irrigated when the imagery was taken but possibly was in the past, and therefore, potentially could be irrigated again during the year after the imagery was taken; and the third category, NI, as aggregate parcel area that is not irrigable (building footprint, hardscape, natural lands, etc.).

INI landscape area as a proportion of total landscape area (II+INI+NI) is about 11 percent. On average, INI area as a proportion of total irrigable landscape area (II+INI) (i.e., [INI/(II+INI)]) is roughly a third (33.4 percent for the subset and 34.0 percent for the full set of urban retail water suppliers). However, the INI proportion of total irrigable area can be large in the case of a few urban retail water suppliers. To assess irrigation received by INI landscape areas per year (aerial imagery only captures a single snapshot within the year), urban retail water supplier-level ETFs are calculated using both II landscape area as well as total irrigable landscape area (II+INI) for comparative purpose and further evaluation.

Figure 5-1 shows ETF distributions for the subset of 259 urban retail water suppliers that passed the eAR data screening algorithms described earlier. For 10 of these, ETF estimates turned out to be either negative or implausibly high causing their removal at this last stage of data editing, leading to a final analysis sample of 249 urban retail water suppliers (Figure 5-2) that was earlier evaluated for geographic and climatic representativeness. The outdoor standard analytics are based on this final sample of 249 urban retail water suppliers. Figure 5-1, Figure 5-2, and Table 5-1 show data with and without these 10 additional excluded urban retail water suppliers to demonstrate that outlier deletion has not biased overall estimates of central tendency.

Statewide average ETF based on total irrigable area is lower than ETF based only on irrigated area because the numerator in Equation 3 remains the same while the denominator decreases in the latter case. Either way, the distributions of ETF across urban retail water suppliers appear quite heterogenous, implying that even after removing the effects of landscape area and weather, quite a bit of variation remains in outdoor use due to other factors.[9] Another notable feature of these distributions is that they are symmetric, with a handful of outliers on both sides of the average. The outliers include a few agencies with negative ETFs, signifying the presence of data problems despite extensive screening of the eAR data. A handful of agencies also exhibit implausibly high ETF levels. Sensitivity analyses are presented in the next section to show that the estimates of central tendency of these distributions are not affected if these outliers are removed.[10]

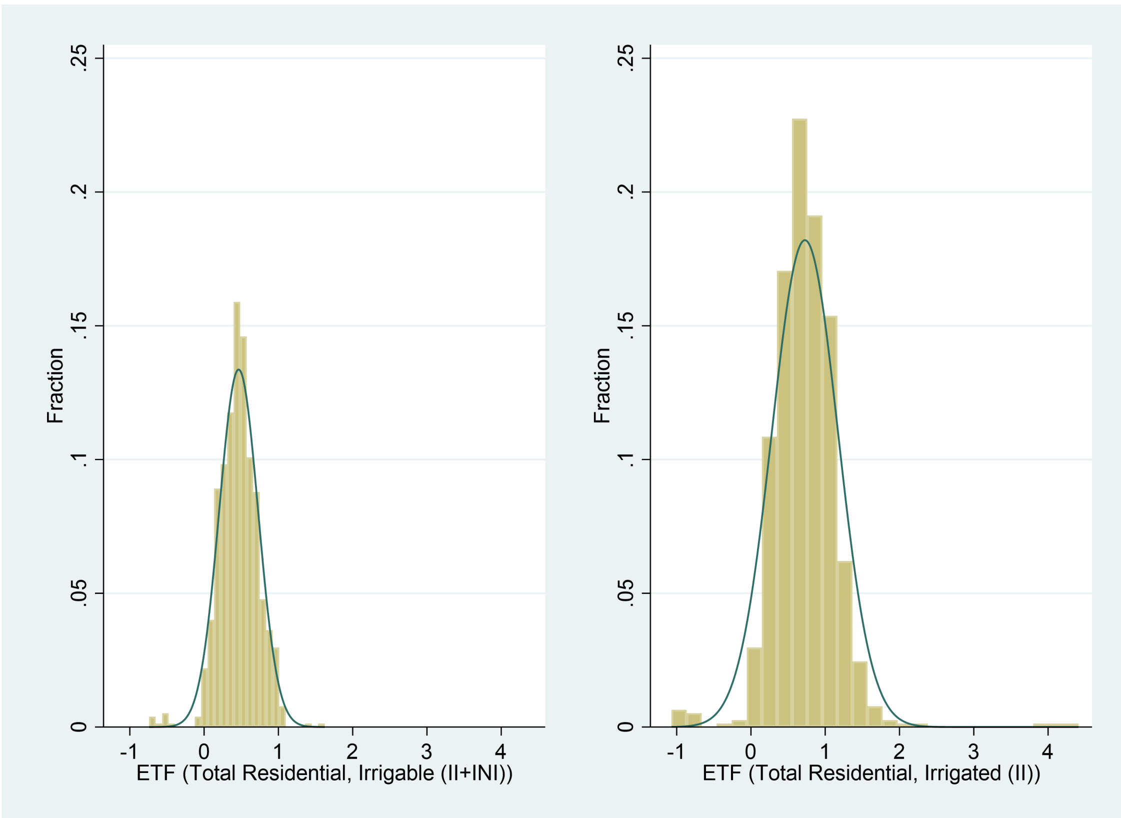

Figure 5-1 Distribution of Evapotranspiration Factor: Total Residential (N=259)

[9] Other factors may include, among other things, differences in water costs, household income levels, community landscape norms and standards, age of housing stock, and size of residential parcels (e.g., households with larger parcels may devote more area to turf than households with smaller parcels).

[10] Subsequent data review were able to resolve some of these outlier ETF suppliers, but not enough to warrant including them and redoing all the analyses.

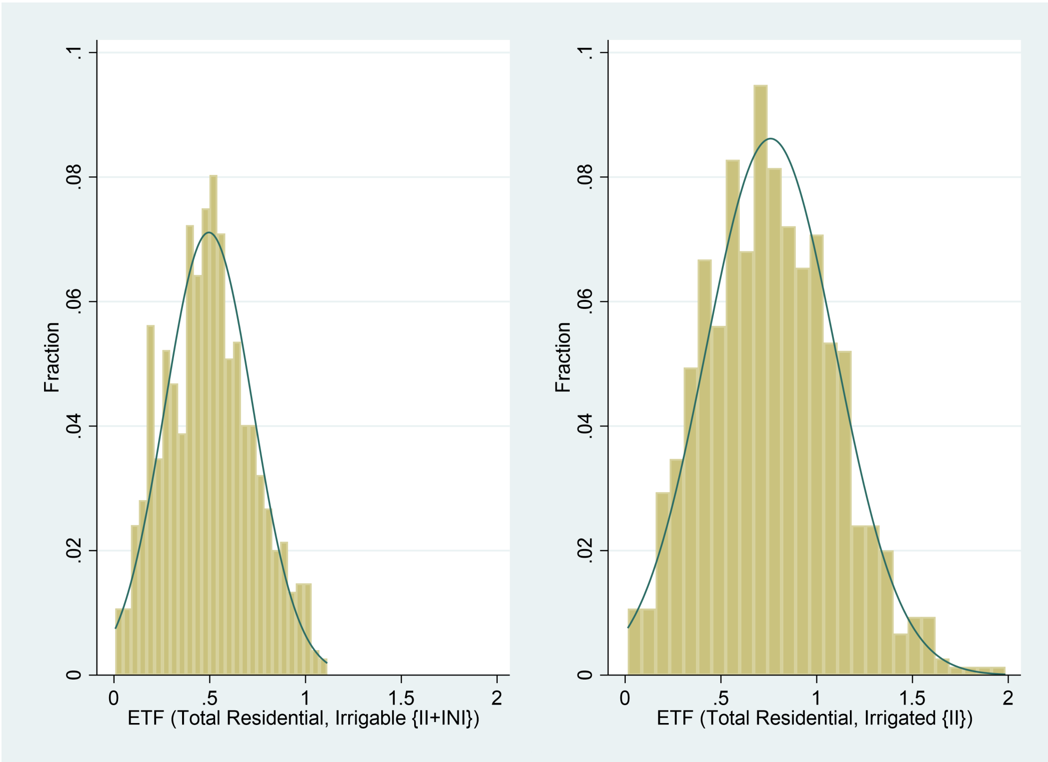

Figure 5-2 Distribution of Evapotranspiration Factor Without Outliers: Total Residential (N=249)

5.2 Impact of Effective Precipitation on Estimated Evapotranspiration Factors

The 2018 Legislation directs DWR to recommend guidelines and methodologies that describe how an urban retail water supplier should calculate its UWUO. It also specifies that the guidelines and methodologies address, as necessary, incorporating precipitation data and climate data into the estimation of EORWU, one of several components of the UWUO. DWR recommends that Peff, the portion of total precipitation that becomes available for plant growth, be incorporated into the estimation of EORWU.

Figure 4-4 shows the variation in effective precipitation estimates across urban retail water suppliers. It is clear from the graph that many urban retail water suppliers have an annual effective precipitation ratio that is higher or lower than 25 percent of total annual precipitation, which is the ratio recommended by MWELO in the absence of better data. Before undertaking detailed analyses of estimated ETFs, it is necessary to settle on how best to incorporate effective precipitation in the calculation of ETFs.

Table 5-1 shows mean ETF (irrigated) across the sample with and without outliers under alternative approaches for handling effective precipitation.[11]

Table 5-1 Impact of Alternative Approaches for Handling Effective Precipitation

Mean	ETF Irrigated (Outliers Included, N=259)	ETF Irrigated (Outliers Removed, N=249)
Mean (Peff from Cal-SIMETAW)	0.78	0.77
Mean (Peff set at 25 percent of precipitation, like MWELO)	0.75	0.74
Mean (Peff from Cal-SIMETAW capped at 25 percent of annual precipitation)	0.74	0.74
Mean (Peff not used in calculation)	0.69	0.68

Key:
Cal-SIMETAW = California Simulation of Evapotranspiration of Applied Water
ETF = evapotranspiration factor (on urban retail water supplier level)
MWELO = Model Water Efficient Landscape Ordinance
N = number of urban retail water suppliers
Peff = effective precipitation

Several patterns are evident from Table 5-1. First, removing the outliers does not appreciably alter estimates of the distribution mean. This is expected, given the symmetry observable in the ETF distributions. Second, the estimated means are not very sensitive to how effective precipitation is handled. Of course, altogether ignoring effective precipitation has an appreciable effect, but the 2018 Legislation calls for the inclusion of precipitation in the outdoor standard, so ignoring effective precipitation is not a viable option. It is only presented for reference.

Overall, to maintain theoretical rigor in the estimation of effective precipitation, consistency with MWELO, and equity across urban retail water suppliers that receive very different amounts of precipitation during the year, the daily soil-moisture (Cal-SIMETAW) based estimates, not to exceed 25 percent of total precipitation, is used in the estimation of ETFs.

All subsequent analyses presented in this document use effective precipitation from Cal-SIMETAW models capped at 25 percent of total precipitation in the estimation of urban retail water supplier‑level ETFs.

[11] Estimates of ETF (irrigable) exhibit similar patterns.

5.3 Comparison of Evapotranspiration Factor Distributions Between Total Residential and Single-Family Sector

Figure 5-3 compares the ETF distributions when they are based only on the single-family sector relative to the total residential sector (single-family and multifamily combined). This sensitivity analysis was undertaken to test whether presumed higher accuracy of data for the single-family sector leads to different conclusions than the total residential sector. The comparison offered in Figure 5-3 does not indicate that to be the case. Therefore, analytics developed for the total residential sector should be relatively free of bias. Perhaps, this finding is not altogether surprising since urban retail water suppliers with missing multifamily sector data were screened out of the analyses.

