Water-Efficient Single-Family New Home Specification Supporting Statement

I. Introduction

The WaterSense® Program is developing criteria for water-efficient new homes. The intent of the Water-Efficient Single-Family New Home Specification (Specification) is to reduce indoor and outdoor water usage in new residential homes and encourage community infrastructure savings. The Specification is applicable to newly constructed single-family homes and townhomes, three stories or less in size.

II. Current Status of Water Use in Residential New Homes

The environmental impact of the residential sector is significant. There are more than 120 million homes in the United States and about 1.5 million new homes are constructed each year. On average for all homes, 70 percent of household water is used indoors and 30 percent is used outdoors; however, these percentages can easily flip during summer months in arid climates. Outdoor water use, especially for irrigation, can strongly affect a municipality's peak water use, upon which the sizing of water supply facilities is based. Table 1 presents the average indoor water consumption data for an existing American home.[1]

Table 1. Typical Indoor Household Water Use

Type of Use	Daily Use (gallons/person)	Approximate % of Total Indoor Use
Toilets	18.5	26.7
Clothes Washers	15.0	21.7
Showers	11.6	16.8
Faucets	10.9	15.7
Leaks	9.5	13.7
Other	1.6	2.2
Baths	1.2	1.7
Dishwashers	1.0	1.4
Total	**69.3**	**100.0**

Water use inside the home has been addressed nationally through two mechanisms. The Energy Policy Act of 1992 (EPAct) established the maximum flush volume of toilets typically installed in residential settings at 1.6 gallons per flush (gpf), and the maximum flow rate for bathroom sink faucets, kitchen faucets, and showerheads at 2.5 gallons per minute (gpm) at 80 pounds per square inch (psi) static pressure. In 1998, the Department of Energy adopted a maximum flow rate standard of 2.2 gpm at 60 psi for all faucets.[2] However, new standards have not been issued to mandate the more efficient plumbing products being manufactured today.

[1] AWWA Research Foundation, 1998. Residential End Uses of Water.
[2] 63 *Federal Register* 13307; March 18, 1998.

The water consumption of appliances found in homes is not currently specified in national standards, but Congress approved future water use standards for dishwashers and clothes washers in the Energy Independence and Security Act of 2007 that would take effect in 2010 for dish washers and 2011 for clothes washers. The water use of clothes washers is addressed in the ENERGY STAR® program.

Due in part to their environmental impact, some of today's home builders are building more efficient homes under voluntary local, regional, and national green building programs. In 2005, 31 percent of builders reported that they were more than moderately involved with green building. Market research suggests continued growth of the residential green building market as more builders, suppliers, and product manufacturers become involved in green building and more homeowners and homebuyers demand green homes. Some reports predict that green home building may have recently reached its tipping point — the point where the builder population turns from "less involved" to "more involved." In 2006, the growth in green home building was expected to rise by 20 percent over 2005, and in 2007, growth was predicted to be 30 percent over 2006 numbers. If this holds true, more than two-thirds of builders will be building green homes (at least 15 percent of their projects), with only one-third not yet engaged in the marketplace. [3]

Every year builders are adopting more green principles in their construction of new homes. As this trend continues and green homes become more mainstream, the way we define a green home will also evolve. Although there is much debate within the industry as to what constitutes a green home, the industry has begun to agree that green homes contain a number of common elements, such as energy efficiency, improved indoor air quality, water conservation, resource efficiency, and high performance construction processes.[4] Reports indicate that energy efficiency is the top practice in green home building.[5] The use of water-efficient products and practices, however, is often overlooked in the construction of green homes and is not considered a priority in many of the existing green building programs being used today.

Recent studies indicate that it is feasible to build a home that uses 20 percent less water than other new homes. Specifically, Environments for Living's Summary Report "Water Efficiency and Performance in Diamond Class Test Homes" states that "the technologies and equipment to achieve overall water savings between 20 and 30 percent and maintain or improve overall performance in new homes are readily available."

The WaterSense Labeled New Homes program is an initiative designed to actively promote the transformation of the mainstream home building industry towards increased water efficiency. While there are already a number of green home building programs, the WaterSense Specification provides national consistency in defining the features of a water-efficient new home and enables builders anywhere in the country to obtain a WaterSense label on their homes. The WaterSense Labeled New Homes program can be integrated into existing green home building programs to reach a large number of home builders and facilitate its adoption as a national specification. To maximize water efficiency, the WaterSense New Homes Program is setting both indoor and outdoor water use criteria and requiring homeowner education to help improve water-efficient behaviors.

