Creating a WaterSense Label for Efficient Landscape Sprinklers

Introduction

To help save water for future generations, the U.S. Environmental Protection Agency (EPA) created the WaterSense Program to help people save water by making it easier to identify water-efficient and high performing products. Products bearing the WaterSense label have been independently certified to use at least 20 percent less water and perform as well or better than standard models. Over the past 10 years, EPA has partnered with manufacturers, retailers and distributors, and utilities to bring millions of WaterSense labeled products to the marketplace. Since the program began in 2006, WaterSense has helped consumers save a cumulative 1.5 trillion gallons of water and more than $32.6 billion in water and energy bills.

Residential outdoor water use across the United States accounts for nearly 9 billion gallons of water each day, mainly for landscape irrigation. The average U.S. household uses more water outdoors than most American homes use for showering and washing clothes combined. Experts estimate that as much as 50 percent of this water is wasted due to overwatering caused by inefficiencies in irrigation methods and systems. To help consumers reduce outdoor water use, the WaterSense label can be found on weather-based irrigation controllers that use local climate and landscape data to determine when and how much to water. WaterSense is currently developing a labeling specification for soil moisture-based control technologies and landscape irrigation sprinklers.

Exploring Specification Development for Landscape Irrigation Sprinklers

In July 2014, WaterSense published a Notice of Intent (NOI) to develop a draft specification for landscape irrigation sprinklers. In the NOI, WaterSense defined a landscape irrigation sprinkler according to the American Society for Agricultural and Biological Engineers and International Code Council's *802-2014 Landscape Irrigation Sprinkler and Emitter Standard (ASABE/ICC 802-2014)*[1], "A sprinkler is a device consisting of a sprinkler body with one or more orifices (i.e., nozzles) to convert irrigation water pressure to high-velocity water discharge through the air, discharging a minimum of 0.5 gallons per minute (gpm) at the largest area of coverage available for the nozzle series when operated at 30 pounds per square inch (psi) or more with a full-circle pattern."

The NOI discussed two main components that influence the efficiency of a sprinkler: the nozzle and the body. The nozzle provides the pattern of water emitted from the sprinkler, either in a fan-like pattern (i.e., a spray nozzle) or by means of one or more moving streams [e.g., multi-stream, multi-trajectory (MSMT)]. The nozzle influences the uniformity of how water is applied. The body of the sprinkler, which houses the nozzle, can provide pressure regulation if applicable and can compensate for changes in inlet pressures. These two components are generally sold separately and are interchangeable between brands in some cases.

WaterSense initially recommended that its draft specification apply to both high-efficiency nozzles and pressure-regulating bodies of landscape irrigation sprinklers. It was EPA's intent to develop one specification that included separate criteria for each component (i.e., a set of nozzles criteria and a set

[1] Note that the standard was in draft form at the time of publication of the NOI, but the definitions and methodology regarding testing pressure regulation received only editorial changes from draft to final.

of bodies criteria). Each component would have been certified and labeled separately and could have either been purchased and used separately, or packaged and sold together as a WaterSense labeled landscape irrigation sprinkler.

Regarding high-efficiency nozzles, WaterSense proposed distribution uniformity (DU) as the appropriate performance measure. DU, as defined by *ASABE/ICC 802-2014*, is the measure of the uniformity of irrigation water applied to a defined area. Because field studies were lacking, the WaterSense NOI suggested incorporating DU into the irrigation schedule, thereby shortening irrigation run times and resulting in theoretical savings.

Regarding pressure-regulating bodies, the NOI proposed setting a performance threshold by developing an acceptable outlet pressure variance across a range of inlet pressures and using the test method for pressure regulation as outlined in *ASABE/ICC 802-2014*. WaterSense suggested calculating savings based on the reduction in flow when pressure regulation is in place, potentially capturing additional savings from devices that reduce flow when a nozzle is damaged or missing.

WaterSense listed several outstanding issues in the NOI regarding both nozzles and bodies and requested feedback during the public comment period on a variety of topics. More than two dozen public comments were received. In general, commenters supported moving forward with a specification for pressure-regulating bodies but expressed concern about high-efficiency nozzles and the use of DU as a performance measure. Specifically, commenters had concerns with WaterSense developing a specification for a product category based on theoretical savings based on improved DU. As discussed in the NOI, WaterSense identified two field studies, conducted by Southern Nevada Water Authority and San Antonio Water System, examining high-efficiency nozzles and savings in the field. While both studies measured an increase in DU with high-efficiency nozzle retrofits, neither resulted in the expected water savings.