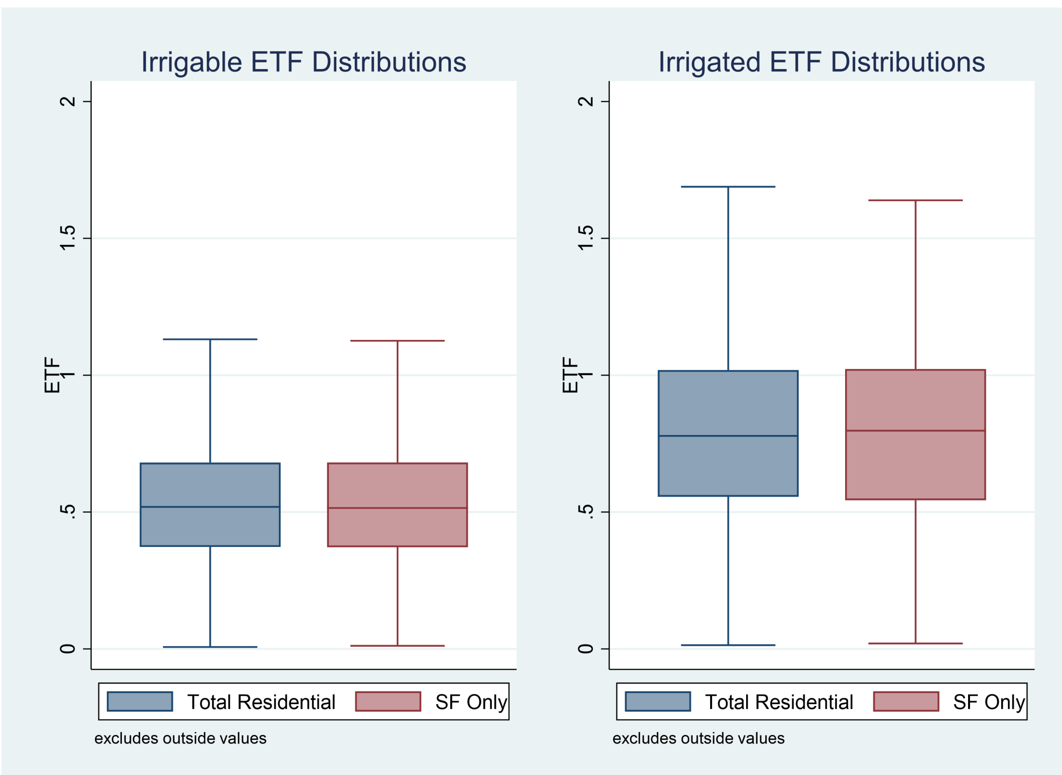

Figure 5-3 Comparison of Evapotranspiration Factor Distributions Between Total Residential Sector and Only Single-Family

5.4 Impact of Relative Proportions of Irrigable-Irrigated and Irrigable-Not Irrigated Landscape Areas on Outdoor Residential Water Use

The 2018 Legislation directs DWR to provide irrigable landscape area to urban retail water suppliers without specifying whether the estimate of efficient outdoor water use should be based only on the following: (1) landscape area classified as irrigated at the time the aerial imagery was taken, or (2) also could include landscape areas with weaker irrigation signatures on account of less frequent irrigation, past irrigation, and therefore, potentially future irrigation as well.

To test for differential levels of irrigation being applied to II versus INI landscape areas, it is necessary to utilize a statistical model. The reason for this is self-evident because each urban retail water supplier’s total irrigable area consists of two components: II and INI. But outdoor water use can only be inferred for an urban retail water supplier in the aggregate, not separately by its II and INI landscaped areas. Urban retail water suppliers fall on a continuum in terms of how much of their total irrigable landscape area falls in the II versus INI categories. It is reasonable to expect that irrigation applied to II areas exceeds that applied to INI areas of equivalent size, given how irrigation signatures embedded in aerial imagery are interpreted.

Figure 5-4 shows a scatterplot of urban retail water supplier‑level ETFs plotted against the proportion of total irrigable area that is irrigated [II/(II+INI)]. The urban retail water supplier‑level ETFs on the Y-axis are calculated using total irrigable area in the normalization algorithm since estimated outdoor use includes irrigation applied to II and potentially also to parts of INI landscape area. The scatterplot is developed using three years (2017 to 2019) of outdoor water use data from 249 urban retail water suppliers geographically and climatically representative of the State.

A regression model is used to explore how water use varies with respect to the ratio of irrigated to total irrigable area. As expected, the best fit line slopes upward from left to right indicating that as the II share of total irrigable area increases, so does outdoor water use. Although this finding is logical, the best fit line does not intercept the left Y-axis at the origin point (at zero), but a little above it, suggesting that INI landscaped areas, on average, also receive some irrigation.

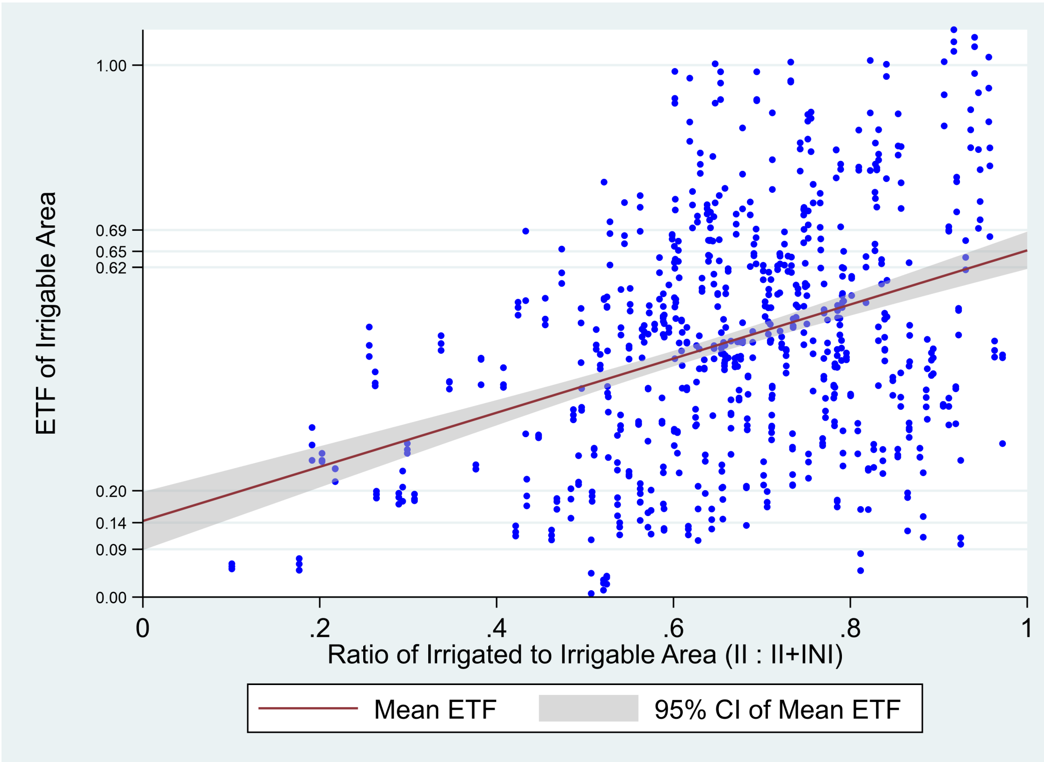

Figure 5-4 Evapotranspiration Factor Versus Ratio of Irrigated to Irrigable Area

Inferring how much irrigation INI receives relative to II requires evaluating two hypothetical urban retail water suppliers; the first, an urban retail water supplier that only has INI, the second, an urban retail water supplier that only has II. For the first hypothetical urban retail water supplier, the X-axis value works out to zero. At X-axis equal to zero, the best fit line cuts the left Y-axis at an ETF value of 0.14 implying that, on average, when all landscape is INI, roughly 0.14 ETF of irrigation is being applied. For the second hypothetical urban retail water supplier, the X-axis value works out to 1.0. At X-axis equal to 1.0, the best fit line cuts the right Y-axis at 0.65, implying that, on average, when all landscape is II, roughly 0.65 ETF of irrigation is being applied. The 95 percent confidence interval around the mean fitted line shows that the finding about INI receiving nonzero irrigation is statistically significant because the confidence interval does not include the origin (0,0). The question about how much irrigation a unit of INI receives relative to a unit of II can now be answered by taking a ratio of their respective inferred ETFs, which roughly works out to one-fifth (0.14/0.65). The finding that INI landscape area also is receiving some irrigation, albeit much less than II area, makes it necessary to incorporate this finding into the estimation of EORWU to maintain equity across urban retail water suppliers.

The conclusions that follow from Figure 5-4 remain unchanged if only a single year of water use data (2018) is used instead of three. Stakeholders expressed concerns that combining a single year of aerial imagery (2018) with three years of water use data may be generating biased results. This was examined, but not found to be the case (Figure 5-5).

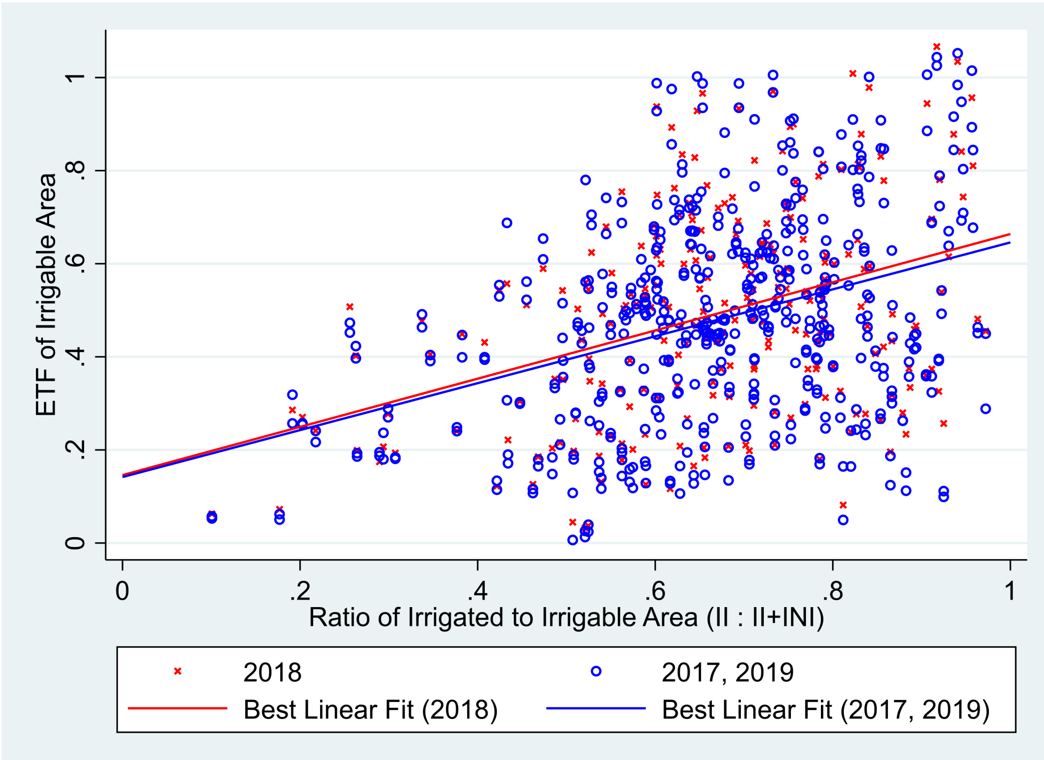

Figure 5-5 Sensitivity of Best Fit Line to Years of Water Use Data Used in the Analyses

DWR developed the data-driven approach to quantify the proportions of INI that could have received irrigation water sometime during the year. This represents areas that were not irrigated at the instant the imagery used in the analysis was taken but were irrigated at other times (before or after the specific image was taken). This proportion, labelled as an INI buffer in DWR's analysis, was estimated to represent, on average, 20 percent of an urban retail water supplier's total INI area using a regression model shown if Figure 5-4. The wide scatter of data points around the regression line is indicative of high variability across urban retail water suppliers, leading to the possibility of getting different levels of accuracy of the INI buffer for individual urban retail water suppliers. For this reason, DWR recommends the following:

1. DWR, jointly with the State Water Board, will conduct further studies and develop a methodology that results in more accurate estimate of INI buffer for individual urban retail water suppliers. With more accurate information on INI buffer, urban retail water suppliers will have updated total irrigable land area data when calculating the residential outdoor efficient water use component of their UWUO.

2. Until the new methodology is developed, DWR recommends that the State Water Board adopt the current 100 percent II plus 20 percent irrigable-not irrigated areas to estimate urban retail water suppliers' total irrigable area.

3. Urban retail water suppliers retain the option of using an alternative data source for irrigable landscape area, if they can demonstrate to DWR that the alternative data are equivalent, or superior, in quality and accuracy to the data provided by DWR.

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6.0 Alternative Outdoor Residential Water Use Efficiency Standard Options: Pros and Cons

Considering the analytic findings presented in the previous section, five potential options for setting the ORWUS can now be evaluated. These five options differ in terms of landscape area used for developing the ORWUS: (1) total irrigable (II+INI); (2) II; or (3) a combination of both. DWR recommends the fifth option, for reasons discussed below.

6.1 Option 1: A Single Outdoor Standard Based on Irrigable Landscape Area

If ETFs are calculated using Equation 3 and total irrigable landscape area, it will lead to a lower ETF threshold being selected as the ORWUS, indicating that the State has achieved a high level of outdoor water use efficiency, likely a false picture since some of the INI areas are truly not irrigated. As mentioned previously, INI landscape areas receive a lot less irrigation than II areas. At the time of calculating EORWU from the outdoor standard, this may not matter much for the average urban retail water supplier because a smaller standard would be combined with the full estimate of irrigable area. However, urban retail water suppliers will be penalized when II is a large proportion of total irrigable area, while those with higher proportion of INI will be rewarded. This obvious inequity makes this approach unacceptable.

