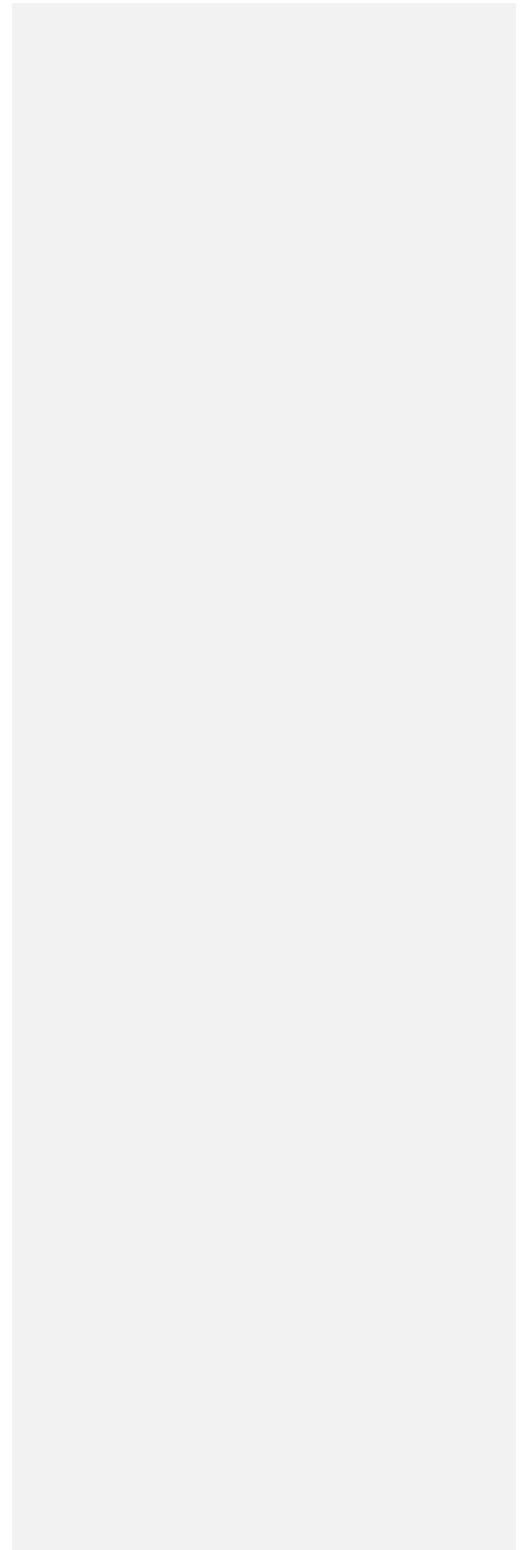


## **BSR/RESNET/ICC**

### **Standard 1101**

Standard for the Calculation  
and Labeling of the Water  
Use Performance of One-  
and Two-Family Dwellings  
Using the Water Rating  
Index



## Contents

1. Purpose.....	5
2. Scope.....	5
3. Definitions.....	5
3.1. General.....	5
3.2. Definitions.....	5
4. Home Water Rating Calculation Procedures.....	6
4.1. Determining the Water Rating Index.....	6
4.2. Calculating the Water Rating Index.....	6
4.3. Determining the Daily Indoor Water Use for the Reference Home.....	6
4.3.1. Determining Daily Reference Home Fixture Water Use.....	7
4.3.2. Determining Daily Reference Home Hot Water Waste.....	7
4.3.3. Determining Daily Reference Home Dish Washer Water Use.....	7
4.3.4. Determining Daily Reference Home Clothes Washer Water Use.....	8
4.3.5. Determining Daily Reference Home Toilet Water Use.....	8
4.3.6. Determining Daily Reference Home Water Softener Use.....	8
4.3.7. Determining Daily Reference Home Other Water Use.....	9
4.4. Determining the Reference Home Outdoor Annual Water Use.....	9
4.4.1. Determining Irrigated Area for the Reference Home.....	10
4.5. Determining Daily Indoor Water Use of the Rated Home.....	10
4.5.1. Determining Daily Shower Water Use for the Rated Home.....	11
4.5.2. Determining Daily Kitchen Faucet Water Use for the Rated Home.....	11
4.5.3. Determining Daily Lavatory Faucet Water Use for the Rated Home.....	11
4.5.4. Determining Daily Hot Water Waste for the Rated Home.....	12
4.5.5. Determining Daily Clothes Washer Water Use for the Rated Home.....	12
4.5.6. Determining Daily Dishwasher Water Use for the Rated Home.....	13
4.5.7. Determining Daily Toilet Water Use for the Rated Home.....	14
4.5.8. Determining Daily Water Softener Water Use for the Rated Home.....	14
4.5.9. Determining Daily Other Water Use for the Rated Home.....	14
4.5.10. Determining Daily Excess Pressure Adjustment Water Use for the Rated Home.....	15
4.6. Determining Outdoor Water Use for the Rated Home.....	15
4.6.1. Smart Controllers.....	16
4.6.2. Commissioning of an Automatic Irrigation System.....	16
4.6.3. Residential Irrigation Capacity Index (RICI).....	16
4.6.3.1. Applying RICI.....	16

CANDIDATE--BSR/RESNET/ICC Standard 1101-- Water Rating Index  
PDS-02

February 18, 2019

4.6.4.	Applying Adjustments to the Outdoor Water Use of Rated Homes.....	17
5.	Minimum Rated Features.....	17
5.1.	Data Sources.....	18
5.1.1.	Net Evapotranspiration.....	18
5.1.2.	Hardness of Water.....	18
5.2.	Default Values.....	18
5.3.	Incomplete Outdoor Area.....	19
6.	Certification and Labeling.....	19
6.1.	Rating Requirements.....	19
6.1.1.	General.....	19
6.1.2.	Cost Savings Estimates.....	20
6.1.2.1.	Water Cost Savings.....	20
6.1.2.1.1.	Water Prices.....	20
6.1.2.1.2.	Relevant Rates and Charges.....	20
6.1.2.1.3.	Water Cost Savings Calculations.....	20
6.1.2.1.3.1.	Average Billed Indoor Volume of the Reference Home.....	20
6.1.2.1.3.2.	Determine Outdoor Water Use for a Billing Period.....	20
6.1.2.1.3.2.1.	Peak Season Irrigation.....	20
6.1.2.1.3.2.2.	Year-Round Irrigation.....	20
6.1.2.1.3.3.	Combine Indoor and Outdoor Water Use Charges.....	21
6.1.2.1.3.4.	Determine Water Use Cost for the Rated Home.....	21
6.1.2.1.3.5.	Total Estimated Water Cost Savings.....	21
6.1.2.2.	Sanitary Sewer Service Cost Savings.....	21
6.1.2.2.1.	Sewer Service Prices.....	21
6.1.2.2.2.	Relevant Rates and Charges.....	21
6.1.2.2.3.	Sewer Cost Savings Calculations.....	21
6.1.2.2.3.1.	Average Billed Indoor Volume of the Water Rating Reference Home.....	21
6.1.2.2.3.2.	Annual Sewer Volume Charge for the Water Rating Reference Home.....	21
6.1.2.2.4.	Determine Annual Sewer charge for the Rated Home.....	22
6.1.2.2.5.	Estimated Sewer Cost Savings.....	22
6.1.2.2.6.	Combined Presentation of Cost Savings.....	22
6.1.2.4.	Other Cost Savings.....	22
6.1.3.	Reports.....	22
6.1.4.	Rating Types.....	22
6.1.4.1.	Confirmed Rating.....	22

CANDIDATE--BSR/RESNET/ICC Standard 1101-- Water Rating Index

PDS-02

February 18, 2019

6.1.4.2. Sampled Ratings.....	23
6.1.4.3. Projected Ratings.....	23
6.2. Innovative Design Requests.....	23
6.2.1. Petition.....	23
6.2.2. Approval.....	24
7. References.....	24

**FORWARD** (Informative)

This Standard provides a consistent, uniform methodology for evaluating, quantifying, and labeling the water use performance of one- and two-family dwellings. The methodology compares the water use performance of an actual home (rated home) with the water use performance of a reference home of the same geometry, resulting in a relative Water Use Rating called the Water Rating Index (WRI). Where the water use performance of the actual home and the reference home are equal, the Water Rating Index is 100.