Based on the lack of field studies demonstrating savings and the public comments received discouraging WaterSense from basing savings on theoretical calculations based on DU, WaterSense put specification development for high-efficiency nozzles on hold. WaterSense continues to collect data and would be interested in collaborating with the industry on field studies or other research that would assess tangible savings, develop consensus around a new performance measure, or demonstrate DU as a viable performance measure for high-efficiency nozzles.

Moving Forward With Pressure-Regulating Spray Sprinkler Bodies

WaterSense moved forward with specification development for pressure-regulating bodies (PRBs), based on the public comments received on the NOI and also potential savings that can be achieved by these products. Sprinklers are usually designed to operate within a range of pressures, and they have an optimum pressure under which the nozzle provides its best performance. Most sprinkler models available on the market have an operating pressure range between 15 and 75 psi, with an optimum pressure between 30 and 45 psi. In many cases, sprinklers are installed at sites where the system pressure is above this optimum operating range, resulting in wasted water.

High operating pressure can result in inefficiencies for a variety of reasons, including excessive flow rates, misting, fogging, and uneven distribution. By regulating system inlet pressure to an optimum level, a sprinkler with pressure regulation can increase efficiency in the irrigation system. The pressure-regulating feature, usually achieved by a device built in the stem, compensates for high inlet pressure and maintains the pressure at a relatively constant level. As a result, the flow through a sprinkler is also constant across a range of inlet pressures, resulting in more even performance and associated water savings. Additionally, by maintaining the pressure within a nozzle's operating range, the nozzle generates appropriate water droplet size and performs with high uniformity.

Although system pressure varies from site to site, high system pressure is not uncommon. Researchers from Utah State University have been conducting a landscape irrigation system evaluation program since 1999. In this program, researchers visit homes and commercial, industrial, and institutional sites to evaluate outdoor irrigation systems. During the visits, researchers collect system pressure at each site. The dataset currently holds 6,462 records[2], 29 percent of which have a pressure higher than 50 psi, including 10 percent that have pressures above 70 psi (see Figure 1).

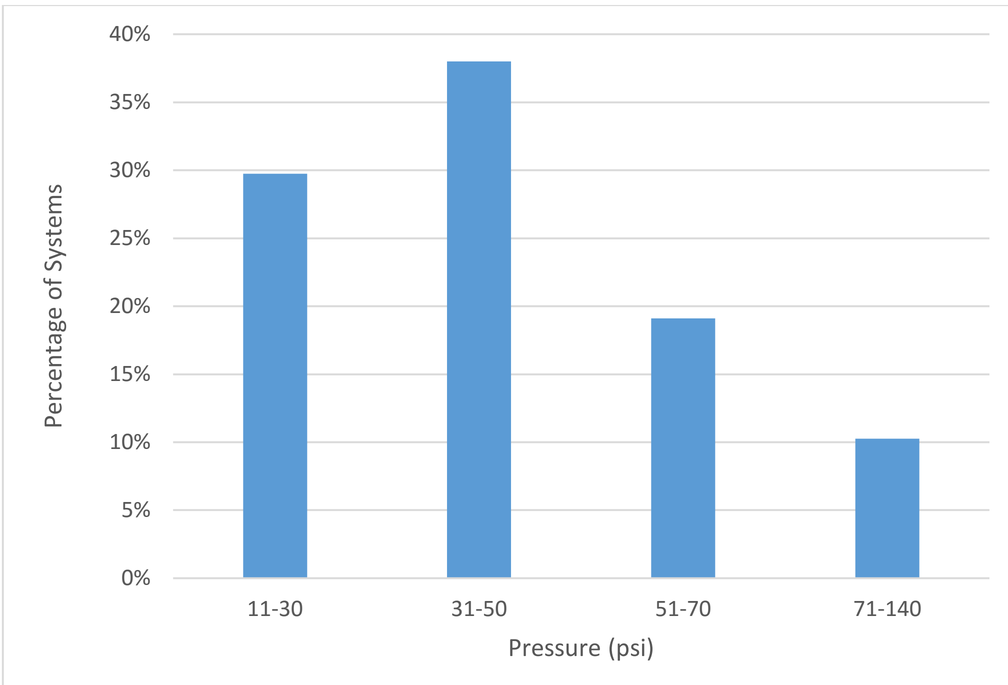

Figure 1. Irrigation System Pressure Data, Utah State University

Similarly, the Center for Resource Conservation in Boulder, Colorado, offers free onsite sprinkler consultations for residential properties. Trained irrigation auditors visit each property to conduct irrigation system inspections. During this process, sprinkler operating pressure is measured. According to the data gathered during these inspections (7,744 records in total)[3], 13 percent of them have a pressure higher than 50 psi, including 3 percent higher than 70 psi (see Figure 2).