6.2 Option 2: A Single Outdoor Standard Based on Irrigated Area

If ETF is calculated using only II landscape area, it will lead to a higher ETF threshold being selected as the standard, providing a more accurate picture of current outdoor water use efficiency in the State as a whole. However, this approach also is characterized by inequity because it would fail to factor in irrigation applied to INI landscape areas, which to be sure is a lot lower than what is applied to II areas, but not negligible. Again, for the average urban retail water supplier this may not matter much because at the time of calculating their EORWU from the larger outdoor standard it will be combined with a smaller estimate of landscape area. However, urban retail water suppliers where II is a small proportion of total irrigable area would be penalized, while those on the other end of the scale will be rewarded. Once again, the built-in inequity makes this approach unacceptable. It also ignores the legislative directive that DWR base the outdoor standard on irrigable landscape area.

Options 3 through 5: The remaining three options explore different ways for capturing II and INI landscape areas during the calculation of efficient outdoor water use, potentially improving equity across urban retail water suppliers.

6.3 Option 3: An Outdoor Standard Based on a Sliding Scale

A sliding scale can be developed using the approach presented in Figure 5-4. In theory, this option can increase fairness across urban retail water suppliers with different proportions of II and INI. It, however, adds complexity to the process as urban retail water suppliers need to estimate the proportions first and insert it into an equation to derive their respective standards. This also will cause the standard to change from year to year for any given urban retail water supplier, making the management of this approach more difficult for DWR and the State Water Board.

6.4 Option 4: Two Outdoor Standards Based on Irrigated Area and Irrigable-Not Irrigated Landscape Areas

In this option, an outdoor water use standard is set using II landscape area. Statistical moments of ETF, horticultural practices, irrigation science, and principles of MWELO can be considered to set the standard for II area. A second standard is then set using the INI landscape area. Since the INI landscape area is comprised of different landscape features that are not irrigated for the most part, this standard is set at a lower value. The lower standard, however, will be set arbitrarily rather than based on science and data. Urban retail water suppliers will calculate their EORWU as the sum of efficient outdoor water use for irrigated area and efficient outdoor water use for the INI area leading to unnecessary complexity.

6.5 Option 5: A Single Outdoor Standard Applied to Irrigated Area, Landscape Area, and a Buffer Based on Irrigable-Not Irrigated Landscape Area

This option retains the simplicity of a single outdoor standard, while at the same time recognizing that INI landscape area also deserves some weightage for calculation of EORWU. As discussed in Option 2, using II landscape area alone might negatively impact urban retail water suppliers that have a low proportion of II area relative to total irrigable (II+INI) area. Thus, to improve equity across urban retail water suppliers, a buffer is included based on an urban retail water supplier's estimate of INI landscape area.

The results presented earlier in Figure 5-4 can be used to set the size of this buffer. Figure 5-4's analyses indicate that INI landscape area uses roughly a fifth of annual irrigation used by comparably sized II landscape area. This allows for a straightforward conversion of INI landscape area into an adjusted estimate of irrigated landscape area. Under this option, urban retail water suppliers would calculate their EORWU by applying the outdoor standard to the adjusted estimated of irrigated landscape area (II + 0.2 x INI).

DWR recommends this Option 5 approach for its equity. In summary, the buffer is calculated as one-fifth or 20 percent of INI area, designed to capture expected annual irrigation of INI landscaped areas. The 20 percent INI buffer may change based on the outcome of further studies and investigations to be conducted jointly by DWR and the State Water Board (see Section 5.4).

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7.0 Detailed Evaluation of Option 5 (Recommended Option)

7.1 Impact of the Buffer on Urban Retail Water Suppliers

Table 7-1 shows how Option 5 (single outdoor standard with buffer) would work for the 398 urban retail water suppliers in practice. Each scenario represents urban retail water suppliers with a different proportion of II and INI landscape area, adding up to 100 landscape area units or 100 percent. The total area upon which EORWU would be based is calculated as the sum of II and 20 percent of INI landscape units. Predictably, urban retail water suppliers with a greater proportion of INI would benefit more from the buffer. For example, an urban retail water supplier falling in scenario A would calculate its EORWU based on 24 landscape area units, which represents a 4.8X increase compared to a standard that gives no weightage to INI landscape area. The multiplier effect, however, rapidly diminishes with decreasing INI proportion.

The last column shows the number of urban retail water suppliers that fall at or below a scenario. For example, only one urban retail water supplier exists with irrigated area less than 5 percent of irrigable area. Six urban retail water suppliers fall between scenarios B and C. The vast majority fall within scenarios E and F where the impact of the buffer is small.

Incorporating INI into the estimation of EORWU results in a more equitable estimate of efficient outdoor use. For example, if EORWU were only based on II, an urban retail water supplier in Scenario A would calculate their EORWU based on 5 units of landscape area even though data analysis conducted by DWR indicates that an equivalent of 24 units is receiving irrigation. Thus, the urban retail water supplier's efficient outdoor water use would be based on just 21 percent (5 out of 24) of their II equivalent landscape area. Meanwhile, an urban retail water supplier's EORWU in Scenario F would be based on 99 percent (95 out of 96) of their II equivalent landscape area. Clearly, basing the calculation of EORWU solely on II without giving any weightage to INI would put urban retail water suppliers with a high proportion of INI at a distinct disadvantage.

Nonetheless, several stakeholders expressed concern that including the buffer could significantly diminish statewide water savings, and therefore, a cap should be placed on the amount by which the buffer can contribute to an urban retail water supplier's calculated EORWU. The effect of capping the buffer on statewide water use is discussed in the next section.

Table 7-1 Effect of the Buffer on Different Urban Retail Water Suppliers

Scenario	Proportional Split of Total Irrigable Area Between II and INI	Proportional Split of Total Irrigable Area Between II and INI	Contribution of INI (20 percent buffer) to EORWU	Total Area Entering Calculation of EORWU	Multiplier Impact of INI (20 percent buffer) on II-Based EORWU	Number of Urban Retail Water Suppliers at or Below Scenario
	II	INI				
A	5 units	95 units	19 units	24 units	4.8X	1
B	10 units	90 units	18 units	28 units	2.8X	1
C	20 units	80 units	16 units	36 units	1.8X	7
D	50 units	50 units	10 units	60 units	1.2X	63
E	90 units	10 units	2 units	92 units	1.02X	373
F	95 units	5 units	1 unit	96 units	1.01X	390‡

Note:
‡ Irrigated area exceeds 95 percent of irrigable area for five urban retail water suppliers; data for three urban retail water suppliers under review.
Key:
EORWU = efficient outdoor residential water use
II = irrigable-irrigated
INI = irrigable-not irrigated

7.2 Effect of Capping the Buffer on Statewide Water Savings

This section considers what effect putting a cap on the INI buffer would have on statewide water use. Capping the buffer was suggested by stakeholders. EORWU can be calculated as the sum of two quantities:

EORWU = [(ETo – Peff) x (0.62) x ORWUS x II] + [(ETo – Peff) x (0.62) x ORWUS x 0.2 x INI]……………(Eq. 4)

The first quantity, [(ETo - Peff) x (0.62) x ORWUS x II], hereafter denoted as $EORWU_{II}$ is the amount of EORWU associated with II landscape area while the second quantity, [(ETo - Peff) x (0.62) x ORWUS x 0.2 x INI], hereafter denoted as $EORWU_{INI}$, is the amount associated with INI landscape area. A cap on the buffer puts a limit on the second quantity's contribution to EORWU relative to the first.

The analysis presented in this section is based on three alternative capping scenarios, as follows:

1. $EORWU_{INI} < 1.0 \times EORWU_{II}$ (100 percent buffer cap)
2. $EORWU_{INI} < 0.5 \times EORWU_{II}$ (50 percent buffer cap)
3. $EORWU_{INI} < 0.25 \times EORWU_{II}$ (25 percent buffer cap)

These caps are increasingly restrictive. The first limits INI's EORWU contribution to no more than the amount contributed by II. The second limits INI's contribution to no more than half of II's contribution, while the third limits it to no more than a quarter of II's contribution.

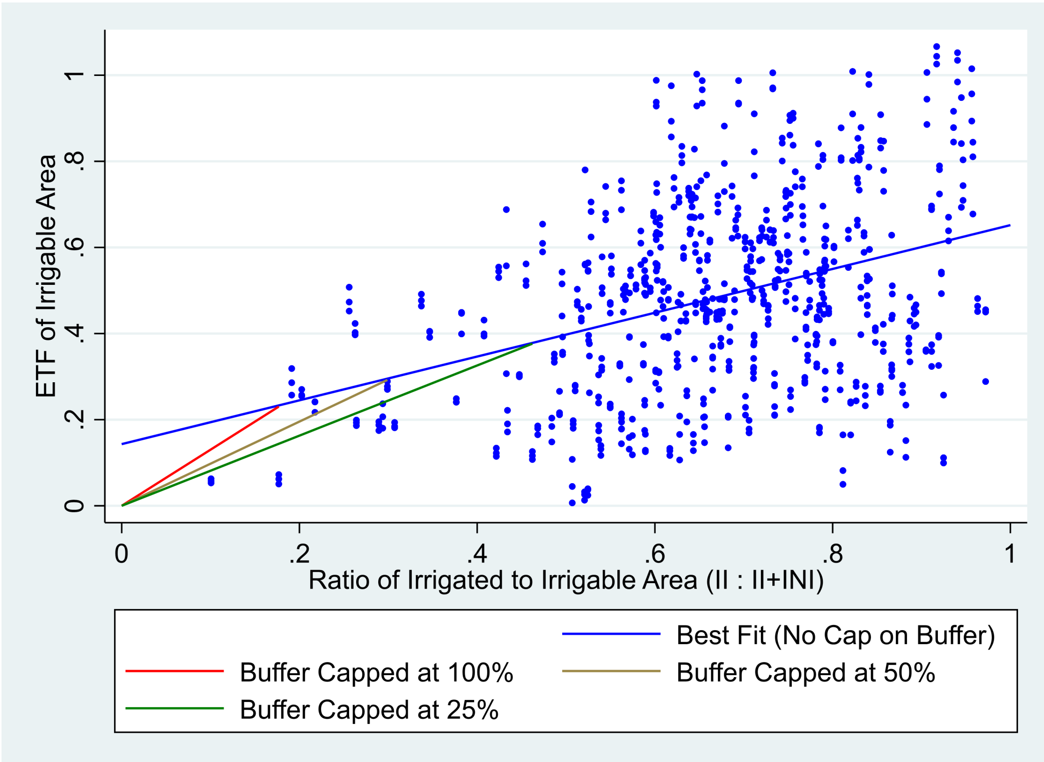

Figure 7-1 Effect of Three Alternative Buffer Caps on the Outdoor Standard

The three capping alternatives are graphically illustrated in Figure 7-1. The effect of these caps is to inflect the best linear fit line towards the origin with the inflection point moving to the right as the cap becomes more binding. This figure shows that only urban retail water suppliers with relatively high proportions of INI would be impacted by a buffer cap. The least restrictive cap (100 percent of $EORWU_{II}$) would impact an urban retail water supplier only if INI comprised more than 83 percent of its irrigable area (between scenarios B and C in Table 7-1). Less than one percent of urban retail water suppliers exceed this threshold. The next least restrictive cap (50 percent of $EORWU_{II}$) would impact an urban retail water supplier only if INI comprised more than 71 percent of its irrigable area. Four percent of urban retail water suppliers exceed this threshold. The most restrictive cap (25 percent of $EORWU_{II}$) would impact an urban retail water supplier only if INI comprised more than 56 percent of its irrigable area. Ten percent of urban retail water suppliers exceed this threshold. Thus, even under the most restrictive of the three buffer caps, 90 percent of urban retail water suppliers would be unaffected. This strongly suggests that putting a cap on the INI buffer would have only a negligible impact on statewide water savings.

Figure 7-1 is used to test if one of the three inflected lines fits the data better than the straight fit line. This can be tested within a linear regression framework by evaluating whether the slope of the inflected line left of the inflection point is significantly different than the slope to the right of the inflection point, given the data. This test was implemented in the case of each capping alternative, but the differences in slope were found to be statistically insignificant in each case. Thus, there is scant empirical evidence to support capping the buffer. Nonetheless, the effect of capping the INI buffer on statewide urban water savings, if one were applied, can be analyzed.

For that, it is important to first define statewide urban water use. Two measures are considered. The first is Objective-Based Total Water Use (OTWU), which is the sum of four components: (1) EIRWU, (2) EORWU, (3) efficient real water loss, and (4) all other uses not subject to water use efficiency standards.[12] The second is Expected Total Water Use (ETWU). ETWU is always equal to or less than OTWU. It will be equal to OTWU if the sum of the urban retail water supplier's current residential, CII-DIM, and real water loss is greater than its UWUO. In this case, it is assumed the urban retail water supplier will take actions to reduce residential, CII-DIM, and real water loss until its UWUO is satisfied. It will be less than OTWU if the sum of these uses is less than its UWUO. In this case, it is assumed the urban retail water supplier will not take actions to incentivize water use to raise it up to the level of its UWUO.