The Reference Home used for this comparative analysis has the attributes of a standard home built circa 2006. The underpinnings of the indoor Reference Home model are based on [ANSI/RESNET/ICC Standard 301-2014, Addendum A](#). The outdoor Reference Home model is adapted using data from the Water Research Foundation's Residential End Uses of Water Study II. Both the indoor and outdoor calculation models are grounded in actual field water use data. It is the opinion of the Standard Development Committee that alternatives not included in the calculation of the Water Rating Index did not have sufficient data to develop an equation (on par with the existing indoor and outdoor model) to confidently and accurately predict their water consumption.

One such element that did not make it into this Preliminary Draft Standard is the use of alternative water sources to displace potable water use. The committee considered this issue, and there was agreement that eventually this standard should account for the impact of alternative water sources, like gray water and harvested rainwater. However, the committee decided that, at this point, there was insufficient reliable data on how these alternative water systems impact water use under a variety of field conditions to develop a calculation to quantify their impact on a home's potable water use. Therefore, in order to maintain the technical rigor of the calculations in the rest of the standard, alternative water sources do not provide water use reductions in a rated home in this current draft. RESNET and ICC are interested in performance and usage data on alternative water sources and systems, and request such data to be submitted through the public comment process.

It should be noted that Section 6.2 does allow Water Rating providers to petition for adjustment to the Water Rating Index for a Rated Home with features or technologies not addressed by Approved Software Rating Tools or this Standard. This process for innovative design requests will allow for technologies or features, not specifically covered in the standard, to petition for credit.

A WRI rating includes water use for: toilets, kitchen faucets, lavatory faucets, showerheads, clothes washers, dishwashers, water softeners, outdoor/landscape irrigation systems and pools/spas. There are additional factors that also influence the rating, including: excess water pressure, house size, geographic location, number of bedrooms, lot and landscape size and hot water distribution layout. The following components are not included in the standard, due to a lack of data: whole house humidifiers, water filtration systems and alternative water sources.

February 18, 2019

This Standard contains both normative and informative material. The body of the Standard is normative and must be complied with to conform to the Standard. Informative materials are not mandatory and are limited to this forward, footnotes, references and annexes, all of which are clearly marked as informative.

PDS-02 includes several substantive changes based on public comments received on PDS-01. These changes include:

- Improved descriptions of the components that make up the clothes washer and dish washer equations.
- Informative Appendix A to provide background on the development of the outdoor water use equations.
- Updates to the dishwasher and clothes washer equations for the rated home
- Specific references to source data for net evapotranspiration and hardness of water.

**1. Purpose.** The provisions of this document establish a uniform methodology for evaluating, rating and labeling the water use performance of single family and duplex dwelling units.

**2. Scope.** This Standard will provide a uniform methodology for evaluating, rating and labeling the indoor and outdoor water use performance of one- and two-family dwellings.

**3. Definitions.** The following terms and acronyms have specific meanings as used in this Standard. In the event that definitions given here differ from definitions given elsewhere, the definitions given here shall govern.

**3.1. General.** Unless stated otherwise, the terms and words in Section 3.2 shall have the meanings indicated therein. Words used in the present tense include the future, words in the masculine gender include the feminine and neuter, and singular and plural are interchangeable. Terms not defined in Section 3.2 shall have ordinary accepted meanings the context implies.

### 3.2. Definitions.

**Approved** – shall mean acceptable to the adopting entity.

**Approved Rating Provider** – An approved entity responsible for the certification of home water efficiency raters working under its auspices and who is responsible for the quality assurance of such Certified Raters and for the quality assurance of water efficiency ratings produced by such home water efficiency raters.

**Approved Software Rating Tool** – A computerized procedure that is approved for the purpose of conducting home water efficiency ratings and calculating the annual water consumption, annual water costs and a Water Rating Index for a home.

**Bedroom** – A room or space 70 square feet of floor area or greater, with egress window and closet, used or intended to be used for sleeping. A "den," "library," "home office" with a closet, egress window, and 70 square feet of floor area or greater or other similar rooms shall count as a Bedroom, but living rooms and foyers shall not.

**Deleted:** This standard is applicable to the indoor and outdoor water use of all single-family dwellings, including townhomes and duplexes.

**Deleted:** approved by an entity adopting and requiring the use of this Standard as a result of investigation and tests conducted by the entity or by reason of accepted principles or tests by nationally recognized organizations

**Automatic Irrigation System**— An irrigation system that is initiated by a clock timer, irrigation controller, or other method that does not require human intervention to initiate an irrigation event.

**Irrigated Area**—the portion of a lot that receives supplemental water for irrigation.

**Lot Size**—the area of a single parcel of land upon which the Rated Home is located.

**Other Water Use**— Water use associated with leaks, minor draws, and other end uses not specified in the Reference Home or Rated Home.

**Outdoor Water Use**— Water use that occurs outside of the exterior walls of a dwelling unit.

Deleted: .

**Rated Home** – The specific real property that is evaluated using the water use performance rating procedures specified by this Standard.

**Residential Irrigation Capacity Index (RICI)**— The intensity with which an automatic irrigation system applies water calculated in accordance with section 4.6.3

**Shall** - means that the action specified is mandatory.

Deleted: As used in this Standard, the word 'shall'

Deleted: and must be accomplished by the responsible party...

**Townhouse**—A single-family Dwelling Unit constructed in a group of three or more attached units in which each unit extends from the foundation to roof and with open space on at least two sides.

**Water Rating Index** – An integer representing the relative water use of a Rated Home as compared with the water use of the Reference Home and where an Index value of 100 represents the water use of the Reference Home and each integer reduction represents a one percent improvement in water use efficiency.

**Reference Home** – A hypothetical home configured in accordance with the specifications set forth in Section 4.3 of this Standard and the basis of comparison for the purpose of calculating the Water Rating Index of a Rated Home.

#### 4. Home Water Rating Calculation Procedures.

**4.1. Determining the Water Rating Index.** The Water Rating Index shall be determined in accordance with Sections 4.2 through 4.6. The Reference Home shall be configured in accordance with Sections 4.3 and 4.4; and the Rated Home shall be configured in accordance with Section 4.5 and 4.6.