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[3] McGraw_Hill Construction. 2006. *Residential Green Building SmartMarket Report*.
[4] Ibid.
[5] Ibid.

III. WaterSense Water-Efficient Single-Family New Home Specification

Scope

The WaterSense Program developed this specification to address criteria for improvement and recognition of water-efficient new homes. The Specification focuses specifically on new homes to address water efficiency during the planning and design stages of home construction where significant impacts can be achieved using readily available best technologies. Due to differences in the design and construction of multi-dwelling units, this specification focuses on single-family detached homes and town homes.

The Specification addresses both indoor and outdoor water use because water savings achieved through indoor improvements can easily be lost through inefficient outdoor water use. With respect to indoor water use, the Specification addresses plumbing fixtures in bathrooms, hot water distribution systems, water-using appliances, and other water-using equipment. The Specification addresses the static service pressure in the home to minimize unintentional water wastage occurring from high water pressure within the home. Kitchen and utility faucets are not addressed since the different uses (e.g., pot filling) and user expectations (e.g., fill the pot quickly) may not be adequately addressed with low-flow faucets. Water efficiency criteria for showerheads also have not been addressed because research is still being conducted to establish acceptable performance criteria for water-efficient showerheads. Outdoor water use is addressed through landscape and irrigation system design criteria. The Specification also addresses homeowner education to inform the homeowner of the water-efficient components of the home and encourage water-efficient behaviors.

Homes must meet the criteria in all areas to be considered for the WaterSense label. This specification provides the minimum water efficiency criteria necessary to be considered a WaterSense labeled home. Additional water conservation measures (e.g., gray water recycling) can be included in the home provided they do not adversely impact the criteria included in this specification. This specification is not intended to contravene local codes and ordinances.

Third-party certification of homes seeking the WaterSense label will be required. EPA is currently developing the certification scheme for WaterSense labeled new homes. This process will be described in detail as part of the final specification for water-efficient single-family new homes.

This specification will be revised as new products such as showerheads and/or weather-based irrigation technologies are labeled under the WaterSense program. Revisions may also occur when additional water-efficient building practices become acceptable and cost-effective to home builders. Revisions to this specification will not be retroactive and would be made following discussions with building partners and other interested stakeholders. Adequate lead time will be provided for builders to implement any changes.

Water Efficiency Criteria

There are three major types of water-efficiency criteria included in this specification: indoor, outdoor, and homeowner education. Each of these is described in detail below.

Indoor Water Efficiency Criteria

- *Service pressure* – This specification establishes a maximum static service pressure of 60 pounds per square inch (psi). Compliance with this measure shall be achieved by use of a pressure-regulating valve downstream of the water meter. All fixture connections shall be downstream of the pressure regulator.

  Because flow rate is related to pressure, the maximum water flow from a fixture operating on a fixed setting can be reduced if the water pressure is reduced. For example, a reduction in pressure from 100 psi to 50 psi at an outlet can result in water flow reduction of about one-third. Water pressure reductions can also save water by reducing the likelihood of leaking water pipes, leaking water heaters, dripping faucets, and catastrophic events when pipes, hoses, or component parts in a water-using product burst. A study in Denver, Colorado demonstrated an annual water savings of about 6 percent for homes that received water service at lower pressures when compared to homes that received water services at higher pressures.

- *Toilets* – This specification requires that all toilets installed in the home be WaterSense labeled high efficiency toilets (HETs). These HETs have a maximum effective flush volume of 1.28 gallons per flush and must effectively clear 350 grams of soy-based media. Information on these HETs is available at http://www.epa.gov/watersense/specs/het.htm.

- *Bathroom faucets* – This specification requires that all bathroom faucets installed in the home be WaterSense labeled bathroom faucets. The WaterSense specification sets the maximum flow rate of faucets and aerators at 1.5 gallons per minute (gpm) tested at a flowing pressure of 60 psi. The specification also includes a minimum flow rate of 0.8 gpm tested at a flowing pressure of 20 psi to ensure performance across a variety of different household conditions. Information on these faucets is available at http://www.epa.gov/watersense/specs/faucet_final.htm.