OTWU and ETWU were estimated for the State's urban retail water suppliers with the DWR Urban Water Use Objective Analyzer (Section 10.3) with and without the INI buffer caps described above. For this analysis, the outdoor residential ETF was set to 0.63 and the INI buffer was set to 20 percent of INI area. The indoor standard was set to 50 gallons per capita per day (gpcd), the real water loss standards were set to the draft standards released by the State Water Board, and potable reuse bonus incentives were taken into account.[13]

Table 7-2 summarizes the estimated effect of the three buffer caps on statewide urban water savings. As expected, the impact is negligible. Compared to the no cap scenario, the most restrictive cap decreases OTWU by two-tenths of one percent and ETWU by one-tenth of one percent. Thus, putting a cap on the INI buffer would have no material effect on statewide urban water savings.

While placing a cap on the INI buffer would have no material effect on statewide water savings, it would adversely impact the small number of urban retail water suppliers with large proportions of INI landscape area. For the seven urban retail water suppliers represented in Table 7-1 with INI landscape area comprising 80 percent or more of their total irrigable area, the least restrictive cap would double the average reduction in outdoor use needed to meet the proposed standard while the most restrictive cap would

[12] While a standard for CII-DIM efficient water use also is being developed, there is currently no way to estimate the level of efficient use that would result from this standard, because landscape area measurements for such meters are not presently available. Therefore, DIM water use has been grouped with all other uses.

[13] This analysis was originally done using the draft water loss standards the State Water Board released in December 2020. It was subsequently updated using the State Water Board's updated draft standards posted to their website in 2022.

quadruple it. These results indicate that capping the buffer would place a large compliance burden on a small subset of urban retail water suppliers while not improving overall water savings. For this reason, DWR does not recommend putting a cap on the INI buffer as has been proposed by some stakeholders.

Table 7-2 Effect of Buffer Cap on Statewide Urban Water Savings

Buffer Cap	Decrease OTWU Relative to No Buffer Cap (Percent of gpcd)	Decrease in ETWU Relative to No Buffer Cap (Percent of gpcd)
$EORWU_{INI} < 1.0 * EORWU_{II}$	0.0 percent	0.0 percent
$EORWU_{INI} < 0.5 * EORWU_{II}$	-0.1 percent	0.0 percent
$EORWU_{INI} < 0.25 * EORWU_{II}$	-0.2 percent	-0.1 percent

Key:
EORWU = efficient outdoor residential water use
ETWU = expected total water use
gpcd = gallons per capita per day
II = irrigable-irrigated
INI = irrigable-not irrigated
OTWU = objective-based total water use

8.0 Evaluating the Outdoor Residential Water Use Efficiency Standard's Consistency with Model Water Efficient Landscape Ordinance Principles

Previous sections analyzed statewide patterns in the distribution of urban retail water supplier-level ETFs and developed a framework for setting an outdoor standard recognizing the differential levels of irrigation going to II and INI landscape areas. To establish the outdoor residential water use efficiency standard, the principles of MWELO must be applied as required by the 2018 Legislation.

To facilitate this, DWR used three approaches to develop a provisional outdoor standard: (1) calculated average ETF for urban retail water suppliers with ETF values within the range of MWELO's ETAF; (2) adjusted ETF values of the 249 subset of urban retail water suppliers so that they are within MWELO's ETAF guidelines and then calculated an average ETF; and (3) used horticultural and irrigation science to calculate statewide average ETF from plant factors published in scientific journals, with an irrigation efficiency of 80 percent derived from MWELO's guidelines. DWR also calculated an average ETF using age distributions of housing stocks and the corresponding MWELO ETAFs to inform the decision-making process, but this was not used in the calculation of the final provisional ORWUS. These approaches are discussed below.

8.1 Mean of Trimmed or Top-and Bottom-Coded Empirical Evapotranspiration Factor Distribution

MWELO's design guidelines allow landscape designers to choose from plant palettes that range from very low water using plants to high water using plants or special landscapes. The assumption that urban retail water suppliers with ETF estimates between 0.1 to 1.0 are consistent with MWELO principles, allows for estimation of a statewide average ETF against which a proposed outdoor standard can be compared for reasonableness. In other words, average statewide ETF under this approach is developed using data only from those urban retail water suppliers whose ETF falls within the 0.1-1.0 range.

A problem with this trimming approach is that water used by urban retail water suppliers that fall outside of the ETF range of 0.1-1.0 are entirely excluded from the statewide mean estimation. However, it can be argued that only their out-of-range use should be excluded, not their entire outdoor use. This can be remedied by replacing estimated ETFs that fall below 0.1 with 0.1; and those that exceed 1.0, with 1.0, respectively. This way, only the portion of outdoor use that falls outside the bound of MWELO-consistent use is removed but not the portion that is potentially consistent with MWELO.

Table 8-1 Estimated Statewide Evapotranspiration Factor Means Under Alternative MWELO Considerations and Landscape Areas

	Landscape Area = II			Landscape Area = II + 0.2 x INI		
	ETF Irrigated	ETF Irrigated (min/max range: 0.1-1.0)	ETF Irrigated (bottom- and top-coded at: 0.1-1.0)	ETF Irrigated	ETF Irrigated (min/max range: 0.1-1.0)	ETF Irrigated (bottom- and top-coded at: 0.1-1.0)
Number of Urban Retail Water Suppliers	249	192	249	249	215	249
Mean ETF (Peff from Cal-SIMETAW capped at 25 percent of precipitation)	0.74	0.62	0.70	0.66	0.60	0.64

Key:
Cal-SIMETAW = California Simulation of Evapotranspiration of Applied Water
ETF = evapotranspiration factor (on urban retail water supplier level)
II = irrigable-irrigated
INI = irrigable-not irrigated
max = maximum
min = minimum
MWELO = Model Water Efficient Landscape Ordinance
Peff = effective precipitation

Table 8-1 shows the statewide mean of these trimmed or bottom- and top-coded ETF distributions. The mean of the raw distribution without any trimming or top and bottom coding are also included for comparative purposes. The means of the trimmed distributions are the lowest, but do not change much whether landscape area is defined as II or as II-equivalent landscape area. This is because with II-equivalent landscape area entering the denominator, ETF estimates drop causing a larger number of urban retail water suppliers to fit within the 0.1-1.0 interval (215 versus 192). For the top- and bottom-coded distributions, the urban retail water supplier count remains the same, but mean ETF drops when II-equivalent landscape area is used in the denominator. The top- and bottom-coded ETF means are broadly consistent with the central tendency of empirically derived urban retail water supplier ETF distributions as discussed in prior sections.

8.2 Theoretical Evapotranspiration Factor Derived from Evaluation of Canopied Versus Non-Canopied Landscape Area

Urban landscapes are more complex than agricultural crops because of their heterogeneity. Water use by urban landscape greatly depends on land cover types (turf, trees, shrubs, annual flowers, vines, ornamental plants, vegetables, etc.) and their biophysical characteristics. Identifying plant types, height, and density at a parcel scale enables one to estimate outdoor water use with reasonable accuracy. Doing so at an urban retail water supplier service area boundary scale, however, is not an easy task. The LAM project covers over 14,000 square miles statewide. It will be extremely difficult, if not impossible, to identify landscape vegetation types and biophysical characteristics using remote sensing methods at such large scale. For this reason, DWR used a less complex, yet scientifically sound and acceptable approach for estimating urban landscape water use.

During the validation exercise of the LAM model output, DWR project team produced irrigation statuses of landscape features that are identified as canopied areas for 168 urban retail water suppliers. DWR verified the statewide representativeness of the 168 sample urban retail water suppliers and used the data to calculate ETF based on plant factors and irrigation efficiency. Two broad categories of land cover types were identified: canopied and non-canopied. Canopy in this context is defined as a landscape feature that casts a shadow on the ground surface, such as trees, shrubs, and vegetation that are not turf or low-lying vegetation. The non-canopied areas include mostly cool season and warm season turf. The canopy area was classified into II canopy, INI canopy, and NI canopy.

About 75 percent of the II area is estimated to be canopied while the remainder 25 percent as non-canopied. Using these proportions and average plant factors from the ASABE S623 with irrigation efficiency of 0.80, average ETF for the horticultural and irrigation science approach was estimated as 0.76.[14]

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[14] Average plant factor for canopied areas was estimated to be the average of plant factors of annual flowers (0.8), woody plants and herbaceous perennials (0.7 for wet climes, 0.5 for dry climes), and 0.3 for desert plants for an average of 0.58 [(0.8 + 0.7 + 0.5 + 0.3) / 4]. Plant factor for non-canopied areas was

Research shows that this approach produces acceptable and defensible results for regulatory purposes. ETF estimated from this method is combined with the other two methods to develop provisional ORWUS.

8.3 Theoretical Evapotranspiration Factor Derived from Housing Age Distribution

MWELO design standards have evolved over time, progressively leaning toward greater levels of outdoor water use efficiency. Assuming that all properties are being irrigated at their design efficiency, it is possible to derive a statewide theoretical ETF for the sake of comparison. This is done by evaluating the age distribution of present and forecasted future housing stocks, assigning MWELO's ETAF values to residential properties according to their year of construction and deriving a statewide weighted average. Note that ETAF values apply at the parcel level.

Annual population data and housing units from the California Department of Finance (DOF) were used for this analysis. Projected population and housing data were also used for the purpose of assessing if there will be significant number of newly built houses that are subject to the current MWELO ETAF regulations to result in significant changes in the outdoor standard by 2030. The housing stock was divided into five age bands based on the timeline of MWELO's development and updates. The housing age bands (and applicable ETAF) are pre-1992 (no ETAF but assumed 0.80 per 2015 amendment to MWELO for existing landscapes), 1993 to 2009 (ETAF of 0.80), 2010 to 2015 (ETAF of 0.70), 2015 to 2020 (ETAF of 0.55), and 2021 to 2030 (ETAF of 0.55).

Figure 8-1 shows the distribution of housing units by MWELO age bands for both single-family and multifamily homes. These percentages were used, along with the ETAF values listed above, to calculate a statewide average ETAF for current (through 2020) and projected (through 2030) housing stocks. These work out to 0.79 and 0.77, respectively. These theoretical ETF estimates offer yet another way of assessing the selected outdoor standard's consistency with MWELO principles.

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calculated as the average of cool season turf (0.8) and warm season turf (0.6) for an average of 0.7. ETF is calculated using a weighted average of canopied and non-canopied plant factors divided by irrigation efficiency of 0.8 [ETF = (0.75 x 0.58 + 0.25 x 0.7) / 0.8 = 0.76].

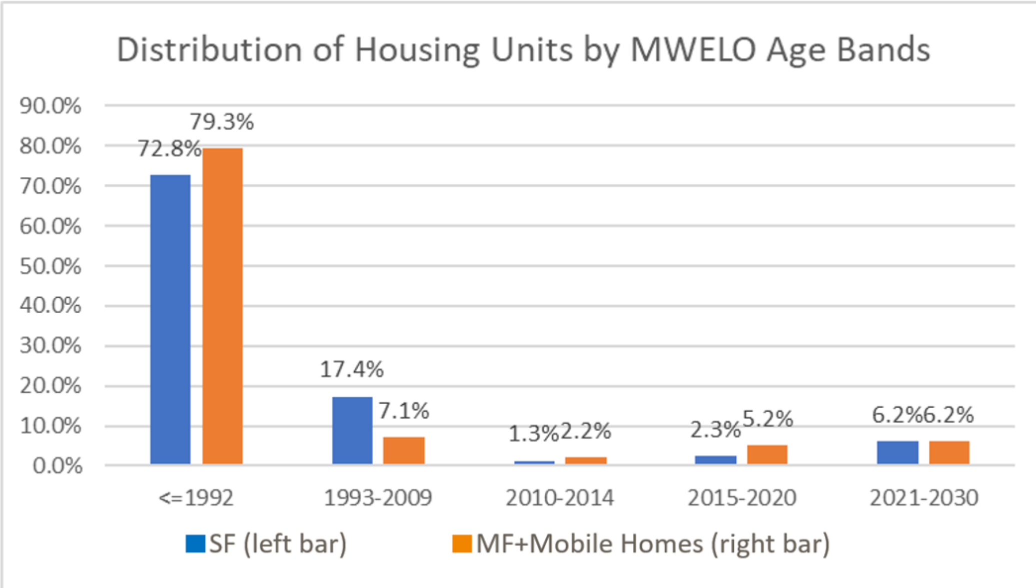

Figure 8-1 Distribution of Housing Units by Model Water Efficient Landscape Ordinance Age Bands

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9.0 Factors Considered During Development of the Outdoor Residential Water Use Efficiency Standard

9.1 Provisional Outdoor Residential Water Use Efficiency Standard

DWR put together findings generated by analyses shown previously to develop a provisional ORWUS.