**4.2 Calculating the Water Rating Index.** A Water Rating Index shall be calculated as follows:

$$WRI = \frac{\text{indoor and outdoor daily water use for the Rated Home}}{\text{indoor and outdoor daily water use for the Reference Home}} * 100$$

**4.3. Determining the Daily Indoor Water Use for the Reference Home.** The indoor daily water use for the Reference Home shall be calculated as follows:

$$ref_{in}gpd = refFgpd + refWgpd + refDWgpd + refCWgpd + refTgpd + refSofgpd + refOther \quad (\text{Eq 4.3-1})$$

Where:

$refF_{gpd}$  = daily fixture water use for the Reference Home  
 $refW_{gpd}$  = daily water use wasted from hot water outlets for the Reference Home  
 $refDW_{gpd}$  = daily dishwasher water use for the Reference Home  
 $refCW_{gpd}$  = daily clothes washer water use for the Reference Home  
 $refT_{gpd}$  = daily toilet water use for the Reference Home  
 $refSof_{gpd}$  = daily water softener water use for the Reference Home  
 $refOther$  = daily total other/unidentified water use for the Reference Home

- 4.3.1. Determining Daily Reference Home Fixture Water Use.** Reference Home daily fixture water use shall be calculated as follows:

$$refFgpd = 14.6 + 10 * Nbr$$

(Eq 4.3-2)

Where:

Nbr= number of bedrooms in the Rated Home

- 4.3.2. Determining Daily Reference Home Hot Water Waste.** Reference Home daily hot water waste shall be calculated as follows:

$$refWgpd = 9.8 * Nbr^{0.43}$$

(Eq 4.3-3)

Where:

Nbr= number of bedrooms

- 4.3.3. Determining Daily Reference Home Dish Washer Water Use.** Reference Home dish washer water use shall be calculated as follows:

$$refDWgpd = \frac{(88.4 + 34.9 X Nbr) * 8.16}{365}$$

(Eq 4.3-4)

Which simplifies to:

$$refDWgpd = 1.97 + 0.7802 * Nbr$$

Where:



February 18, 2019

Nbr= number of bedrooms

(88.4+34.9\*Nbr) = best fit regression equation for dishwasher cycles per year using data from the 2005 Residential Energy Consumption Survey.

8.16 = gallons per cycle from the DOE Technical Support Document from the NAECA standard in effect in 2006

This value is determined in accordance with ANSI/RESNET/ICC 301 Addendum A.

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**4.3.4. Determining Daily Reference Home Clothes Washer Water Use.** Reference Home daily clothes washer water use shall be calculated as follows:

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$$refCW_{gpd} = \frac{3.0 * 11.4 * ACY}{365}$$

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(Eq 4.3-5)

where

3.0 = reference washer capacity (CAPw) in ft3

11.4 = reference integrated water factor (IWF) in (gal/cyc) per ft3

ACY = Adjusted Cycles per Year = (164 + 46.5 \* Nbr)

Nbr = number of bedrooms

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**4.3.5. Determining Daily Reference Home Toilet Water Use.** Reference Home daily toilet water use shall be calculated as follows:

$$refTgpd = refFPO * refGPF * Occ$$

(Eq 4.3-6)

Where:

refFPO= the Reference Home flushes per person per day = 5.05

refGPF= the Reference Home gallons per flush for toilets = 1.6

Occ= the number of occupants = 1.09 + 0.54 \* Nbr

Nbr= number of bedrooms

**4.3.6. Determining Daily Reference Home Water Softener Use.** Where the Rated Home has a water softener and the water hardness at the Rated Home location is greater than or equal to 180 milligrams/liter, the Reference Home water softener daily water use shall be calculated as follows:

$$\text{refSofgpd} = \frac{\text{grains of hardness}}{\text{gallon of water}} * \frac{\text{sum of indoor water uses in the Reference Home}}{5 \text{ gallons used}} * \frac{1}{1,000 \text{ grains removed}}$$

(Eq 4.3-7)

Where Rated Home does not meet these conditions the  $\text{refSofgpd} = 0$ .

**4.3.7. Determining Daily Reference Home Other Water Use.** Reference Home daily other water use shall be determined as follows:

$$\text{refOther} = 5.93 * \text{Nbr}$$

(Eq 4.3-8)

Where:

Nbr= the number of bedrooms in the Rated Home

**4.4. Determining the Reference Home Outdoor Water Use.** The reference home outdoor annual water use (in thousands of gallons per year) shall be calculated using the following two equations:

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Deleted: (in thousands of gallons per year)

If the rated home has a netET of less than 12 inches/year OR the rated home has an automatic irrigation system, use Equation 1.

**Equation 1:**

$$\left[ \frac{\exp(A)}{1 + \exp(A)} \right] * 1.18086 * [2.0341 * \text{netET}^{0.7154} * \text{Ref\_Irr\_Area}^{0.6227} + 0.5756 * \text{ind\_Pool} * \text{netET}]$$

(Eq 4.4-1a)

If the rated home has a netET of greater than 12 inches/year AND the rated home does NOT have an automatic irrigation system, use Equation 2.

**Equation 2:**

$$\left[ \frac{\exp(B)}{1 + \exp(B)} \right] * 1.22257 * [1.4233 + 0.6311 * \text{netET} + 0.9376 * \text{Ref\_Irr\_Area}] + \text{ref\_Pool}$$

(Eq 4.4-1b)

Either equation shall be constrained as follows:

**IF**

$$\text{Rat\_Irr\_Area} < \text{Ref\_Irr\_Area}$$

**THEN**

Ref\_Out = equation 1 or 2 (as identified above)

$$\frac{\text{equation 1 (Using Rat\_Irr\_Area and ind\_Pool} = 0)}{\text{equation 1 (with Ref\_Irr\_Area and ind\_Pool} = 0)}$$

**AND**

*Outdoor Reference Home Annual Water Use shall never be lower than equation 2*

**Where:**

Exp(A)= exponent of [1.4416 + 0.5069 \* (IrrArea/1,000)]

Exp(B)= exponent of [0.6911 + 0.00301 \* netET \* (IrrArea/1,000)]

Ref\_Irr\_Area= The size of the irrigated area in the reference home, calculated in accordance with section 4.4.1

Rat\_Irr\_Area= The size of the irrigated area in the rated home

netET= The annual historic sum of mean reference evapotranspiration minus the mean precipitation for all months that evapotranspiration exceeds precipitation

ind\_Pool= Indicator representing the presence or absence of a swimming pool in the rated home

ref\_Pool= equation 1 (using ind\_Pool = 1) – equation 1 (using ind\_Pool = 0)

4.4.1. Determining Outdoor Daily Water Use for the Reference Home. Reference Home daily outdoor water use shall be determined by multiplying the result of either Eq 4.4-1a or Eq 4.4-1b, as appropriate, by 1,000 and dividing the product by 365.