[2] Updated data are currently under analysis and will be published at a later date.
[3] Updated data are currently under analysis and will be published at a later date.

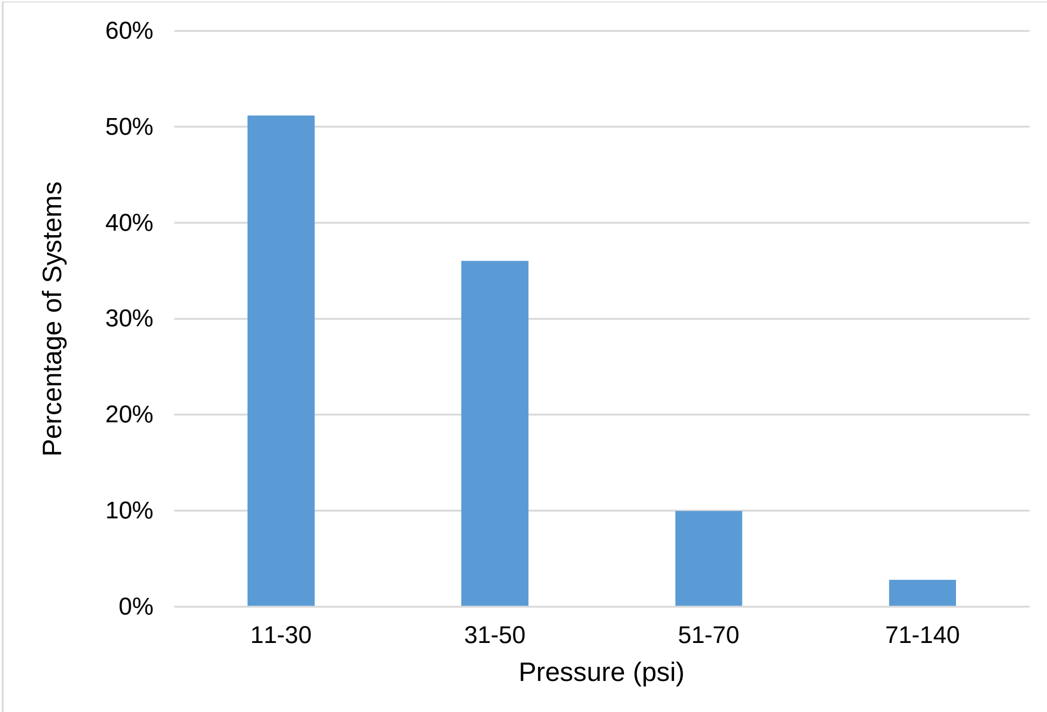

Figure 2. Irrigation System Pressure Data, Center for Resource Conservation

Additionally, the American Water Works Association Research Foundation published a table of water pressures in distribution systems for 15 cities across the United States and Canada in its *Residential End Uses of Water Study*.[4] Pressures ranged from 20 psi to 500 psi (see Table 1).

Table 1. Water Pressure Ranges in Distribution Systems

Utility/Provider	What are the range of pressures in your water distribution system?
Boulder, Colorado	80-160 psi
Cambridge, Ontario	20-100 psi
Waterloo, Ontario	20-100 psi
Denver, Colorado	40-110 psi
Eugene, Oregon	40-80 psi
Las Virgenes Municipal Water District (California)	30-500 psi
Lompoc, California	85-120 psi
Phoenix, Arizona	60-120 psi
Municipal Region of Waterloo (Ontario)	50-70 psi
San Diego, California	40-85 psi
Scottsdale, Arizona	40-120 psi
Seattle, Washington	40-80 psi
Tampa, Florida	20-65 psi (typical = 45 psi)

[4] Mayer, Peter W. and William B. DeOreo. American Water Works Association Research Foundation. 1999. *Residential End Uses of Water*.

Tempe, Arizona	50-90 psi
Walnut Valley Water District (California)	40-180 psi

With the prevalence of high system pressure, as demonstrated above, WaterSense anticipates that labeling and promoting PRBs can improve outdoor water efficiency in a wide range of service territories.