Many urban retail water suppliers already exhibit current residential outdoor water use levels (2017 to 2019) that are consistent with the range of ETFs from very low to high (0.1-1.0) that are permitted for use in California landscapes by MWELO. Average ETF across urban retail water suppliers whose individual ETF estimates fall within the 0.1-1.0 range works out to 0.62. This is one indicator of the level of outdoor water use efficiency possible in the State.

A second possible metric was also calculated, not so much by excluding urban retail water suppliers whose ETFs fell outside the MWELO-consistent range of between 0.1 and 1.0, but by excluding only their out-of-range use. For example, if an urban retail water supplier's current ETF is estimated to be 1.3, it could be that they have a preponderance of high water-using plants, and potentially many irrigation deficiencies as well. In such cases, only what appears to be implausibly high use is removed by recoding their estimated ETF to 1.0, the high end of what could be plausibly considered consistent with MWELO. After top- and bottom-coding estimated ETFs to either 0.1 if estimated ETF is below 0.1, and to 1.0 if estimated ETF exceeds 1.0, a statewide average ETF of 0.70 was estimated. This is a second indicator of the level of outdoor water use efficiency possible in the State.

The third measure of achievable outdoor water use efficiency was derived from a theoretical analysis of water needs of canopied and non-canopied landscape areas found in a representative sample of the State's urban retail water suppliers, leading to an ETF estimate of 0.76.

DWR's initial standard was estimated as the average of the above three metrics [(0.62+0.70+0.76)/3], rounded to yield a provisional ORWUS value of 0.70. Calculation of efficient outdoor water use will be based on the sum of II and 20 percent of INI landscape area based on the finding that one unit of INI landscape appears to use roughly one-fifth of the water used by a comparable unit of II landscape area, on average. The 20 percent INI buffer may change based on the outcome of further studies and investigations to be conducted jointly by DWR and the State Water Board (see Section 5.4).

With respect to residential SLAs, urban retail water suppliers need to capture them under CII-DIMWUS to take advantage of higher water budgets. If residential SLAs are captured under CII-DIMWUS, an outdoor water use standard for SLAs will be 1.0. The residential SLA should then be subtracted from the aggregate II estimate that was provided by DWR to avoid double counting. Urban retail water suppliers can also choose to retain the SLAs within the residential sector for calculation of efficient residential outdoor water use if it makes internal record keeping easier or other reasons. If an urban retail water supplier chooses to retain the residential SLAs in the ORWU sector, however, the current ORWUS (0.80 in 2023 to 2029, and 0.63 in 2030 and thereafter) shall be used to calculate efficient outdoor water use for SLAs.

A few urban retail water suppliers may have residential landscapes on DIMs that also qualify as SLAs. For example, residential landscapes irrigated with recycled water with larger water allowance under CII-DIMWUS can potentially qualify for the high total dissolved solid variance. To take advantage of this, urban retail water suppliers must capture such landscape areas under CII-DIMWUS, removing the SLA estimate from the aggregate II estimate provided by DWR. For new residential construction that occurs after the aerial imagery was taken (2018 in most cases), efficient outdoor water use shall be estimated using an ORWUS of 0.55, until MWELO requirements are amended, at which point the amended requirements shall go into effect.

9.2 Stakeholder Feedback on the Provisional Outdoor Residential Water Use Efficiency Standard

Two broad categories of stakeholder feedback were received in response to the above provisional standard.

1. **The proposed standard is too low and infeasible**. Some stakeholders expressed concerns that an outdoor standard of 0.70 renders cost-effective implementation infeasible because urban retail water suppliers lack authority to force residential customers, many of whom live in homes predating MWELO design criteria, to cut back their water use or make significant alterations to their landscapes. They also argued that the irrigation efficiency of 0.80 that DWR used in the horticultural and irrigation sciences method for the derivation of the outdoor standard is too high and does not reflect actual field conditions.

2. **The outdoor standard should ramp down over time**. Some stakeholders preferred to see the outdoor water use standard ramp down over time, placing implementation on a more realistic "glide path," without losing sight of the long-term imperative to continue to conserve. They argue that the State is experiencing more frequent and severe drought and reduced runoff than ever before due to climate change, hence the need for more stringent long-term ORWUS.

Considerations of stakeholder feedback and impact analysis of the proposed standard resulted in DWR modifying its provisional ORWUS to incorporate a phased approach. Under this phased approach, ORWUS is set to 0.80 in 2023, and transitions to 0.63 in 2030 and beyond. The phase-in approach was presented as the draft recommendation to the stakeholders at the final stakeholder meeting on January 25, 2022. The stakeholders were then asked to submit written comments on the draft recommendation by February 8, 2022. DWR received and thoroughly reviewed the written stakeholder comments.

Taking into consideration DWR's legislative mandate and the imperative to achieve reasonably greater long-term water use efficiency for climate resilience, DWR recommends an ORWUS of 0.8 for 2023, and 0.63 for 2030 and beyond. For new landscapes installed any time after the year the LAM imagery was obtained, DWR recommends an ORWUS of 0.55, or MWELO's ETAF value as amended, to stay consistent with post-2015 MWELO guidelines.

Note that the proposed 0.80 standard in 2023 is derived from the age distribution of housing stocks and their corresponding ETAFs analysis presented in Section 8.3. It is also consistent with the current MWELO standard ETAF for existing non-rehabilitated landscapes, which represents over 80 percent of all residential parcels. Similarly, a lower standard of 0.63 is also compatible with the existing level of average outdoor water use efficiency empirically observed in the State for urban retail water suppliers that have efficient outdoor water use (Section 8.1). Raising the standard to 0.80 and the phase-in refinement is meant to reduce the impact of a provisional ORWUS of 0.70, which may be significant for some urban retail water suppliers at the start, allowing for a more realistic implementation glide path without compromising on long-term water conservation goals. This revision deals with both elements of stakeholder feedback described above.

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10.0 Assessment of Urban Water Use Standards in Relation to Senate Bill X7-7 Statewide Target

10.1 Legislative Directive

Section 10609.2(d) of the WC states:

> *The long-term standards shall be set at a level designed so that the water use objectives, together with other demands excluded from the long-term standards such as CII indoor water use and CII outdoor water use not connected to a dedicated landscape meter, would exceed the statewide conservation targets required pursuant to Chapter 3 (commencing with Section 10608.16).*

The relevant parts of Chapter 3 of the WC are as follows:

> *The [S]tate shall achieve a 20-percent reduction in urban per capita water use in California on or before December 31, 2020* (WC Section 10608.16(a)).

> *Each urban retail water supplier shall develop urban water use targets and an interim urban water use target by July 1, 2011. Urban retail water suppliers may elect to determine and report progress toward achieving these targets on an individual or regional basis, as provided in subdivision (a) of Section 10608.28, and may determine targets on a fiscal year or calendar year basis* (WC Section 10608.20(a)(1)).

> *It is the intent of the Legislature that the urban water use targets described in paragraph (1) cumulatively result in a 20-percent reduction from the baseline daily per capita water use by December 31, 2020* (WC Section 10608.20(a)(2)).

Using the data that urban retail water suppliers submitted in their Urban Water Management Plans, DWR determined statewide baseline water use to be 199 gpcd and the 2020 statewide water use target (80 percent of baseline) to be 159 gpcd.[15]

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[15] Page 3-3 of DWR and State Water Board, 2018.

DWR interprets WC Section 10609.2(d) to mean that the urban water-use efficiency standards it recommends to the State Water Board must result, on average, in statewide objective-based total water use that is less than the 2020 statewide cumulative daily per capita water use target of 159 gpcd.[16]

WC Section 10609.20(c) defines an urban retail water supplier's UWUO as the sum of the following:

1. Aggregate estimated efficient indoor residential water use.
2. Aggregate estimated efficient outdoor residential water use.
3. Aggregate estimated efficient outdoor irrigation of landscape areas with dedicated irrigation meters (or equivalent technologies) in connection with CII water use.
4. Aggregate estimated efficient water loss.
5. Aggregate estimated water use associated with variances, as appropriate.

WC Section 10609.2(d) defines objective-based total water use as urban retail water suppliers' UWUO plus other demands excluded from the long-term standards. These other demands consist of CII water uses that are not delivered through a DIM, other miscellaneous metered uses, such as water delivered through temporary or construction meters, authorized unbilled water uses, and apparent water loss.

Urban retail water suppliers' UWUO plus other demands excluded from the long-term standards comprise the State's estimate of efficient urban water use. Under the provisional standards, this volume of water must be less than the 2020 cumulative statewide water use target of 159 gpcd.

[16] An alternative interpretation of WC Section 10609.2(d) is that the standards must be set such that they result in each urban retail water supplier's objective-based total water use being less than its individual daily per capita water use target pursuant to Chapter 3 of the WC. There are three reasons why DWR has not adopted this interpretation. First, WC Section 10608.20(a)(2) clearly states that it was the Legislature's intent that the urban water use targets cumulatively result in a 20 percent reduction from baseline per capita water use. The emphasis is on the cumulative result, not the individual urban retail water supplier's result. Second, because the Legislature gave urban retail water suppliers substantial discretion in how they set their individual targets, collectively, they do not cumulatively result in a 20 percent reduction. The population-weighted average of the individual urban retail water supplier targets is 171 gpcd, whereas the cumulative statewide target is 159 gpcd. Third, WC Section 10608.20(a)(1) allows urban retail water suppliers to comply with their targets on a regional basis. Under this provision of the WC, urban retail water suppliers in a regional alliance are not individually responsible for meeting their targets, provided the regional alliance's overall target is met.

10.2 Legislative Test of Water Code Section 10609.2(d)

To ensure DWR's proposed standards are consistent with WC Section 10609.2(d), DWR enacted the test illustrated in Figure 10-1 comparing statewide objective-based total water use to the 2020 statewide cumulative water use target of 159 gpcd.

Due to data limitations, certain adjustments to the calculation of objective-based total water use were required in the implementation of this test. First, because DWR does not have access to Commercial, Industrial, and Institutional dedicated Irrigation meter (CII-DIM) landscape area data, it is unable to calculate efficient CII-DIM water use. To address this issue, DWR used current CII-DIM water use in the test. Because current CII-DIM water use is expected to be greater than efficient CII-DIM water use, this yields a more conservative test. Second, DWR was not able to include variance water uses in the test since these will be approved by the State Water Board on a case-by-case basis after the standards are adopted. Therefore, DWR used the difference between the 2020 statewide cumulative water use target and calculated objective-based total water use as a measure of the volume of water available for variances. A large difference indicates that variances could be accommodated while still meeting the requirements of WC Section 10609.2(d).

Legislative Test Implemented by DWR

Objective-based Total Water Use = Efficient Indoor Residential Use + Efficient Outdoor Residential Use + Efficient Real Water Loss + Current CII-DIM Use + CII and Other Miscellaneous Use + Authorized Unbilled Use + Apparent Water Loss	≤	**2020** **Statewide Cumulative** **Daily Per Capita Water Use Target** **of 159 GPCD**

Figure 10-1 California Water Code Section 10609.2(d) Legislative Test

10.3 Urban Water Use Objective Analyzer

DWR used its Urban Water Use Objective Analyzer to evaluate many aspects of the provisional ORWUS in combination with alternative IRWU standards, such as:

- The impact of capping the buffer.
- Whether the standards meet the SB X7-7 legislative test.
- Urban retail water supplier‑level reductions required to comply with UWUOs.
- Statewide water savings.

For a given set of indoor residential standards and the recommended ORWUS, this spreadsheet model compares current and objective-based total water use to the 2020 statewide and individual urban retail water supplier SB X7-7 water use targets.

The Urban Water Use Objective Analyzer draws on the following data sources:

- **2017 to 2019 eAR** – eAR data are used to estimate urban retail water supplier service area population, number of metered and unmetered service connections, and current residential, CII-DIM, CII non-DIM, and other miscellaneous water uses.
- **2017 to 2019 Water Audit Reports** – Urban retail water suppliers' water audit report data are used to estimate current real and apparent water loss and authorized unbilled water uses, which together make up urban retail water suppliers' non-revenue water use.
- ***Results of the Indoor Residential Water Use* Study (DWR, 2021) –** Using data developed with the methodology from this study, DWR estimated the urban retail water suppliers' IRWU. Indoor use estimates based on an urban retail water supplier's own data are privileged over alternative estimates produced by other methods, as discussed earlier in this report.
- **LAM, CIMIS, and Cal-SIMETAW** – Data from the LAM project are used to estimate an urban retail water suppliers' residential landscape area, decomposed into II and INI components. CIMIS and Cal-SIMETAW data are used to estimate an urban retail water suppliers' reference evapotranspiration minus effective precipitation.
- **UWMPs** – UWMP data are used to determine urban retail water suppliers' 2020 per capita water use targets. UWMP data also are used to fill in missing eAR data and to correct aberrant eAR data, as described below. Additionally, UWMP

data are used to estimate current potable reuse, which is used by the Urban Water Use Objective Analyzer to estimate the potable reuse bonus incentive.