**4.4.2. Determining Irrigated Area for the Reference Home.** Reference Home Irrigated Area shall be calculated as follows:

Where the lot size of the Rated Home is less than 7,000 ft<sup>2</sup>, the Irrigated Area of the Reference Home shall be calculated as follows:

$$Ref\_Irr\_Area = Lot\_Area * (0.002479 * Lot\_Area^{0.6157})$$

(Eq 4.4-2a)

Where the Lot Size of the Rated home is greater than or equal to 7,000 ft<sup>2</sup>, the Irrigated Area of the Reference Home shall be calculated as follows:

$$Ref\_Irr\_Area = lot\_area * 0.577$$

(Eq 4.4-2b)

**Where:**

Ref\_Irr\_Area= The size of the landscape that receives supplemental water in the Reference Home

Lot\_Area= The size of the lot on which the Rated Home is being constructed

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**4.5. Determining Daily Indoor Water Use of the Rated Home.** The daily Indoor Water Use of the Rated Home shall be calculated as follows:

$$Indoor_{gpd} = Shower_{gpd} + KitchF_{gpd} + LavF_{gpd} + Waste_{gpd} + CW_{gpd} + DW_{gpd} + Toilets_{gpd} + Soft_{gpd} + Other + EP_{gpd}$$

(Eq 4.5-1)

**Where:**

Showe<sub>gpd</sub> = daily shower water use for the Rated Home

KitchF<sub>gpd</sub> = daily kitchen faucet water use for the Rated Home

February 18, 2019

LavF<sub>gpd</sub> = daily lavatory water use for the Rated Home  
 Waste<sub>gpd</sub> = daily water use wasted for the Rated Home  
 CW<sub>gpd</sub> = daily clothes washer water use for the Rated Home  
 DW<sub>gpd</sub> = daily dishwasher water use for the Rated Home  
 Toilets<sub>gpd</sub> = daily toilet water use for the Rated Home  
 Soft<sub>gpd</sub> = daily water softener water use for the Rated Home  
 Other<sub>gpd</sub> = daily other/ unidentified water use for the Rated Home  
 EP<sub>gpd</sub> = daily excess pressure adjustment

**4.5.1. Determining Daily Shower Water Use for the Rated Home.** Rated Home daily shower water use shall be calculated as follows:

$$Shower_{gpd} = FixtureTot * shower_{pc} * SHEff$$

(Eq 4.5-2)

Where:

FixtureTot= Determined in accordance with ANSI/RESNET/ICC 301, Addendum A =

$$\frac{adjFmix}{Fmix} * refFgpd$$

Shower<sub>pc</sub>= Percent of fixture water use consumed by showers = 54%

SHEff= the ratio of the average rated flow rate of showerheads to the reference home flow rate

$$= \frac{\text{average flow rate of showerheads in the rated home}}{2.5}$$

**4.5.2. Determining Daily Kitchen Faucet Water Use for the Rated Home.**

Rated Home daily kitchen faucet water use shall be calculated as follows:

$$KitchF_{gpd} = FixtureTot * faucet_{pc} * KitchFeff * kitch$$

(Eq 4.5-3)

Where:

FixtureTot= Determined in accordance with ANSI/RESNET/ICC 301 Addendum A =

$$\frac{adjFmix}{Fmix} * refFgpd$$

faucet<sub>pc</sub>= Percent of fixture water use consumed by faucets = 46%

KitchFeff= the ratio of the average rated flow rate of kitchen faucets to the reference home flow rate =  $\frac{\text{average flow rate of kitchen faucets in the rated home}}{2.2}$

Kitch= the percentage of faucet use that is attributed to kitchen faucets= 69%

**4.5.3. Determining Daily Lavatory Faucet Water Use for the Rated Home.** Rated Home daily lavatory faucet use shall be calculated as follows:

$$LavF_{gpd} = FixtureTot * faucet_{pc} * LavFeff * Lav$$

(Eq 4.5-4)

Where:

Lav = the percentage of faucet use that is attributed to lavatory faucets= 31%

FixtureTot= Determined in accordance with ANSI/RESNET/ICC 301

Addendum A =

$$\frac{adjFmix}{Fmix} * refFgpd$$

faucet\_pc = Percent of fixture water use consumed by faucets = 46%

LavFeff = the ratio of the average rated flow rate of lavatory faucets to the Water Rating Reference Home flow rate = 1 for standard faucets and 0.95 for high efficiency faucets

**4.5.4. Determining Daily Hot Water Waste for the Rated Home.** Rated Home daily hot water waste shall be calculated as follows:

$$Waste_{gpd} = Feff * (oWgpd + sWgpd * WDeff)$$

(Eq 4.5-5)

Where:

Feff = Fixture efficiency of showerheads, kitchen faucets, and lavatory faucets weighted by contribution to total fixture use (by volume)

oW<sub>gpd</sub> = daily standard operating condition hot water wasted quantity as determined by ANSI/RESNET/ICC 301 Addendum A

sW<sub>gpd</sub> = daily structural hot water wasted quantity as determined by ANSI/RESNET/ICC 301 Addendum A

WDeff = distribution system water use effectiveness from Table 4.2.2.5.2.11(3) of ANSI/RESNET/ICC 301 Addendum A

This value is determined in accordance with ANSI/RESNET/ICC 301 Addendum A.

**4.5.5. Determining Daily Clothes Washer Water Use for the Rated Home.** Rated Home daily clothes washer water use shall be calculated as follows:

$$CW_{gpd} = \frac{CAPw * IWF * ACY}{365}$$

(Eq 4.5-6)

Where:

CAPw = washer capacity in cubic feet = the manufacturer's data or the CEC database or the EPA Energy Star website

IWF = Integrated Water Factor from manufacturer's data [gal/cyc/ft<sup>3</sup>]

ACY = Adjusted cycles per year

Determining ACY:

$$ACY = (164 + 46.5 * Nbr) * ((3.0 * 2.08 + 1.59) / (CAPw * 2.08 + 1.59))$$

Where

CAPw = the capacity of the clothes washer in ft<sup>3</sup>

Deleted: CWwf

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Deleted: CWwf

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CANDIDATE--BSR/RESNET/ICC Standard 1101-- Water Rating Index

PDS-02

February 18, 2019

$(164 + 46.5 * Nbr) = \text{Standard Cycles per Year based on 2005 Residential Energy Consumption Survey data}$   
 $((3.0 * 2.08 + 1.59) / (CAPw * 2.08 + 1.59)) = \text{best fit regression equation to adjust the standard cycles per year to account for occupancy and size of clothes washer. Based on 2005 Residential Energy Consumption Survey data.}$

**4.5.6. Determining Daily Dishwasher Water Use for the Rated Home.** Rated Home daily dish washer water use shall be calculated as follows:

$$DW_{gpd} = [(88.4 + 34.9 * Nbr) * (12 / dW_{cap}) * \underline{gal/cycle}] / 365 \text{ (Eq 4.5-7)}$$

**Deleted:**  $(4.6415 * (1 / DW_{EF}) - 1.9295)$

Where:

Nbr= number of bedrooms in the Rated Home

dWcap= capacity of the dishwasher in the Rated Home (in place settings) as included in the manufacturer's data

$(88.4 + 34.9 * Nbr) = \text{best fit regression equation for dishwasher cycles per year using data from the 2005 Residential Energy Consumption Survey.}$

**Deleted:** DW\_EF= The energy factor of the dishwasher installed in the Rated Home

gal/cycle can be entered either directly or as listed on:

- The ENERGY STAR product finder database
- The California Energy Commission (CEC) Modernized Appliance Efficiency Database
- The Department of Energy (DOE) Compliance Certification Management System (CCMS)