- *Showerheads* – This specification does not establish a new maximum flow rate for individual showerheads; however it does establish a total allowable flow rate from all showerheads flowing at any given time at 2.5 gpm per shower compartment. This requirement also applies to rain systems, waterfalls, bodysprays, and jets. This specification defines a shower compartment as an area no larger than 2,500 square inches. An exception to this requirement is the use of recirculating showers. Recirculating showers are those designed to recirculate the water used in a shower by capturing it in a basin and then pumping it through the shower system. Most of these systems are designed to be switched on after initial cleaning using a conventional showerhead and may include a filtering process.

  Market research suggests that up to four percent of new homes are being constructed with multiple showerheads per shower compartment due in part to the ease of installation of these shower systems and consumer demand for upgraded showers that allow for luxury shower experiences. These systems can use as much as 10 gpm of water.[6] Limiting showers designed for single individuals to one showerhead minimizes the amount of water used per shower.

The Specification also requires that showers be equipped with automatic compensating valves that comply with ASSE 1016 for ASME A112.18/CSA B125.1 and designed to provide thermal shock and scald protection at the flow rate of the showerhead that is installed.

- *Hot Water Delivery Systems* – This specification establishes that all hot water pipes, both above and below ground, be insulated to a minimum of R4 and that each home be equipped with at least one of the following features: demand-initiated hot water recirculating system, whole house manifold system, and/or core plumbing system. These systems are to be designed to contain less than 0.38 gallons of water between the hot water source and any hot water fixture for whole house manifold and core plumbing systems and 0.13 gallons of water between the recirculating loop and any hot water fixture for demand-initiated water recirculating systems.

  The intent of requiring water efficient hot water delivery systems is to reduce water waste by using technologies that provide hot water at the tap with a minimal wait time. An average American household wastes over 10,000 gallons of water each year while waiting for hot water to get to the fixture.[7] Researchers believe that water waste can be reduced by 90 percent in new homes that are constructed with water-efficient hot water systems addressing plumbing design, pipe insulation, demand recirculation, and drain heat recovery.

  Insulating hot water piping reduces the amount of water wasted while waiting for hot water by keeping the water hotter and getting hot water to the point of use quicker. Insulating hot water piping also reduces energy losses as hot water moves through the lines to the point of use and when hot water sits in the lines between draws. Insulation can keep the water temperature 2°F to 4°F hotter compared to uninsulated pipes, allowing for a lower water heater temperature setting.

  Recirculating hot water delivery systems reduce water wasted while waiting for hot water by circulating the water in the pipes through the water heater until a specified temperature is reached. Demand-initiated recirculating systems save energy by not circulating hot water through the piping system continuously. Whole house manifold systems can use smaller diameter piping for some fixtures which allows hot water to arrive at fixtures faster, and less hot water is left standing in pipes after a draw, reducing both water and energy use. Core plumbing systems can reduce the total amount of plumbing pipe installed; the amount of conductive heat loss from the pipe; the amount of time it takes for hot water to reach baths, laundry areas, and the kitchen; and the amount of hot water left standing in pipes after a draw.

- *Dishwashers* – This specification establishes that dishwashers offered, financed, installed, or sold as upgrades through the homebuilder shall be ENERGY STAR® labeled. ENERGY STAR qualified dishwashers use at least 41 percent less energy than

[6] Biermayer, Peter. 2006. Potential Water and Energy Savings from Showerheads. Ernest Orlando Lawrence Berkley National Laboratory. LBNL-58601-Revised.
[7] Home Builders Association of Metro Denver. 2007. Guide to the 2007 Built Green® Checklist.

the federal minimum standard for energy consumption and much less water than conventional models.

- *Clothes Washers* – This specification establishes that clothes washers offered, financed, installed, or sold as upgrades through the homebuilder shall be ENERGY STAR labeled and have a water factor (WF) of less than or equal to 6.0 gallons per cycle per cubic foot capacity. WF is the number of gallons used per cycle per cubic foot of clothes washer capacity. The lower the WF, the more water-efficient the clothes washer.