- **Census American Community Survey (ACS) and DOF Population and Housing Estimates** – In addition to the UWMP data, in certain cases population and housing data from the Census ACS and DOF are used to cross-check and correct aberrant eAR service area population estimates. Additionally, these data are used to decompose service area population into residential and group quarters components for purposes of estimating IRWU.

Rigorous data consistency and quality assurance checks were used to screen the data used in the Urban Water Use Objective Analyzer, including:

- Flagging unusual, outlier, or missing eAR data.
- Cross-checking flagged data with UWMP and/or ACS or DOF data.
- Filling in missing eAR data and correcting eAR data determined to be erroneous.

All data corrections are documented within the Urban Water Use Objective Analyzer and the original and corrected data are stored side-by-side in the model. There is no data destruction. Results generated by DWR’s Urban Water Use Objective Analyzer were cross-checked against results produced by a similar spreadsheet model developed by State Water Board staff. Both tools produce comparable results.

Water Use Definitions

The DWR Urban Water Use Objective Analyzer uses the following urban retail water supplier water use definitions:

- **Current Total Use** – The average total water use reported by urban retail water suppliers for 2017 to 2019.
- **2020 Target Use** – The urban retail water supplier’s (SB X7-7) 2020 per capita water use target multiplied by its 2017 to 2019 average population.
- **Objective-Based Total Use** – The urban retail water supplier’s estimated objective-based water use is calculated from the sum of the following components:
  - Efficient indoor residential use.
  - Efficient outdoor residential use.
  - Efficient real water loss.

- Current CII-DIM use.
- CII and other miscellaneous use.
- Authorized unbilled use.
- Apparent water loss.

The urban retail water supplier’s current CII-DIM water use serves as a stand-in for efficient CII-DIM water use because DWR does not have the landscape area data needed to calculate aggregate estimated efficient outdoor irrigation of landscape areas with DIMs in connection with CII water use. Adjustments for variances also remain excluded. These will be approved by the State Water Board on a case-by-case basis after the standards are adopted and urban retail water suppliers submit their requests for variances. However, if an urban retail water supplier includes potable reuse in its supply portfolio, an estimate of its potable reuse bonus incentive, per WC Section 10609.20(d), is added to its objective-based total use when analyzing potential water savings and urban retail water supplier impacts of the provisional standards.

Because current DIM water use is expected to be greater than efficient DIM water use (under the recommended CII-DIMWUS), statewide objective-based total water use in the tool is biased upward, making the SB X7-7 legislative test more difficult to pass. Since variances cannot be included in the test for the reason discussed above, the difference between the statewide SB X7-7 target and estimated statewide objective-based total water gauges the maximum volume of water available for variances.

- **Expected Total Use** – Lesser of the urban retail water supplier’s current total use and their objective-based total use. It is expected that urban retail water suppliers with current total use above their objective would implement policies to reduce use to meet their objective. It is not expected that urban retail water suppliers will implement policies to increase use up to their objectives.[17]
- **Expected Water Savings** – The difference between current total use and expected total use under the provisional standards.

Additionally, the DWR Urban Water Use Objective Analyzer decomposes residential water use into indoor and outdoor components as follows:

- **Total Residential Use** – Average residential water use reported by urban retail water suppliers for 2017 to 2019.

[17] For the same reason that DWR does not observe urban retail water suppliers with current use below their 2020 target implementing policies to increase use up to their target.

- **Indoor Residential Use** – The estimate of indoor residential per capita water use for the urban retail water supplier multiplied by the urban retail water supplier's service area residential population.

- **Outdoor Residential Use** – The difference between total residential use and indoor residential use.

10.4 Standards Evaluated in the Legislative Test

DWR evaluated two alternative sets of standards, which are summarized in Table 10-1 and Table 10-2. The sets differ only in terms of the indoor residential standards. In all other respects, they are identical. The first set uses the indoor residential standards in the WC. These are 55 gpcd until 2025, 52.5 gpcd from 2025 to 2029, and 50 gpcd from 2030 onward. The second set uses the indoor residential standards recommended by DWR and the State Water Board in their report to the Legislature on IRWU.[18] These are 55 gpcd until 2025, 47 gpcd from 2025 to 2029, and 42 gpcd from 2030 onward.

The ORWUS is 0.80 through 2029, after which time the standard steps down to 0.63.[19] The standard is applied to 100 percent of II and 20 percent of INI residential landscape area. Net reference evapotranspiration is equal to reference evapotranspiration minus effective precipitation. Effective precipitation is capped at 25 percent of annual rainfall.

The WLS is set to the draft standard for real water loss posted on State Water Board's website.[20] If an urban retail water supplier's baseline real water loss is less than 16 gallons per connection per day, it is assumed they will pursue the State Water Board's proposed alternative compliance pathway. This sets the urban retail water supplier's WLS at 16 gallons per connection per day, provided the urban retail water supplier maintains real water loss at or below this level and satisfies several reporting

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[18] https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Water-Use-And-Efficiency/AB-1668-and-SB-606-Conservation/IRWUS-Public-Review-Draft-ReportPAO7May21-v1.pdf

[19] The provisional standard for new residential landscape is 55 percent of net reference evapotranspiration. However, the legislative test is based only on existing residential landscape area and thus the provisional standard for new landscape area does not factor into it.

[20] https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/docs/standards-to-release.xlsx and https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/docs/waterlosscontrol/2020/proposed_water_loss_standards_1dec2020.pdf

requirements. The WLS takes effect January 1, 2028.[21] Prior to this date, urban retail water suppliers' UWUOs are calculated using their baseline water loss.[22]

Table 10-1 Recommended Outdoor Standard with Indoor Residential Standard in the Water Code

Period	Residential Indoor	Residential Outdoor	Distribution System Real Loss
Before 2025	55 gpcd	ETF = 0.80 applied to 100% II + 20% INI	Baseline
2025 to 2027	52.5 gpcd	ETF = 0.80 applied to 100% II + 20% INI	Baseline
2028 to 2029	52.5 gpcd	ETF = 0.80 applied to 100% II + 20% INI	State Water Board Draft Standard
2030 onward	50 gpcd	ETF = 0.63 applied to 100% II + 20% INI	State Water Board Draft Standard

Key:
ETF = evapotranspiration factor (on urban retail water supplier level)
gpcd = gallons per capita per day
II = irrigable-irrigated
INI = irrigable-not irrigated
State Water Board = State Water Resources Control Board

Table 10-2 Recommended Outdoor Standard with Indoor Residential Standard Recommended by California Department of Water Resources and State Water Resources Control Board to the Legislature

Period	Residential Indoor	Residential Outdoor	Distribution System Real Loss
Before 2025	55 gpcd	ETF = 0.80 applied to 100% II + 20% INI	Baseline
2025 to 2027	47 gpcd	ETF = 0.80 applied to 100% II + 20% INI	Baseline
2028 to 2029	47 gpcd	ETF = 0.80 applied to 100% II + 20% INI	State Water Board Draft Standard
2030 onward	42 gpcd	ETF = 0.63 applied to 100% II + 20% INI	State Water Board Draft Standard

Key:
ETF = evapotranspiration factor (on urban retail water supplier level); gpcd = gallons per capita per day
II = irrigable-irrigated; INI = irrigable-not irrigated; State Water Board = State Water Resources Control Board

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[21] The deadline may be extended to January 1, 2031, for DAC-designated urban retail water suppliers meeting certain conditions. Additionally, suppliers with standards that require at least a 30 percent reduction from baseline real water loss may be eligible for the same deadline extension provided they demonstrate progress in lowering their water loss and satisfy other reporting and verification requirements.

[22] Personal communication with State Water Board staff.

10.5 Legislative Test Results

DWR implemented the legislative test using its Urban Water Use Objective Analyzer (Section 10.3). The results are summarized in Table 10-3 and Table 10-4. Table 10-3 shows the results when the indoor residential standards in the WC are used in the test. Table 10-4 shows results when DWR's and the State Water Board's recommended indoor residential standards are used instead in the test. Under either set of standards, objective-based total water use is less than the 2020 statewide target in all time periods. Under the long-term standards commencing in 2030, the difference is 22 gpcd under the first case and 30 gpcd under the second.

Table 10-3 Legislative Test Results (Indoor Standards in the Water Code)

Period	Statewide Target (gpcd)	Objective-Based Total Use (gpcd)	Target Exceedance (gpcd)
Before 2025	159	154	5
2025 to 2027	159	151	8
2028 to 2029	159	149	10
2030 onward	159	137	22

Key:
gpcd = gallons per capita per day

Table 10-4 Legislative Test Results (Indoor Standards Recommended by the California Department of Water Resources and State Water Resources Control Board to the Legislature)

Period	Statewide Target (gpcd)	Objective-Based Total Use (gpcd)	Target Exceedance (gpcd)
Before 2025	159	154	5
2025 to 2027	159	146	13
2028 to 2029	159	144	15
2030 onward	159	129	30

Key:
gpcd = gallons per capita per day

10.6 Sensitivity of the Legislative Test Results to Variances and Potable Reuse Bonus Incentive

Variance water use, which is not included in the test, would need to exceed 22 gpcd under the first case and 30 gpcd under the second case, for the evaluated standards to fail the legislative test. This is equivalent to 15 to 20 percent of current urban water use or about 0.9 to 1.2 million acre-feet. It is implausible that variances granted by the State Water Board would potentially account for such a large volume of water use. Thus, DWR concludes that the evaluated standards are consistent with WC Section 10609.2(d) even when variances are considered.

WC Section 10609.20(d) specifies that an urban retail water supplier that delivers water from a groundwater basin, reservoir, or other source that is augmented by potable reuse water may add to its UWUO a bonus incentive based on the amount of their potable reuse. The bonus incentive is an adjustment to the urban retail water supplier's UWUO rather than part of its UWUO, as defined in WC Section 10609.20(c). As such, the bonus incentive was excluded from the legislative test discussed in the previous section.

Based on data provided in urban retail water suppliers' Urban Water Management Plans and other sources of information received from the State Water Board staff (as reported by wholesalers), DWR has estimated that 66 urban retail water suppliers could be eligible for the potable reuse bonus incentive. Using publicly available data on groundwater recharge with recycled water and groundwater pumping, DWR has calculated the potable reuse bonus incentive for these 66 urban retail water suppliers in accordance with WC Section 10609.20(d).

To assess the sensitivity of adding bonus incentive to the SB X7-7 test, DWR re-ran the legislative test with the potable reuse bonus incentive included in urban retail water suppliers' objective-based total water use. This had the effect of increasing statewide objective-based total water use by approximately 2 gpcd. Thus, the exceedance volumes in Tables 10-3 and 10-4 are decreased by 2 gpcd when the potable reuse bonus incentive is included in the test. This is not enough to materially change the results of the test. There remains an ample difference between objective-based total water use and the 2020 statewide target such that variances can be accommodated while remaining consistent with the requirements of WC Section 10609.2(d).

It should be noted that the statewide 2020 target of 159 gpcd also excludes potable reuse and industrial process water uses. Objective-based total water use, on the other hand, includes industrial process water use and allows urban retail water suppliers to add to their objective a credit for potable reuse. To make an apples-to-apples comparison with objective-based total water use, therefore, the industrial process water and potable reuse volumes excluded from the statewide target should be added back. However, because WC Section 10609.2(d) does not refer to the need for such adjustments, DWR chose not to do this. Nonetheless, the results of the legislative test strongly indicate that the long-term standards will result in statewide objective-based total water use, even with the inclusion of variances and the potable reuse bonus incentive, that is lower than the statewide 2020 target. Thus, DWR has concluded the proposed standards satisfy the requirements of WC Section 10609.2(d).

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11.0 Impact on Urban Retail Water Suppliers of Alternative Indoor Residential and Recommended Outdoor Residential Standards

As discussed previously, ORWU exhibits a large spread (heterogeneity) across urban retail water suppliers, raising concerns that the use of statewide efficiency standards will require some urban retail water suppliers to make very large reductions, while others will have to do little or nothing at all. This question was also addressed using DWR's Urban Water Use Objective Analyzer (Section 10.3) in two different ways. The first examines current total use (2017 to 2019) relative to objective-based total use; the second restricts the assessment to just the water uses subject to efficiency standards – residential indoor and outdoor use plus CII-DIM use and real water loss. The second assessment is more pertinent, since it is restricted to the water uses that determine compliance with the water use efficiency standards.