OR gal/cycle can be calculated from the Energy Guide label as follows (developed using the equations from 10 CFR 430, Subpart B, Appendix C and values on the Energy Guide label) to isolate the energy used by the appliance from the energy used in water heating):

$$\underline{gal/cycle} = h2o\_kWh * elec\_h2o$$

$$\underline{h2o\_kWh} = LER - Appl\_kWh$$

LER= Labeled Energy Rating in kWh per year per the dishwasher Energy Guide label

Appl kWh= dishwasher appliance annual electric energy use =  $(GHWC * gas\_h2o / \$\_therm - LER * \$\_kWh * elec\_h2o / per\_kWh) / (\$\_kWh * gas\_h2o / \$\_therm - elec\_h2o)$

where

$\$\_kWh = \text{the cost of one kWh per the dishwasher Energy Guide label}$

$\$\_therm = \text{the cost of one therm per the dishwasher Energy Guide label}$

GHWc= Gas Hot Water Cost per the dishwasher Energy Guide label

$$\text{elec\_h2o} = \frac{\text{gallons of hot water use per cycle per unit of annual electricity use in gal-y/kWh-cyc}}{= 1/(80*0.0024*215)} = 0.02423$$

$$\text{gas\_h2o} = \frac{\text{gallons of hot water use per cycle per unit of annual gas use in gal-y/therm-cyc}}{= 1/(80*8.2/0.75*215/100,000)} = 0.53176$$

80= the average hot water heater temperature rise per 10 CFR 430, Subpart B, Appendix C

0.0024 = specific heat of water in kWh/gal-F per 10 CFR 430, Subpart B, Appendix C

8.2 = specific heat of water in Btu/gal-F per 10 CFR 430, Subpart B, Appendix C

0.75 = recovery efficiency of gas hot water heater per 10 CFR 430, Subpart B, Appendix C

215= cycles per year per 10 CFR 430, Subpart B, Appendix C

This value is determined in accordance with ANSI/RESNET/ICC 301Addendum A.

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**4.5.7. Determining Daily Toilet Water Use for the Rated Home.** Rated Home daily toilet water use shall be calculated as follows:

$$\text{Toilet}_{gpd} = \text{refFPO} * \text{gpf} * \text{Occ}$$

Where:

refFPO= the reference flushes per person per day = 5.05

gpf= the average gallons per flush of all toilets installed in the Rated Home. For tank-type dual-flush toilets, use the effective flush volume per flush based on EPA Water Sense specification for Tank Type Toilets.

Deleted:

Occ= the number of predicted occupants in the Rated Home= 1.09 + 0.54\*Nbr

Nbr= the number of bedrooms in the Rated Home

**4.5.8. Determining Daily Water Softener Water Use for the Rated Home.** Rated Home daily water softener water use shall be calculated as follows:

(Eq 4.5-8)

$$\text{Soft}_{gpd} = \frac{\text{grains of hardness}}{\text{gallon of water}} * \left[ \frac{\text{sum of softened water uses in the Rated Home}}{\text{gallons used per 1,000 grains of hardness}} \right]$$

Deleted: indoor

Where:

Softened water = water conditioned by a water softener

**4.5.9. Determining Daily Other Water Use for the Rated Home.** Rated Home daily other water use shall be calculated as follows:

$$\text{Other}_{gpd} = 5.93 * \text{Nbr}$$

(Eq 4.5-9)

Where:

Nbr= the number of bedrooms in the rated home

**4.5.10. Determining Daily Excess Pressure Adjustment Water Use for the Rated Home.**

Where a Rated Home does not have a pressure-reducing valve or pressure tank, additional water use attributed to excess water pressure shall be calculated as follows:

$$EP_{gpd} = MAX \{ [(Shower_{gpd} + (0.5 * (Lav_{gpd} + Kitch_{gpd} + Other_{gpd})))] * 0.006 * (PR - 90), 0 \}$$

(Eq 4.5-10)

Where:

PR= Static water pressure (in psi) measured at the indoor fixture outlet on the lowest floor and (if more than one) closest to the water service entry to the house

Note: Shower and lavatory faucets controlled by integral or accessory pressure-compensating devices may be excluded from this equation.

**4.6. Determining Outdoor Water Use for the Rated Home.** The Rated Home Outdoor Water Use shall be calculated as follows:

Where the Rated Home has an Automatic Irrigation System, Outdoor Water Use shall be calculated as follows:

Equation 1:

$$\left[ \frac{\exp(A)}{1 + \exp(A)} \right] * 1.18086 * [2.0341 * netET^{0.7154} * Rat_{Irr\_Area}^{0.6227} + 0.5756 * ind\_Pool * netET]$$

(Eq 4.6-1)

Where the Rated Home does not have an Automatic Irrigation System, Outdoor Water Use shall be calculated as follows:

Equation 2:

$$\left[ \frac{\exp(B)}{1 + \exp(B)} \right] * 1.22257 * [1.4233 + 0.6311 * netET + 0.9376 * Rat\_Irr\_Area] + Pool\_use$$

(Eq 4.6-2)

The Outdoor Water Use for the Rated Home shall never be less than the result of the following calculation:

$$\left[ \frac{\exp(B)}{1 + \exp(B)} \right] * 1.22257 * [1.4233 + 0.6311 * netET + 0.9376 * Rat\_Irr\_Area]$$

(Eq 4.6-3)

Where:



February 18, 2019

Exp(A)= exponent of [1.4416 + 0.5069 \* (Rat\_Irr\_Area/1,000)]

Exp(B)= exponent of [0.6911 + 0.00301 \* netET \* (Rat\_Irr\_Area/1,000)]

Rat\_Irr\_Area= The size of the landscape that might receive supplemental water in the rated home

netET= The annual historic sum of mean reference evapotranspiration minus the mean precipitation for all months that evapotranspiration exceeds precipitation

ind\_Pool= Indicator representing the presence or absence of a swimming pool

Pool\_use= equation 1 (using ind\_Pool = 1) – equation 1 (using ind\_Pool = 0)

**4.6.1. Determining Outdoor Daily Water Use for the Rated Home.** Rated Home daily outdoor water use shall be determined by multiplying the result of either Eq 4.6-1 or Eq 4.6-2, as appropriate, as such result may be further modified pursuant to Sections 4.6.1 through 4.6.4, by 1,000 and dividing the product by 365.

**4.6.2 Weather-based Controllers.** Sensor and weather based irrigation controllers that are certified by the U.S. EPA WaterSense program shall decrease the portion of predicted rated home outdoor water use associated with irrigation (less the water use associated with pools) by 15% in homes that have automatic irrigation system.

Deleted: Smart

**4.6.3. Commissioning of an Automatic Irrigation System.** In rated homes, with an automatic irrigation system, where documentation is provided the water use associated with irrigation shall be decreased by 5% where a certified professional, as identified by a WaterSense labeled certification, and the irrigation system has been inspected according to the protocols identified in ASABE 626 and verified as follows:

- Average distribution uniformity of at least 65% on turf areas
- Sprinklers are operating at the manufacturer's recommended water pressure +/- 10%
- The system operates without leaks
- The system prevents runoff and overspray from leaving the property (checked during the audit)
- Two seasonal water schedules (initial grow-in period and established landscape) are posted at the controller

**4.6.4 Residential Irrigation Capacity Index (RICI).** In a Rated Home, with an automatic irrigation system, where documentation is provided, a RICI shall be calculated as follows:

Deleted: 4.6.1

$$RICI_{rat} = \frac{\text{sum of flow (gpm) of all irrigation valves}}{\text{square feet irrigated area}} * 1,000$$

(Eq 4.6-4)

**4.6.4.1 Applying RICI.** A Rated Home where documentation for a RICI is provided may adjust the volume of water use associated with irrigation (less the water use associated with pools) in the Outdoor Water Use of the Rated Home by 10% for every point from a baseline RICI (RICI\_ref) of 5.