- *Evaporative Air Conditioners* – This specification establishes that evaporative air conditioners installed by the homebuilder shall use 5 gallons (or less) of water per ton-hour of cooling when adjusted to maximum water use. Blow-down shall be based on time of operation, not to exceed 3 times in one 24-hour operating period. The reservoir discharge outlet should be easily visible so the homeowner can see when the refill valve is leaking.

  Although evaporative air conditioners use about one-fourth the electricity of a conventional air conditioner, they add about 19,000 gallons, on average, to a homeowner's annual water consumption.[8] Research indicates that some units appear to more efficiently evaporate water, thus, producing more cooling per unit of water used.

- *Water Softeners* – This specification establishes that water softeners installed by the homebuilder shall be certified to meet the NSF/ANSI 44 standard and have demand-initiated regeneration. If the water softener uses an ion exchange technology, it shall be capable of using potassium rather than sodium salt. Water softeners that use auto-initiated regeneration (fixed schedule) do not meet this specification.

  NSF/ANSI 44 standard is a third party certification that confirms the performance of the water softener. Demand-initiated systems measure water usage with a water meter and regenerate only when the meter counts down to zero. These systems do a better job of providing treated water than auto initiated systems because they regenerate more closely to the time they need to and do not waste water during unnecessary regenerations.

  Potassium chloride is as effective as sodium chloride for water softening in both residential and commercial processes. Plus, using potassium chloride has several benefits: it reduces the amount of sodium in drinking water; the treated water contributes potassium to people's diets; and it eliminates the addition of sodium from water softeners into a household's septic system tank and drainfield. Potassium is an essential mineral for plants; whereas, sodium can damage plant tissues. Because sodium is replaced by potassium, this diluted wastewater is beneficial to a grass covered drain field.

- *Drinking Water Treatment Systems* – This specification establishes that drinking water treatment systems installed by the homebuilder shall be certified to meet applicable

[8] National Association of Home Builders Research Center. Toolbase Services. Evaporative Coolers Whole-house Cooling in Arid Regions at a Low First Cost. http://www.toolbase.org/Technology-Inventory/HVAC/evaporative-coolers.

NSF/ANSI certifications and have an efficiency rate of not less than 85 percent. Systems using carbon filters can exceed efficiency ratings of 85 percent.

- *Whole House Humidifiers* – This specification does not address whole house humidifiers installed by the homebuilder. EPA is interested in receiving any data relating to the water use and performance of furnace humidifiers.

Outdoor Water Efficiency Criteria

- *Landscape Design*s – This specification establishes that homebuilders shall landscape the entire yard so that either (1) the turf shall not exceed 40 percent of the landscapable area or (2) the evapotranspiration (ET) limit on the landscapable area shall be no more than 60 percent of the reference ET_0 for cool season grass. The available precipitation for calculation purposes shall be no more than 25 percent of the average annual rainfall amount. The Specification also establishes that turf shall not be installed on slopes greater than 4:1.

  How and where turf is placed in the landscape can significantly reduce the amount of irrigation water needed to support the landscape. Lawns require a large amount of supplemental water and generally greater maintenance than other vegetation. Limiting turf to areas where it aesthetically highlights the house or where it has a practical function, such as in play areas, and grouping turf areas together can increase watering efficiency and significantly reduce evaporative and runoff losses. Long, narrow turf areas are difficult to water efficiently, and water tends to create excessive runoff on slopes greater than 4:1.

  The landscape water budget establishes the maximum amount of water to be applied through the irrigation system, based on climate, landscape size, irrigation efficiency, and plant needs. A properly designed water budget ensures that a landscape receives adequate irrigation without over-watering, saving water and the homeowner's time and money. Limiting available precipitation to no more than 25 percent in the water budget calculations better ensures that the landscape will survive during seasons with less than average rainfall amounts.

- *Mulching* – This specification establishes that non-turf, non-hardscape areas shall include a 2 to 3-inch layer of mulching materials. Mulches aid in greater retention of water by minimizing evaporation, reducing weed growth, moderating soil temperatures, and preventing erosion. Organic mulches also improve the condition of your soil as they decompose. Mulches are typically composed of wood bark chips, wood grindings, pine straws, nut shells, small gravel, or shredded landscape clippings.