As in the legislative test discussed in the previous section, current CII-DIM water use is used instead of efficient CII-DIM water use and variances are not included in the calculation of urban retail water suppliers' UWUO. These two adjustments impact the exceedance results in opposite directions. Using current CII-DIM water use inflates the water use objective while excluding variances deflates it. The net effect on the exceedance distributions presented in this section is indeterminate, but not expected to be large given that CII-DIM water use and variances are expected to comprise a relatively small share of objective-based total water use for most urban retail water suppliers.[23]

The assessment of urban retail water supplier impacts also is affected by the exclusion or inclusion of an urban retail water suppliers' potable reuse bonus incentive. Inclusion of the bonus incentive affords larger water use budgets to urban retail water suppliers with potable reuse, and therefore, may reduce the amount by which they need to reduce their current water use to comply with the water use standards. However, an urban retail water supplier only stands to benefit from this if the sum of its current water uses subject to the four established standards exceeds its UWUO.

In order to gauge the effect of the potable reuse bonus incentive, the impact analysis was conducted with and without its inclusion. As shown in the next section, the effect of

[23] DWR estimates, for example, that CII-DIM water use currently comprises only 8 percent of urban water use.

the bonus incentive is to increase the number of urban retail water suppliers that would have to make either no or only small adjustments to their water use to comply with the standards. However, it does not significantly alter the subset of urban retail water suppliers that would have to make substantial, and possibly infeasible, reductions in their water use to comply with the standards.

11.1 Exceedance Assessment Results: Objective-Based Total Water Use

The first assessment examines the amount by which an urban retail water supplier's current total water use exceeds its 2030 objective-based total water use under the recommended standards. These results are summarized in Table 11-1 through Table 11-4.

As shown in Table 11-1 and Table 11-2, if the indoor standards in the WC are maintained, then 46 percent of urban retail water suppliers do not have a reduction requirement when the bonus incentive is excluded from the analysis, and 51 percent do not have a reduction requirement when the bonus incentive is included. Under either scenario, there are 19 urban retail water suppliers (5 percent) whose current use exceeds their objective-based total use by more than 30 percent. The mean exceedance for this group of urban retail water suppliers is 45 percent. A cap on the reduction requirement for these urban retail water suppliers may be needed to make compliance feasible.

Table 11-1 2030 Objective-Based Total Water Use Exceedance Distribution, Excluding the Potable Reuse Bonus Incentive (Indoor Standard of 50 Gallons Per Capita Per Day in the Water Code)

	Current Water Use Exceedances				
	≤0 percent	0-10 percent	10-20 percent	20-30 percent	>30 percent
Supplier N	182	103	60	34	19
Percent of Suppliers	46 percent	26 percent	15 percent	8 percent	5 percent
Cumulative Percent	46 percent	72 percent	87 percent	95 percent	100 percent
Mean Exceedance Percent	N/A	5 percent	14 percent	24 percent	45 percent

Key:
gpcd = gallons per capita per day
N/A = not applicable
Supplier N = number of urban retail water suppliers

Table 11-2 2030 Objective-Based Total Water Use Exceedance Distribution, Including the Potable Reuse Bonus Incentive (Indoor Standard of 50 Gallons Per Capita Per Day in the Water Code)

	Current Water Use Exceedances				
	≤0 percent	**0-10 percent**	**10-20 percent**	**20-30 percent**	**>30 percent**
Supplier N	204	96	45	34	19
Percent of Suppliers	51 percent	24 percent	11 percent	9 percent	5 percent
Cumulative Percent	51 percent	75 percent	87 percent	95 percent	100 percent
Mean Exceedance Percent	N/A	5 percent	14 percent	24 percent	45 percent

Key:
gpcd = gallons per capita per day
N/A = not applicable
Supplier N = number of urban retail water suppliers

As shown in Table 11-3 and Table 11-4, if the indoor standards recommended by DWR and the State Water Board are adopted, then 31 percent of urban retail water suppliers do not have a reduction requirement when the bonus incentive is excluded from the analysis, and 35 percent do not have a reduction requirement when the bonus incentive is included. Under either scenario, there are 39 urban retail water suppliers (10 percent) whose current use exceeds their objective-based total use by more than 30 percent. The mean exceedance for this group of urban retail water suppliers is 44 percent. A cap on the reduction requirement for these urban retail water suppliers may be needed to make compliance feasible.

Table 11-3 2030 Objective-Based Total Water Use Exceedance Distribution, Excluding the Potable Reuse Bonus Incentive (Indoor Standard of 42 Gallons Per Capita Per Day, Recommended by the California Department of Water Resources and State Water Resources Control Board)

	Current Water Use Exceedances				
	≤0 percent	**0-10 percent**	**10-20 percent**	**20-30 percent**	**>30 percent**
Supplier N	125	100	83	51	39
Percent of Suppliers	31 percent	25 percent	21 percent	13 percent	10 percent
Cumulative Percent	31 percent	57 percent	77 percent	90 percent	100 percent
Mean Exceedance Percent	N/A	6 percent	15 percent	24 percent	44 percent

Key:
gpcd = gallons per capita per day;
N/A = not applicable
Supplier N = number of urban retail water suppliers

Table 11-4 2030 Objective-Based Total Water Use Exceedance Distribution, Including the Potable Reuse Bonus Incentive (Indoor Standard of 42 Gallons Per Capita Per Day, Recommended by the California Department of Water Resources and State Water Resources Control Board)

	Current Water Use Exceedances				
	≤0 percent	0-10 percent	10-20 percent	20-30 percent	>30 percent
Supplier N	138	109	74	38	39
Percent of Suppliers	35 percent	27 percent	19 percent	9 percent	10 percent
Cumulative Percent	35 percent	62 percent	81 percent	90 percent	100 percent
Mean Exceedance Percent	N/A	5 percent	14 percent	24 percent	44 percent

Key:
gpcd = gallons per capita per day
N/A = not applicable
Supplier N = number of urban retail water suppliers

11.2 Exceedance Assessment Results: Urban Water Use Objective

DWR's Urban Water Use Objective Analyzer was used to assess the amount by which an urban retail water supplier's current residential water use, CII-DIM water use, and real water loss exceed its 2030 UWUO under the recommended standards. In other words, this assessment is focused only on the water uses that determine compliance with the water use standards and the resulting UWUO. Results are summarized in Table 11-5 through Table 11-8.

As shown in Table 11-5 and Table 11-6, if the indoor standards in the WC are maintained, then 46 percent of urban retail water suppliers do not have a reduction requirement when the bonus incentive is excluded from the analysis, and 51 percent do not have a reduction requirement when the bonus incentive is included. Under either scenario, there are 46 urban retail water suppliers (12 percent) whose current use exceeds their UWUO by more than 30 percent. The mean exceedance for this group of urban retail water suppliers is 57 percent when the bonus incentive is excluded from the analysis, and 56 percent when it is included. A cap on the reduction requirement for urban retail water suppliers with such high exceedances may be needed to make compliance feasible.

Table 11-5 2030 Water Use Objective Exceedance Distribution, Excluding the Potable Reuse Bonus Incentive (Indoor Standards in the Water Code)

	Current Water Use Exceedances				
	≤0 percent	0-10 percent	10-20 percent	20-30 percent	>30 percent
Supplier N	182	81	52	37	46
Percent of Suppliers	46 percent	20 percent	13 percent	9 percent	12 percent
Cumulative Percent	46 percent	66 percent	79 percent	88 percent	100 percent
Mean Exceedance Percent	N/A	5 percent	14 percent	24 percent	57 percent

Key:
N/A = not applicable
Supplier N = number of urban retail water suppliers

Table 11-6 2030 Water Use Objective Exceedance Distribution, Including the Potable Reuse Bonus Incentive (Indoor Standards in the Water Code)

	Current Water Use Exceedances				
	≤0 percent	0-10 percent	10-20 percent	20-30 percent	>30 percent
Supplier N	204	75	44	29	46
Percent of Suppliers	51 percent	19 percent	11 percent	7 percent	12 percent
Cumulative Percent	51 percent	70 percent	81 percent	88 percent	100 percent
Mean Exceedance Percent	N/A	5 percent	14 percent	24 percent	56 percent

Key:
N/A = not applicable
Supplier N = number of urban retail water suppliers

As shown in Table 11-7 and Table 11-8, if the indoor standards recommended by DWR and the State Water Board are adopted, then 31 percent of urban retail water suppliers do not have a reduction requirement when the bonus incentive is excluded from the analysis, and 35 percent do not have a reduction requirement when the bonus incentive is included. Under the first scenario there are 80 urban retail water suppliers (20 percent), and under the second scenario there are 70 urban retail water suppliers (18 percent) whose current use exceeds their UWUO by more than 30 percent. The mean exceedance for these urban retail water suppliers is 54 percent when the bonus incentive is excluded and 57 percent when it is included. A cap on the reduction requirement for urban retail water suppliers with such high exceedances may be needed to make compliance feasible.

Table 11-7 2030 Water Use Objective Exceedance Distribution, Excluding the Potable Reuse Bonus Incentive (Indoor Standards Recommended by the California Department of Water Resources and State Water Resources Control Board)

	Current Water Use Exceedances				
	≤0 percent	**0-10 percent**	**10-20 percent**	**20-30 percent**	**>30 percent**
Supplier N	125	66	76	51	80
Percent of Suppliers	31 percent	17 percent	19 percent	13 percent	20 percent
Cumulative Percent	31 percent	48 percent	67 percent	80 percent	100 percent
Mean Exceedance Percent	N/A	6 percent	15 percent	24 percent	54 percent

Key:
N/A = not applicable
State Water Board = State Water Resources Control Board
Supplier N = number of urban retail water suppliers

Table 11-8 2030 Water Use Objective Exceedance Distribution, Including the Potable Reuse Bonus Incentive (Indoor Standards Recommended by the California Department of Water Resources and State Water Resources Control Board)

	Current Water Use Exceedances				
	≤0 percent	**0-10 percent**	**10-20 percent**	**20-30 percent**	**>30 percent**
Supplier N	138	73	75	42	70
Percent of Suppliers	35 percent	18 percent	19 percent	10 percent	18 percent
Cumulative Percent	35 percent	53 percent	72 percent	82 percent	100 percent
Mean Exceedance Percent	N/A	5 percent	14 percent	24 percent	57 percent

Key:
N/A = not applicable
Supplier N = number of urban retail water suppliers

11.3 Impact of the Proposed Long-Term Standards on Urban Trees

The 2018 Legislation recognizes the benefits of urban landscape trees and states that long-term standards and UWUO should acknowledge the shade, air quality, and heat-island reduction benefits provided to communities by trees through the support of water-efficient irrigation practices that keep trees healthy (WC Section 10609(c)(3)). It further directs the State Water Board to consider the policies and proposed efficiency standards' effects on local wastewater management, developed and natural parklands, and urban tree health when adopting the standards (WC Section 10609.2(c)). For this reason, DWR did not conduct detailed studies and investigations to determine the impact of the recommended long-term standards on urban landscape trees. Based on limited literature review and DWR staff expertise, however, the recommended standards do not adversely impact the urban landscape trees.

WC Section 10609(c)(1) states that local urban retail water suppliers should have primary responsibility for meeting standards-based water use targets, and they shall retain the flexibility to develop their water supply portfolios, design and implement water conservation strategies, educate their customers, and enforce their rules. This means that each landscape feature in an urban retail water supplier’s service area does not necessarily have to receive the same amount of water based on the recommended ORWUS. Potential adverse impacts of the recommended standards on urban trees can be avoided by improving landscape irrigation systems and properly managing landscape plants. Since long-term standards apply to a mix of landscape species that require different amounts of water, local urban retail water suppliers should adopt measures that supply adequate water to urban shade trees and less water as is appropriate for low water demanding landscape features. The requirement is for the average ETF to remain less or equal to the ORWUS at the service area level.

Successful implementation of the water use efficiency standards and water use objectives require urban retail water suppliers to educate and assist their customers, as well as the State to provide complementary assistance to urban retail water suppliers, and particularly the low income and disadvantaged communities.

11.4 Exceedance Assessment Summary

The results of the exceedance analysis indicate that the proposed statewide efficiency standards may impose an undue compliance burden on a subset of urban retail water suppliers at current levels of residential water use. Mean exceedance for suppliers with current use more than 30 percent above their UWUO is greater than 50 percent (see Tables 11-5 through 11-7). While the variance process may attenuate exceedances for some of these urban retail water suppliers, others will face an unreasonable, and likely infeasible, reduction requirement. It is for this reason that DWR recommends that the State Water Board place a time-limited cap on the extent of required water use reductions by individual urban retail water suppliers.

At the same time, there are some urban retail water suppliers for whom the UWUO is greater than their SB X7-7 2020 target. Current water use for most of these urban retail water suppliers is less than their 2020 target, while a few have current water use that is greater. The latter group do not appear to be on track to meeting their 2020 targets under SB X7-7. DWR recommends that if an urban retail water supplier’s UWUO exceeds its 2020 target, the State Water Board adjust its UWUO to prevent backsliding from its 2020 target.