Deleted: 4.6.1.1

February 18, 2019

**4.6.5 Applying Adjustments to the Outdoor Water Use of Rated Homes.** Because the Water Rating Index model includes a number of percent adjustments for the outdoor water use of the rated home, the order of application becomes important. The correct order in which to apply these adjustments is as follows:

Deleted: 4.6.2

**Table 4.6.5, Applying Adjustments to Outdoor Water Use of the Rated Home**

Deleted: 4

1	4.6.1- Smart Controllers	Shall be determined by the presence or absence of a smart controller in the installed portion of the landscape.
2	4.6.2- Commissioning of an Automatic Irrigation System	Shall be determined by the presence or absence of commissioning in the installed portion of the landscape.
3	4.6.3- Residential Irrigation Capacity Index (RICI)	<p><u>Shall be calculated in accordance with section 4.6.4 and adjusted in partially finished landscapes to be calculated as:</u></p> $RICI_{rat} = \frac{\text{sum of flow (gpm) of all irrigation valves} + (0.005 * \text{predicted Back\_irr square feet irrigated area})}{* 1,000}$ <p><u>(Predicted Back\_irr is defined in Section 5.3.)</u></p>

Deleted: Shall be calculated as sum of flow (gpm) + 0.005 \* Predicted Back\\_yard...

**5. Minimum Rated Features.** The estimated annual indoor and outdoor water use shall be determined using the minimum rated features set forth in Table 5.0.

**Table 5.0. Minimum Rated Features**

Building Element	Minimum Rated Feature
1. Toilet	Flush volume for each toilet as measured on-site or from manufacturer's data.
2. Shower/Bath	As imprinted on the product, stated by manufacturer in product documentation, or tested via flow rate test in the field.
3. Bathroom Faucet	As imprinted on the product, stated by manufacturer in product documentation, or tested via flow rate test in the field.
4. Kitchen Faucet	As imprinted on the product, stated by manufacturer in product documentation, or tested via flow rate test in the field.
5. Clothes Washer	Washer capacity (cubic feet) from manufacturer's data or the CEC Appliance Efficiency Database or the EPA ENERGY STAR website for all clothes washers located within the Rated Home.
6. Dishwasher	Capacity of the dishwasher (in place settings) as included in the manufacturer's data, labeled energy factor

February 18, 2019

	(cycles/kWh) for all dishwashers located within the Rated Home.
7. Water Softener	Gallons of water used per 1,000 grains of hardness removed.
8. Hot Water Distribution	Insulation R-value of pipe insulation, type of recirculation system, length of pipe
9. Outdoor Water Use	Irrigation system type (automatic or manual), lot size, irrigated area (square feet)
10. Pool/Spa	Indicate presence or absence of a pool or spa.
11. Service Water Pressure	Service pressure of water being supplied to the home, as established by the setting of an installed pressure-reducing valve OR the setting of an installed pressure tank OR written documentation from the water supplier that service pressure to the site is ≤ 90 psi OR an on-site static pressure test.

**Deleted:** Distribution System Type (Standard, recirculation), Recirculation System controls [none, timer, temperature, demand (manual) or demand (sensor)], pipe insulation R-value, pipe length for standard distribution, branch length for recirculation, supply + return loop length, pump power (Watts, HP)

**5.1. Data Sources.** Data required for the calculation of indoor and outdoor daily water use in the Rated and Reference Homes shall be determined by the location of the Rated Home and using data as set forth in 5.1.1 and 5.1.2.

**5.1.1. Net Evapotranspiration.** Data for net evapotranspiration shall be determined for the location of the rated home using [the World Water and Climate Atlas](#).

**Deleted:** a

**Deleted:** dataset approved by RESNET.

**5.1.2. Hardness of Water.** Data for the hardness of water shall be determined by the location of the Rated Home and one of the following:

a) [U.S. Geological Survey Concentrations of Hardness as Calcium Carbonate Map](#),

b) Data provided by the local water supplier

c) [A hardness test of water collected in the home using an EPA approved method for determination of hardness](#).

**Deleted:** A dataset approved for use by RESNET

**5.2 Default Values.** Values that are not available in accordance with Table 5.0 or are absent from the home at time of the rating shall use default values in accordance with Table 5.2. Values for building elements that are not specified in table 5.2 are required for a rating to be issued.

**Deleted:** A hardness test conducted at the site<sup>11</sup>

**Table 5.2 Default Values**

Building Element	Default
1. Water Softeners	Can be entered as 0 if they are absent from a Rated Home. If they are present and no documentation is available they may be assumed to use 5 gallons/1,000 grains removed for cation water softeners if information is unavailable.
2. Clothes Washer	Same as Reference Home
3. Dishwasher	Determined by ANSI/RESNET/ICC 301. <a href="#">A rated home without either a dishwasher or an undercounter cavity for</a>

February 18, 2019

	<u>placement of a dishwasher shall be assigned a Daily Dishwasher Water Use of 0</u>
4. Hot Water Distribution	Determined by ANSI/RESNET/ICC 301 Addendum A
5. Outdoor Water Use	Must be done in accordance with Section 4.2.3

**5.3. Incomplete Outdoor Area.** To receive a rating, a home must (at a minimum) have the front yard landscape completed. Homes that do not have landscaping completed in the back yard shall be determined in accordance with Section 4.6 with the portion of landscaping that is done determining the presence or absence of an automatic irrigation system. The following steps shall be followed in determining irrigated area in this instance.

*Rater must determine a line between the front and back area (front\_area + back\_area must = total available area)*

$$\begin{aligned} \text{Lot\_Area} - \text{Pad Footprint} &= \text{total available area} \\ (\text{Back\_area}/\text{total available area}) * \text{Ref\_Irr\_Area} &= \text{Predicted Back\_irr} \\ \text{Irr\_Area} &= \text{Predicted Back\_irr} + \text{Front\_irr} \end{aligned}$$

Where:

- Pad Footprint= the portion of the lot area covered by the dwelling unit and any attached or detached garage.*
- Total\_available\_area= The portion of the lot excluding the pad of the house that is available for landscaping or other design features (hardscape, softscape, etc.)*
- Front\_area= the area (in sq. ft.) of the total available area that is located primarily in front of the house*
- Back\_area= the area (in sq. ft.) of the total available area that is located primarily behind the house*
- Front\_irr= The area located primarily in front of the house that receives supplemental water for irrigation at the time of the rating*
- Predicted Back\_irr= the portion of the area located primarily behind the house that can be predicted to receive supplemental water for irrigation in the future*

**6. Certification and Labeling.** This section establishes minimum uniform standards for certifying and labeling home water use performance using the Water Rating Index. These include minimum requirements of the home water use rating process, standard methods for estimating water use, minimum reporting requirements, and specification of the types of ratings that are performed in accordance with this Standard.