Development of a Test Method and Performance Data

In order for WaterSense to develop a specification for a product category, a repeatable test method must be available, or be developed. Additionally, a set of performance data resulting from the testing of several products according to the test method must be available to provide the basis for the performance and water efficiency criteria. Once WaterSense decided to move forward with specification development for PRBs, achieving these two goals was key to moving forward.

WaterSense began this process in early in 2015 by developing a method for performance testing that was heavily based on *ASABE/ICC 802-2014, Section 303.5.2 (pressure regulation)* with several modifications. First, stakeholders requested through public comment that a low and a high flow be tested. The standard only requires testing at one flow rate (1.5 gpm), so WaterSense incorporated testing at a high flow rate (3.5 gpm) as well. Second, stakeholders requested that outlet flow be measured in addition to outlet pressure, so WaterSense incorporated an outlet flow rate measurement. Additionally, WaterSense allowed the laboratories to use a variety of devices to control flow (e.g., needle valve, variable arc nozzle, or other device) instead of the standard orifice required by *ASABE/ICC 802-2014,* because the laboratories found the standard orifice to be onerous and unnecessary. WaterSense also reduced the number of pressure levels from 12, as specified in *ASABE/ICC 802-3014*, to five pressure levels. This change reduced the time required for each test, though it still allowed for each product to be tested at a range of pressures (i.e.,10 psi above the regulated pressure to the maximum operating pressure).

The three laboratories conducted performance testing using the revised methodology between April 2015 and April 2016. Each laboratory tested three models (three separate brands) of PRBs and three models of standard spray bodies of the same brands, with three samples of each model. Results from the performance testing demonstrated that the products perform as intended, though results were inconsistent among laboratories, indicating that the test method needed to be clarified in several sections. Therefore, WaterSense revised the test method to specify that a needle valve shall be used to control flow. Additionally, WaterSense revised the method to introduce a reduction to 0 psi between each pressure level to address hysteresis found in initial results. For additional information on the independent laboratory performance testing and subsequent test method revisions, please review *Landscape Irrigation Sprinklers: WaterSense Specification Update* on the WaterSense website, published in November 2015.

WaterSense then used the revised test method at the University of Florida to conduct a final round of performance testing on nine PRBs and three standard spray sprinkler bodies. This testing was conducted to determine a range of performance of PRBs using a consistent test method, as well as to determine the water savings of these products when compared to their standard counterparts (e.g., standard spray sprinkler bodies). The data from the University of Florida performance testing will form the basis of the water savings calculations included in WaterSense program materials, as well as the performance criteria included in the specification. The performance testing at the University of Florida was not complete at the time of the submission of this paper, but will be discussed during the technical presentation at the 2016 Irrigation Show & Education Conference (December 6, 2016).

Regarding the flow shut-off feature and associated missing nozzle test, WaterSense indicated in the NOI that products could be required to undergo a missing nozzle test included in *ASABE/ICC 802-2014, Section 303.5.6*, to determine how well the PRBs reduce flow in a situation where a nozzle is damaged or missing. This commonly occurs when a mower damages or completely severs the nozzle from the sprinkler body, among other causes. WaterSense included this test for two products in the initial performance testing conducted at the independent laboratories, as well as for four products at the University of Florida. Results indicate that products with flow shutoff can reduce flow 100 percent when the nozzle is damaged or missing. However, since PRBs without this feature can also significantly reduce the flow when compared to a standard spray sprinkler body, WaterSense has decided not to include this as an additional performance criterion in this version of the specification. Though this is an important water-saving feature, currently WaterSense is only aware of two products on the market that include flow shut-off technology and would like to see the market develop more in this arena before requiring this feature.

Draft Specification Publication

As of this writing, WaterSense is planning the release of a draft specification for PRBs in late 2016. This specification defines the scope of the product category, as well as the performance test method and water efficiency and performance criteria. General requirements regarding product marking and product certification are included as well. For details on the draft specification, visit the WaterSense website at www.epa.gov/watersense.

Next Steps

The public comment period associated with the draft specification is open through the end of January 2017. Two public meetings will be held during this time. The first will take place at the 2016 Irrigation Show & Education Conference in the Oasis (please see the IA Show guide for date and time), and the second will be a webinar (for a date and time, please visit the WaterSense website). Official public comments should be submitted in written form to watersense@epa.gov. Once the comment period closes, WaterSense will review all submissions and revise the draft specification as necessary. EPA is expecting to publish a final specification for PRBs in summer 2017.