- *Pools/spas* – This specification establishes that the water surface area of pools and/or spas installed by the homebuilder shall be considered in the landscape design as part of the turf allowance and/or landscapable area used to calculated a water budget. Under this specification, pools are treated as turf to account for their annual evaporation rates and water use requirements.

- *Ornamental Water Features* – This specification establishes that builders shall not install or facilitate the installation of ornamental water features. Ornamental water features are defined as fountains, ponds, waterfalls, man-made streams and other decorative water-related constructions provided solely for aesthetic or beautification purposes. Because these water features serve no functional or practical purpose their water use is not considered efficient.

- *Irrigation System Designs* – This specification establishes that irrigation systems, if installed, shall, at a minimum, (1) be designed to sustain the landscape without creating flow or spray that leaves the property during a minimum continuous operating duration specific for the type of irrigation system used; (2) be designed and installed by a WaterSense Irrigation Partner; (3) not use sprinkler heads to water plantings other than maintained turf grass; and (4) use microirrigation for planting beds and turf installed in strips of less than 8 feet wide.

  Good irrigation design and scheduling provides one of the greatest opportunities for water efficiency in the landscape. Irrigation design consists of the layout of the sprinkler system, equipment selection and sizing, filtration, pressure control, hydraulics and layout. The goal of a good design and layout is to provide an irrigation system with good overall distribution uniformity to maintain plant health while conserving water resources. Lower uniformity results in over-application of water to parts of the landscape in order to apply enough water to those areas that are under-irrigated. Efficient systems should have no overspray across or onto a street, driveway, or any other non-vegetated area that does not require irrigation. Microirrigation applies water at a low flow rate and low pressure to the roots of plants by depositing the water either on the soil surface or directly to the root zone. Microirrigation systems lose significantly less water to runoff and ET than conventional systems because the water is applied to the roots and/or soil and soaks directly into the soil. These systems are good for slopes and small strips of turf which generally lose a lot of water to runoff and evaporation.

  WaterSense Irrigation Partners have a specified level of experience and/or training and have passed a comprehensive exam covering general irrigation subjects as well as specialty areas including water efficiency. These professionals have also agreed to follow a code of ethics. WaterSense Irrigation Partners evaluate site conditions and prepare professional irrigation plans to meet the needs of individual projects. This professional chooses the most effective irrigation equipment and design methods for the site and individual project requirements, ensuring that the best system is used for a particular site.

- *Irrigation Controllers* – This specification establishes that irrigation controllers shall have multiple programming capabilities, multiple start times, variable run times, variable scheduling, a percent adjust (water budget) feature, the capability to accept external soil moisture and/or rain sensors, non-volatile memory or self-charging battery circuit, and complete shut off capability for the total cessation of outdoor irrigation. Irrigation controllers are one of the most important components of an irrigation system because they determine when and where the water goes in the landscape. The more programming flexibility the controller has, the more efficiently water can be applied to the landscape. The current controller requirements are based on draft recommendations from irrigation professionals. EPA plans to conduct additional research on the criteria for controllers before releasing a final specification for water-efficient new homes.

- *Sprinkler Heads* – This specification establishes that sprinkler heads shall have a 4 inch or greater pop-up height and matched precipitation nozzles. It is important for the pop-up height to be greater than the grass height to prevent the sprinkler heads from being blocked by the grass, thereby reducing the distribution uniformity.

- *Mircroirrigation Systems* – This specification establishes that microirrigation systems shall be equipped with pressure regulators, filters, and flush end assemblies. Pressure regulators control the pressure of the water in the system and prevent more water being applied than necessary. Filters remove sand and larger suspended particles before they enter the distribution network and flush end assemblies allow the systems to be maintained properly by flushing out particles that accumulate in microirrigation pipelines before they build-up to sizes and amounts that cause plugging problems.

- *Schedules* – This specification establishes that two seasonal water schedules be posted at the controller. One schedule shall be designed to address the initial grow-in phase of the landscape and the second schedule shall be designed to address an established landscape. Regularly changing the irrigation schedule is an important component of a water-efficient landscape.

Homeowner Education

This specification establishes that the builder shall develop and provide to the homebuyer a written operating and maintenance manual for all water-using equipment or controls installed in the house or yard. If clothes washers or dishwashers are not provided, information about water-efficient appliances shall also be included. The intent of the manual is to educate homeowners on the efficient use of water and the benefits of doing so, as well as how to operate and maintain their home to achieve the highest level of performance.