**6.1. Rating Requirements.**

**6.1.1. General.** The rating for a home shall be determined in accordance with sections 6.1.1.1 through 6.1.1.2.

**6.1.1.1.** For an existing home, required data shall be collected on site.

**6.1.1.1.1.** For a new, to-be-built home, the procedures of Section 5.0 shall be used to collect required data.

**6.1.1.2.** The collected data shall be used to estimate the annual water consumption for indoor and

February 18, 2019

outdoor water use for both the Rated Home and the Reference Home as specified by Section 4.0.

**6.1.2. Cost Savings Estimates.** Where determined, cost savings estimates for water and wastewater (sanitary sewer) service for the Rated Home shall be calculated in accordance with Sections 6.1.2.1 through 6.1.2.3.

**6.1.2.1. Water Cost Savings.**

**6.1.2.1.1. Water Prices.** Water cost savings for homes receiving potable water service from a water supplier shall be based on the schedule of rates and charges adopted by the water supplier serving the Rated Home.

**6.1.2.1.2. Relevant Rates and Charges.** Water cost savings shall be calculated from the volumetric portion of the schedule of rates and charges, sometimes referred to as the commodity charge. Fixed or flat charges that do not vary with the volume of water delivered to the home, sometimes referred to as the meter charge or service charge, shall not contribute to the cost savings estimate.

**6.1.2.1.3. Water Cost Savings Calculations.**

**6.1.2.1.3.1. Average Billed Indoor Volume of the Reference Home.** Convert the total annual volume of indoor water use by the Reference Home to an increment of indoor use during a water billing period by dividing the annual indoor volume by the number of bills per year generated by the water supplier, e.g., for monthly billing divide by 12 and for quarterly billing divide by 4. Convert the units of consumption of the Reference Home as necessary to match the units of the rate schedule (e.g., 1,000 gallons, 100 cubic feet) to yield the average billed indoor volume of the Reference Home.

**6.1.2.1.3.2. Determine Outdoor Water Use for a Billing Period.** Convert the total annual volume of outdoor water use in the Reference Home to an increment of outdoor use during a water billing period using one of two methods, based on prevailing practice at the location of the Rated Home.

**6.1.2.1.3.2.1. Peak Season Irrigation.** Divide the annual outdoor volume by the number of bills generated by the water supplier during the irrigation season, e.g. for a 6-month irrigation season with monthly billing, divide by 6; for a 6-month irrigation season with quarterly billing, divide by 2. Convert the units of consumption of the Reference Home as necessary to match the units of the rate schedule (e.g., 1,000 gallons, 100 cubic feet) to yield the average billed outdoor volume of the Reference Home.

**6.1.2.1.3.2.2. Year-Round Irrigation.** Divide the annual outdoor volume by the number of bills generated by the water supplier during a full year, e.g., for monthly billing divide by 12 and for quarterly billing divide by 4. Convert the units of consumption of the Reference Home as necessary to match the units of the rate schedule (e.g., 1,000 gallons, 100 cubic feet) to yield the average billed outdoor volume of the Reference Home.

**6.1.2.1.3.3. Combine Indoor and Outdoor Water Use Charges.** For each billing period in a year, calculate the billed water volume by combining the average billed indoor volume with any average billed outdoor volume applicable to such billing period. Note that where peak season irrigation has been calculated, the billed water volume for billing period outside of the irrigation season will consist entirely of the average billed indoor volume. Apply the volumetric portion of the rate schedule to the billed volume for each billing period, accounting for any rate blocks or seasonal variations in the rate schedule, to produce the billed volume charge (in dollars) for each billing period. Combine the billed volume charge for each billing period to yield the annual water volume charge of the Reference Home.

**6.1.2.1.3.4. Determine Water Use Cost for the Rated Home.** Repeat the process described in Section 6.1.2.1.3 through 6.1.2.1.3.3 for the Rated Home to calculate the annual water volume charge of the Rated Home.

**6.1.2.1.3.5. Total Estimated Water Cost Savings.** Estimated water cost savings shall be the difference between the estimated annual water volume charge of the Reference Home and the estimated annual water volume charge of the Rated Home.

**6.1.2.2. Sanitary Sewer Service Cost Savings.**

**6.1.2.2.1. Sewer Service Prices.** Sanitary sewer service cost savings for homes with a permanent connection to sanitary collection and treatment works shall be based on the schedule of rates and charges adopted by the sanitary sewer service provider serving the Rated Home. Note that collection and treatment of sanitary discharges may be performed by separate entities, and that billing to the Rated Home by such entities may be combined or separate.

**6.1.2.2.2. Relevant Rates and Charges.** Sanitary sewer service cost savings shall be calculated from the volumetric portion of the schedule of rates and charges. Fixed or flat charges that do not vary with the volume of water delivered to the home shall not contribute to the cost savings estimate.

**6.1.2.2.3. Sewer Cost Savings Calculations.**

**6.1.2.2.3.1. Average Billed Indoor Volume of the Reference Home.** Convert the total annual volume of indoor water use by the Reference Home to an increment of indoor use during a sewer billing period by dividing the annual indoor volume by the number of bills per year generated by the sewer service provider, e.g., for monthly billing divide by 12 and for semi-annual billing divide by 2. Convert the units of consumption of the Reference Home as necessary to match the units of the rate schedule (e.g., 1,000 gallons, 100 cubic feet) to yield the average billed indoor volume of the Reference Home.

**6.1.2.2.3.2. Annual Sewer Volume Charge for the Reference Home.** Apply the volumetric portion of the sewer rate schedule to the average billed indoor volume for each billing period, accounting for any rate blocks or seasonal variations in the

February 18, 2019

rate schedule, to produce the billed volume charge (in dollars) for each billing period. Combine the billed volume charge for each billing period to yield the annual sewer volume charge of the Reference Home.

**6.1.2.2.4. Determine Annual Sewer charge for the Rated Home.** Repeat the process described in Section 6.1.2.2.3 for the Rated Home to calculate the annual sewer volume charge of the Rated Home.

**6.1.2.2.5. Estimated Sewer Cost Savings.** Estimated sewer cost savings shall be the difference between the estimated annual sewer volume charge of the Reference Home and the estimated annual sewer volume charge of the Rated Home.

**6.1.2.2.6 Combined Presentation of Cost Savings.** Estimated water cost savings and estimated sewer cost savings may be presented as a total estimated cost savings when designated as "water and sewer" savings.

**6.1.2.4. Other Cost Savings.** Performance attributes of the Rated Home may influence other types of charges, depending on the fee structure in the jurisdiction of the Rated Home. While less common, these savings may be significant. Any determinations for cost savings associated with the following charges shall be submitted for individual review and approval by the body providing quality assurance for the rating service provider of the Rated Home.

- (a) water service connection charges, also known as tap fees;
- (b) sanitary sewer service connection charges, also known as capacity charges;
- (c) stormwater fees.

**6.1.3. Reports.** All reports generated by an Approved Software Rating Tool shall, at a minimum, contain the information specified by Sections 6.1.3.1 through 6.1.3.6.

**6.1.3.1.** The property location, including city, state, zip code and either the street address or the Community Name and Plan Name for the Rating.