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12.0 Recommendation

12.1 Recommendation for the Outdoor Residential Water Use Efficiency Standard

In summary, DWR evaluated several factors while developing its ORWUS recommendation for the State Water Board. These include:

- Urban retail water suppliers' current outdoor residential water-use patterns.
- Efficiency guidelines codified in MWELO.
- SB X7-7 legislative test.
- Balancing long-term outdoor water use efficiency with equity across urban retail water suppliers.
- Implementation feasibility, stakeholder views and acceptance.
- Distributional impacts of long-term efficiency standards.

Based on these considerations, DWR recommends an ORWUS that includes the following requirements and specifications:

1. **Phase-In Approach**. For existing residential landscapes (homes built a year after the imagery that was used in the LAM project was taken), start with an ORWUS of 0.80 in 2023, and transition to a lower ORWUS of 0.63 in 2030 and beyond. This phase-in refinement is meant to reduce the impact that the stakeholders anticipated from a fixed provisional ORWUS of 0.70 that DWR initially proposed, which could be significant for some urban retail water suppliers in the early compliance years, allowing for a more realistic implementation glide path without compromising on long-term water conservation goals.

2. **New Residential Construction**. New residential construction's efficient outdoor water use should use an ORWUS of 0.55, or MWELO's ETAF value as amended, to stay consistent with MWELO's guidelines. New residential construction refers to landscapes installed after the year of imagery processed by the LAM project (2018 for most urban retail water suppliers).

3. **Special Landscape Areas in Residential Parcels**. Many urban retail water suppliers have SLAs in residential parcels. Urban retail water suppliers need to report their residential SLAs with CII-DIMs and subtract the SLA from the aggregate II landscape area estimates provided by DWR to avoid double

counting. When applied with the CII-DIM, an outdoor water use standard for SLAs will be 1.0. If an urban retail water supplier chooses to include the residential SLAs in the ORWU report for ease of internal record keeping or other reasons; however, the current ORWUS standard (0.80 in 2003 to 2029, and 0.63 in 2030 and thereafter) shall be used to calculate efficient outdoor water use for SLA.

4. **Include 20 Percent of INI and All of II Landscape Area**. For calculating EORWU, urban retail water suppliers should apply the ORWUS to the sum of II and 20 percent of INI landscape areas, with the former adjusted for residential SLAs evaluated according to the methodology in CII-DIMWUS. The 20 percent INI buffer may change based on the outcome of further studies and investigations to be conducted jointly by DWR and the State Water Board (see Section 5.4).

5. **Capping the Severity of Demand Reductions Required by the UWUO, Variances, and Bonus Incentive**. DWR recommends to the State Water Board that it consider placing a cap for a limited time on how large a reduction urban retail water suppliers should be expected to make per year, in case their actual water use that is subject to efficiency standards exceeds their UWUO plus variances and bonus incentive.

6. **Compliance with 2020 SB X7-7 Targets**. Most urban retail water suppliers are on track to comply with their SB X7-7 targets. They must maintain their water use below these targets in the future as the State transitions to efficiency-standard based UWUOs. Urban retail water suppliers that are not on track to meeting their 2020 SB X7-7 targets must come into compliance with these targets as well as their UWUO. DWR recommends that for this group of urban retail water suppliers whose calculated water use objective exceeds their 2020 targets, the State Water Board adjust components of their UWUO to prevent backsliding from their 2020 targets.

12.2 Stakeholder Suggestions and Recommendations

Several suggestions and recommendations were proposed by stakeholders in the various working groups and public meetings. These are not specific recommendations by DWR to the State Water Board, but are included as suggestions, since improving urban water use efficiency depends on the successful implementation of the final water use efficiency standards adopted by the State Water Board. These suggestions and recommendations also recognize that successful implementation of the new water use efficiency standards and water use objectives require complementary actions by the State to assist local agencies as they implement the new framework. DWR heard repeatedly from stakeholders that technical and financial support for urban retail water suppliers is key to the successful implementation of the new framework. DWR includes these suggestions here to underscore their importance for future consideration.

- Technical Assistance:
  - The State should consider providing technical assistance to urban retail water suppliers, especially small urban retail water suppliers with limited resources, for implementation and reporting of water use objectives, variances, actual water use, and other progress reports to DWR.
  - The State should consider providing technical assistance and guidance to urban retail water suppliers on measuring landscapes associated with CII-DIMs.
  - The State should consider providing technical assistance to urban retail water suppliers on how customers can improve outdoor water use efficiency while protecting existing landscapes. This includes landscapes with higher plant factors, urban wildlife habitat, and urban shade trees.
- Financial and Local Assistance:
  - The State should consider providing direct financial assistance programs, not rebates, for low-income communities to assist in potential water affordability and support human right to water.
  - The State should consider providing financial assistance to urban retail water suppliers, wastewater, and recycled water utilities to mitigate the financial impact of new UWUOs and support the implementation of water use efficiency programs.
  - The State should consider offering incentives to urban retail water suppliers to support customer water use efficiency via local assistance grants and loan programs.
- Outreach and Messaging:
  - The State should augment efforts by Save Our Water to assist customers in understanding the need for water and wastewater rate changes.
  - The State should support additional statewide messaging to incentivize customers to participate in water use efficiency programs and upgrades.
- Data:

  - The State should consider providing updated landscape area measurement data to the urban retail water suppliers every five years.

- Other:

  - The State should encourage local jurisdictions responsible for MWELO to improve MWELO implementation and enforcement.

13.0 Guidelines for Assessing Compliance

Full details about calculation of the UWUO, variances, and bonus incentive are included in the *Recommendations for Guidelines and Methodologies for Calculating Urban Water Use Objective* (WUES-DWR-2021-01B). Only the calculation of EORWU, one of the components of an urban retail water supplier's UWUO, is shown here.

13.1 Calculation of Efficient Outdoor Residential Water Use

Urban retail water suppliers should calculate their EORWU as follows:

EORWU (supplier level) = (ETo – Peff) x (0.62) x ORWUS x (II + 0.2 x INI) .... (Eq. 5)

where,

- EORWU is the efficient outdoor residential water use in gallons.
- ETo is the reference evapotranspiration in inches.
- Peff is the Cal-SIMETAW-based effective precipitation in inches capped at 25 percent of total precipitation.
- 0.62 is a unit conversion factor.
- ORWUS is the Outdoor Residential Water Use Efficiency Standard.
- II + 0.2 x INI is the adjusted II residential landscape area for an urban retail water supplier in square feet.

Aggregate estimate of II landscape area must be adjusted for residential landscape areas evaluated according to the methodology in CII-DIMWUS, which at a minimum must include all residential SLAs and could optionally include all other residential landscapes irrigated by DIMs as well. For new homes built after the imagery was taken (2018 for most urban retail water suppliers), EORWU should be calculated using an ORWUS equal to 0.55.

Urban retail water suppliers can substitute their own data in place of DWR-provided data for calculation of EORWU provided they can demonstrate that their own data are of equal or better quality than data provided by DWR. Additional details about the use of alternative data are included in the *Recommendations for Guidelines and Methodologies for Calculating Urban Water Use Objective* (WUES-DWR-2021-01B).

13.2 Comparison of Water Use Objective to Actual Water Use

The efficient residential outdoor water use is one of several components that goes into development of an urban retail water supplier's UWUO. Compliance with the 2018 Legislation requires urban retail water suppliers to demonstrate that their actual water use subject to efficiency standards is less than their UWUO plus variances, bonus incentive, and potentially a cap on the severity of water use reductions required of urban retail water suppliers if approved by the State Water Board. These issues are discussed in greater detail in the *Recommendations for Guidelines and Methodologies for Calculating Urban Water Use Objective* (WUES-DWR-2021-01B).

14.0 Glossary

The following key terms are listed below for easy reference. Where applicable, existing definitions from statutes and regulations are provided.

California Irrigation Management Information System. A network of automated weather stations that are owned and operated cooperatively between the California Department of Water Resources and local agencies. The stations are installed in most of the agricultural and urban areas in the State of California and provide farm and large landscape irrigation managers and researchers with “real time” weather data to estimate reference evapotranspiration use to estimate crop and landscape evapotranspiration rates and make irrigation management decisions.

evapotranspiration. The amount of water transpired by plants, retained in plant tissues, and evaporated from plant tissues and surrounding soil surfaces.

evapotranspiration factor. An adjustment factor when applied to reference evapotranspiration that adjusts for plant factors and irrigation efficiency which are two major influences upon the amount of water that needs to be applied to the landscape.

evapotranspiration of applied water. The amount of consumptive use by crops, landscapes, or other vegetation. Evapotranspiration of applied water is the portion of evapotranspiration that was provided by applied irrigation water.

irrigable-irrigated land. A landscape area of healthy vegetation where the vegetation appears to be in growth, not senesced, and is foliated. The area is presumed to be maintained and managed through active irrigation.

irrigation efficiency. The efficiency of water application and use, calculated by dividing a portion of applied water that is beneficially used by the total applied water, expressed as a percentage. The two main beneficial uses are crop water use (evapotranspiration) and leaching to maintain a salt balance.

material effect. Having real importance or great consequences. In the context of California Department of Water Resources’ recommendations regarding the urban water use objective and variances, a material effect is an effect on the urban water use objective that could influence the compliance status of an urban retail water supplier.

public water system. A system for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year. A public water system includes the following: (1) any collection, treatment, storage, and distribution facilities under control of the operator of the system that are used primarily in connection with the system; (2) any collection or pretreatment storage facilities not under the control of the operator that are used primarily in connection with the system; and (3) any water system that treats water on behalf of one or more public water systems for the purpose of rendering it safe for human consumption, as defined in California Health and Safety Code Section 116275(h).

reference evapotranspiration. The evapotranspiration rate from an extended surface of 3- to 6-inch-tall (8- to 15-centimeter-tall) green grass cover of uniform height, actively growing, completely shading the ground, and not short on water (the reference evapotranspiration rate reported by the California Irrigation Management Information System).

service connection. The point of connection between the customer’s piping or constructed conveyance, and the water system’s meter, service pipe, or constructed conveyance (California Health and Safety Code Section 116275(s)).

urban retail water supplier. A water supplier, either publicly or privately owned, that directly provides potable municipal water to more than 3,000 end users or that supplies more than 3,000 acre-feet of potable water annually at retail for municipal purposes, as defined in California Water Code Section 10608.12(t).

urban water use efficiency standards. The standards effective through California Water Code Section 10609.4 (indoor residential use) or adopted by the State Water Resources Control Board (outdoor residential, water loss, and commercial, industrial, and institutional outdoor irrigation of landscape areas with dedicated meters) pursuant to California Water Code Section 10609.2.

urban water use objective. An estimate of aggregate efficient water use for the previous year based on adopted water use efficiency standards and local service area characteristics for that year, as described in California Water Code Section 10609.20, as defined in California Water Code Section 10608.12(u).

water loss. The total of apparent loss and real loss (California Code of Regulations, Title 23, Section 638.1(a) and Section 638.1(k), respectively) in an urban retail water supplier's system. Apparent loss means loss due to unauthorized consumption and/or nonphysical (paper) loss attributed to inaccuracies associated with customer metering or systematic handling errors. Real loss means the physical water loss from the pressurized potable water system and the urban retail water supplier's potable water storage tanks, up to the point of customer consumption.

15.0 References

DWR and State Water Board (California Department of Water Resources and State Water Resources Control Board). 2018. Making Water Conservation a California Way of Life. Primer of 2018 Legislation on Water Conservation and Drought Planning Senate Bill 606 (Hertzberg) and Assembly Bill 1668 (Friedman). Accessed at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Water-Use-And-Efficiency/Make-Water-Conservation-A-California-Way-of-Life/Files/PDFs/Final-WCL-Primer.pdf?la=en&hash=

_____. 2021. Results of the Indoor Residential Water Use Study. Accessed at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Water-Use-And-Efficiency/AB-1668-and-SB-606-Conservation/Results-of-the-Indoor-Residential-Water-Use-Study.pdf

Tanverakul, S. A. and J. Lee. 2015. “Impacts of Metering on Residential Water Use in California,” *Journal AWWA*, American Water Works Association, Vol. 107:2, pp. 69-75. February 1. doi: https://doi.org/10.5942/jawwa.2015.107.0005

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Appendix A - Urban Water Use Efficiency Recommendation Package Reports Incorporated by Reference

DWR (California Department of Water Resources). September 2022. Recommendations for Guidelines and Methodologies for Calculating Urban Water Use Objective. DWR Report Number: WUES-DWR-2021-01B.

DWR (California Department of Water Resources). September 2022. Landscape Area Measurements Final Project, Report EA-133C-16-CQ-0044. DWR Report Number: WUES-DWR-2021-02.T1.

DWR (California Department of Water Resources). September 2022. Summary of Recommendations for Variances. DWR Report Number: WUES-DWR-2021-04.

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