Potential Water and Energy Savings

Water Savings

The average indoor household water usage for homes constructed after 1994 with toilets, faucets, and showerheads that comply with EPAct standards is estimated to be approximately 50 gallons per person per day (see Table 2). Expected water usage for homes constructed to be water-efficient is difficult to estimate as limited data are available. Data from six studies are shown:

- High efficiency homes being offered by Durham Region in Canada, in conjunction with Tribute Communities, Natural Resources Canada, and the Federation of Canadian Municipalities demonstrated a water savings of 22.3 percent during a six month period (October 2006 – March 2007) over standard homes constructed at the same time in the same development. The 91 upgraded homes were constructed with ENERGY STAR water-efficient front-loading clothes washers, ENERGY STAR dishwashers, HETs, and efficient showerheads.[9]

- The Masco Contractor Services Environments for Living® program conducted a detailed study of water efficiency in three new homes in 2004 to 2005. The homes were constructed with low-flow faucets and showerheads, high performing toilets, ENERGY STAR dishwashers, top performing clothes washers, electronic-demand hot water distribution systems, weather-based irrigation controllers, and a water-efficient landscape. The study encountered problems getting data after the houses were bought but one of the homes demonstrated an indoor water savings of 34 percent.[10]

- A series of three intervention studies were conducted from 1999 to 2003 to collect data on water conserving fixtures and appliances. Seattle Public Utilities conducted the first study on 37 single-family homes in 1999 to 2000, East Bay Municipal Utility District (EBMUD) conducted the second study on 33 homes in 2001 to 2003, and Tampa Water conducted the third study on 26 homes in 2003. All homes included in the studies were retrofitted with high efficiency clothes washers, showerheads, toilets, and faucets. Water usage data after the retrofits demonstrated a water savings of 37.2 percent in Seattle, 39 percent in EBMUD, and 49.7 percent in Tampa.[11,12,13]

- Water-efficient homes labeled under Southern Nevada Water Authority's Water Smart Home program are expected to save 75,000 gallons of water per year per home over homes built a decade ago. These homes are constructed with water-smart landscaping in the front yard, high-efficiency dishwashers, faucets, and showerheads.[14]

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[9] Veritec Consulting, Inc. 2007. Region of Durham Efficiency Community, Interim Report. May 4.

[10] Environments for Living. Summary Report: Water Efficiency and Performance in Diamond Class Test Homes. September 2005.

[11] Mayer, P., DeOreo, W., et al. 2000. *Seattle Home Water Conservation Study: The Impacts of High Efficiency Plumbing Fixture Retrofits in Single-Family Homes.* Aquacraft, Inc. Water Engineering and Management. December.

[12] Mayer, P., DeOreo, W., et al. 2003. *Residential Indoor Water Conservation Study: Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in the East Bay Municipal Utility District Service Area*. Aquacraft, Inc. Water Engineering and Management. July.

[13] Mayer, P., DeOreo, W., et al. 2004. *Tampa Water Department Residential Water Conservation Study: The Impacts of High Efficiency Plumbing Fixture Retrofits in Single-Family Homes*. Aquacraft, Inc. Water Engineering and Management. January.

[14] Southern Nevada Water Authority Web site http://www.snwa.com/html/cons_wshome_features.html.

To estimate the potential indoor water savings of water-efficient single-family homes, WaterSense developed an expected water use associated with the required features of the home and then compared those usage estimates to standard water usage for those features to derive savings per feature. Savings for all of the features in the new home specification were added to estimate the total water savings. As shown in Table 2, WaterSense expects a water-efficient home to use 21 percent less water indoors than a standard home.

Assuming that the average indoor household water usage for homes constructed to current standards is 130 gallons/day (gpd), the water savings from the indoor requirements can result in an annual savings of approximately 10,000 gallons per home (see Calculation 1).

Calculation 1. Average Household Water Savings

50 gpd/person · 2.6 people/household · 0.21 water savings = 27.3 gpd savings · 365 days/yr = 9,965 gal saved/yr/house

Extrapolated to the national level, potential estimated water savings from the indoor components of the home could be as great as 15 billion gallons annually (see Calculation 2). These estimates clearly demonstrate the significant water saving potential of building water-efficient new single family homes.