**6.1.3.2.** The name of the certified rater conducting the Rating.

**6.1.3.3.** The name of the Approved Rating Provider under whose auspices the rater is certified.

**6.1.3.4.** The date the Rating was conducted.

**6.1.3.5.** The name and version number of the Approved Software Rating Tool used to determine the Rating.

**6.1.3.6.** The following statement in no less than 10-point font: "The Home Water Rating Standard Disclosure for this home is available from the Rating Provider." At a minimum, this statement shall also include the Rating Provider's mailing address and phone number.

**6.1.4. Rating Types.** There shall be three Rating Types in accordance with Sections 6.1.4.1 through 6.1.4.3.

**6.1.4.1. Confirmed Rating.** A Rating Type that encompasses one individual dwelling and is conducted in accordance with Sections 6.1.4.1.1 through 6.1.4.1.3.

**6.1.4.1.1.** All Minimum Rated Features of the Rated Home shall be field-verified

February 18, 2019

through inspection and testing in accordance with Section 5.

**6.1.4.1.2.** All field-verified Minimum Rated Features of the Rated Home shall be entered into the Approved Software Rating Tool that generates the home water rating. The home water rating shall report the Water Rating Index that comports with these inputs.

**6.1.4.1.3.** Confirmed Ratings shall be subjected to Quality Assurance requirements equivalent to Section 900 of the *Mortgage Industry National Home Energy Rating Systems Standard*.

**6.1.4.2. Sampled Ratings.** A Rating Type that encompasses a set of dwellings and is conducted in accordance with Sections 6.1.4.2.1 through 6.1.4.2.3.

**6.1.4.2.1.** For the set of Rated Homes, all Minimum Rated Features shall be field verified through inspection and testing of a single home in the set, or distributed across multiple homes in the set, in accordance with the requirements equivalent to Section 600 of the *Mortgage Industry National Home Energy Rating Systems Standard*.

**6.1.4.2.2.** The threshold specifications from the Worst-Case Analysis for the Minimum Rated Features of the set of Rated Homes shall be entered into the Approved Software Rating Tool that generates the home water use rating. The home water use rating shall report the Water Rating Index that comports with these inputs.

**6.1.4.2.3.** Sampled Ratings shall be subjected to Quality Assurance requirements equivalent to Section 900 of the *Mortgage Industry National Home Energy Rating Systems Standard*.

**6.1.4.3. Projected Ratings.** A Rating Type that encompasses one individual dwelling and is conducted in accordance with Sections 6.1.4.3.1 through 6.1.4.3.5.

**6.1.4.3.1.** All Minimum Rated Features of the Rated Home shall be determined from architectural drawings, threshold specifications, and the planned location for a new home or from a site audit and threshold specifications for an existing home that is to be improved.

**6.1.4.3.2.** Unknown values shall be determined in accordance with Section 5.2.

**6.1.4.3.3.** The Projected Rating Report shall contain the following text in no less than 14-point font at the top of the first page of the report: "Projected Rating Based on Plans—Field Confirmation Required."

## **6.2. Innovative Design Requests.**

**6.2.1. Petition.** Water Rating providers can petition for adjustment to the Water Rating Index for a Rated Home with features or technologies not addressed by Approved Software Rating Tools or this Standard. Innovative Design Requests (IDRs) shall be submitted to an Approved IDR authority and shall include, at a minimum, the following:

**6.2.1.1.** A Rating generated from Approved Software Rating Tool for the Rated Home without feature(s) that cannot be modeled in the software tool.



CANDIDATE--BSR/RESNET/ICC Standard 1101-- Water Rating Index  
PDS-02

February 18, 2019

**6.2.1.2.** Written description of feature(s) not included in Rating generated from software.

**6.2.1.3.** Manufacturer's technical and/or performance specifications for feature(s) not included in the Rating generated from the Approved Software Rating Tool.

**6.2.1.4.** Estimated water use impact. Calculations or simulation results estimating the water use impact of feature(s) not included in the Rating generated from an Approved Software Rating Tool and documentation to support the calculation methodology and/or describe the modeling approach used.

**6.2.1.5.** Estimated adjustment to the Water Rating Index. Calculations shall follow procedures of Sections 4.1 and 4.2.

**6.2.2. Approval.** IDRs shall be approved on a case by case basis. The Approved IDR review authority shall accept or reject the IDR as submitted, or request additional information. The Approved IDR review authority shall assign a unique identifier to each IDR and maintain a database of IDRs. If the IDR is approved, the Water Rating provider is authorized to issue a supplemental report that adjusts the Water Rating Index, as approved.

## 7. Normative References

ANSI/RESNET/ICC 301-2014, Addendum A-2015 Domestic Hot Water Systems, Residential Energy Services Network, Oceanside, CA

World Water and Climate Atlas, International Water Management Institute, Colombo, Sri Lanka. (<http://www.iwmi.cgiar.org/resources/world-water-and-climate-atlas/>)

Concentrations of Hardness as Calcium Carbonate Map, U.S. Geological Survey, Washington, DC. (<https://water.usgs.gov/owq/hardness-alkalinity.html>)

### Informative Appendix A

#### Background on Outdoor Water Calculations

##### Base Outdoor Water Use Calculations:

Base equations for outdoor water use in both the reference and rated home (4.4 and 4.6) are established as a best fit regression equation using data from the Residential End Uses of Water, Version 2 (REUWS II)<sup>1</sup>.

The equation is based on the findings of the REUWS II report summarized in "Outdoor use model 1" with some modifications applied. REUWS II finds outdoor water use to be a non-linear trend best described as a factor of:

- The natural log of (irrigated area + 1)
- The natural log of net evapotranspiration
- The natural log of the average cost of water at 25,000 gallons of consumption
- An indicator for in ground sprinkler irrigation
- An indicator for swimming pools

The modifications applied to this equation are:

- Removal of the average cost of water term as an operational descriptor not

<sup>1</sup> <http://www.waterrf.org/Pages/Projects.aspx?PID=4309>

CANDIDATE--BSR/RESNET/ICC Standard 1101-- Water Rating Index  
PDS-02

February 18, 2019

appropriate for an asset-based rating system

- Replacing the natural log +1 technique with one that removes homes that reported values of "0" and using an adjustment factor<sup>2</sup>
- Improving fit by separating into predictions for homes with and without in ground sprinkler irrigation into two equations with a switch between them in lieu of an indicator
- Forcing the indicator for swimming pools into the equation for homes without in ground sprinkler systems<sup>3</sup>

Residential Irrigation Capacity Index:

The Residential Irrigation Capacity Index (RICI) is developed based on research conducted on the "xeriscape conversion" of landscapes by the Southern Nevada Water Authority (SNWA)<sup>4</sup>. The original research completed in the SNWA territory was used to establish the calculation and application method for RICI. The data from the REUWS II dataset was then used to validate the relationship between flow rate and outdoor water use of an automatic irrigation system on a national level and to establish the standard reference RICI of 5.0.

To calculate RICI scores for homes included in the REUWS II dataset, the following processing was completed:

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<sup>2</sup> Both "natural log +1" and adjustment factors are techniques for non-linear best fit regressions when values of "0" are present, as one cannot take the natural log of "0".

<sup>3</sup> While this term was not statistically significant, the subcommittee felt this to be the result of a lack of data for homes with swimming pools but without in ground sprinkler systems.

<sup>4</sup> <https://www.snwa.com/assets/pdf/reports-xeriscape.pdf>