Calculation 2. National Water Savings Potential

9,965 gal/yr/house · 1,465,400 annual housing starts for single family homes[15] = 14.6 billion gallons water saved per year

WaterSense also expects significant outdoor water savings for homes installing a water-efficient landscape and irrigation system, if applicable. However, there are little data on the "standard" landscape and "standard" outdoor water usage for single family homes. Data indicate that the national average for residential irrigation ranges from 25 to 29 gallons per person day.[16]

WaterSense estimates that a reduction of turf from about 80 percent in a standard yard to 40 percent in a water-efficient landscape results in a water savings of approximately 25 percent.[17] In addition, WaterSense estimates that an efficient irrigation system with appropriate scheduling can result in a water savings of 25 percent over non-efficient irrigation systems.[18] WaterSense has not tried to estimate potential household or national savings associated with the outdoor criteria due to the variability associated with outdoor water usage across the country.

Energy Savings

WaterSense expects water-efficient single family homes to save approximately 3,500 gallons of hot water per year (see Table 3 and Calculation 3). This expected hot water savings results in 618 kilowatts (kWh) of electricity or 3,070 cubic feet of natural gas savings each year (see Calculations 4 and 5).

[15] NAHB. 2007. *Housing Facts, Figures and Trends*. p. 3 - 2006 Annual Housing Starts for Single-Family. May.

[16] Vickers, A. 2002. Handbook of Water Use and Conservation. Plow Press.

[17] WaterSense analysis based on evaluation of watering requirements of landscapes with 80 percent turf and 20 percent bushes and trees compared to landscapes with 40 percent turf and 60 percent bushes and trees in various locations in the country.

[18] Gleick, P., Haasz, D., et al. 2003. *Waste Not, Want Not: The Potential for Urban Water Conservation in California*. p 70. Pacific Institute for Studies in Development, Environment, and Security. November.

In addition to the energy savings from the home itself, WaterSense estimates that an additional 33 kWh of electricity is saved by not supplying and treating the 9,965 gallons of water saved per home (see Calculation 6). National energy savings could exceed 403 million kWh of electricity and 2.5 billion cubic feet (Bcf) of natural gas each year (see Calculations 7 and 8).

Calculation 3. Average Household Hot Water Savings
9.6 gpd hot water saved · 365 days/yr = 3,504 gal hot water saved/yr

Calculation 4. Electricity Savings Per Household from Hot Water Savings
3,504gal/year · 176.5 kWh of electricity/1,000 gal = 618 kWh of electricity/yr

Calculation 5. Natural Gas Savings Per Household from Hot Water Savings
3,504 gal/yr · 0.8768 thousand cubic feet (Mcf) of natural gas/1,000 gal = 3.07 Mcf (3,070 cubic feet) of natural gas/yr

Calculation 6. Electricity Savings From Not Supplying Saved Water to the House
9,965 gal/yr · 0.0033 kWh of electricity/gal = 32.88 kWh of electricity/yr saved

Calculation 7. National Electricity Savings Potential
(618 kWh/yr/home · 0.40 · 1,465,400) + (32.88 kWh/yr/home · 0.85 · 1,465,400 homes)
= 403 million kWh of electricity/yr

Calculation 8. National Natural Gas Savings Potential
3.07 Mcf/yr/home · 1,465,400 homes · 0.56
= 2.5 million Mcf of natural gas/yr = 2.5 Bcf of natural gas/yr

These calculations are based upon the following assumptions:

- Approximately 70 percent of faucet water used in a household is hot water, [19] 100 percent of dishwasher water is hot water, and 28 percent of water used for clothes washing is hot water.[20]
- Approximately 40 percent of occupied residences in the United States heat their water using electricity and 56 percent heat their water using natural gas.[21]
- Approximately 85 percent of households in the United States are connected to a water supply system.[22]
- Total electricity required to supply and dispose of each gallon of water delivered to a house is 0.0033 kWh. Surface water supply requires 0.0015 KWh of electricity per gallon of water delivered (includes pumping raw water, filtration/treatment, and distribution) and wastewater treatment requires 0.0018 KWh of electricity per gallon of water treated (average across various treatment types and plant sizes). [23]
- Water heating consumes 0.2 kWh of electricity per gallon of water heated (see Calculation 9), assuming:

[19] Mayer, P., DeOreo, W., et al. 2004.
[20] Mayer, P., DeOreo, W., et al. 2000.
[21] U.S. Department of Housing and Urban Development and U.S. Census Bureau. American Housing Survey for the United States 2005. Table 1A-4, page 6.
[22] Hudson, Susan S. et al. *Estimated Use of Water in the United States in 2000*. U.S. Geological Survey Circular 1268. Department of the Interior. Table 5. page 14.
[23] Goldstein, R. & W. Smith. 2002. *Water & Sustainability Volume 4: U.S. Electricity Consumption for Water Treatment & Supply – the Next Half Century*. Electric Power Research Institute, March 2002.

- Specific heat of water = 1.0 BTU/lb · °F
- 1 gallon of water = 8.34 lbs
- 1 kWh = 3,412 BTUs
- Incoming water temperature is raised from 55°F to 120°F (Δ 65°F)
- Water heating process is 90 percent efficient, electric hot water heater

Calculation 9.

[(1 gal · 1.0 BTU/lbs · °F) (1 KWh/3,412 BTUs)/(1 gal/8.34 lbs) · 65°F] / 0.90
= 0.1765 kWh/gal

- Water heating consumes 0.8768 Mcf of natural gas per 1,000 gallons of water heated (See Calculations 10 and 11) assuming:
  - Specific heat of water = 1.0 BTU/lb · °F
  - 1 gallon of water = 8.34 lbs
  - 1 Therm = 99,976 BTUs
  - Incoming water temperature is raised from 55°F to 120°F (Δ 65°F)
  - Water heating process is 60 percent efficient, natural gas hot water heater

Calculation 10.

[(1 gal · 1.0 BTU/lbs · °F) (1 Therm/99,976 BTUs)/(1 gallon/8.34 lbs) · 65°F] / 0.60
= 0.009037 Therms/gal

Calculation 11.

0.009037 Therms/gal · 1,000 gal · 1 Mcf/10.307 Therms = 0.8768 Mcf/kgal

Table 2. Expected Daily Per Capita Indoor Water Savings from WaterSense Labeled New Homes

Indoor Features	Standard Water Use	Standard Use (gal/day/capita)	WaterSense Criteria	Expected Use (gal/day/capita)	Expected Water Savings (gal/day/capita)
Toilets	1.6 gpf	8.16[24]	1.28 gpf	6.53	1.63 (20%)
Bathroom faucets	2.2 gpm	11.21[25]	1.5 gpm[26]	10.64	0.57 (5%)
Showerheads	2.5 gpm	10.33[27]	2.5 gpm	10.33	0 (0%)
Hot water delivery systems	~10 gallons per day per household wasted[28]	3.85[29]	Assume 10% water savings for insulation and between 15 – 20% water savings for improved design.[30]	2.89	0.96 (25%)
Dishwashers	8.6 gallons per load[31] (6 gallons per cycle)[32]	1.04	5.8 gallons per load (4 gallons per cycle)[33]	0.69	0.35 (33%)
Clothes washers	39.6 gallons per load[34] (12 gallons per cycle per cubic foot)	15.35	24 gallons per load[35] (6 gallons per cycle per cubic foot)	8.44	6.91 (45%)
Total Indoor		49.89		39.52	10.42 (21% savings)

[24] Assumes 5.1 flushes/day/person per Mayer. P, DeOreo, W. et al 2000 and 2003.
[25] Assumes flow of 1.2 gpm and average use of 9.34 minutes/person/day per Mayer , P., DeOreo, W. et al 2000 and 2003.
[26] Assumes flow of 0.97 gpm and average use of 10.97 minutes/person/day per Mayer , P., DeOreo, W. et al 2000 and 2003.
[27] Assumes flow of 2.13 gpm, average use of 8.36 min/shower/person, and 0.58 showers/person/day per Mayer P., DeOreo W. et al 2000 and 2003.
[28] Klein, Gary. *Hot Water Distribution Considerations for BMPs*. Presentation made on August 21, 2006 to the California Urban Water Conservation Council.
[29] Assumes 2.6 persons per household per U.S. Department of Housing and Urban Development 2005 .
[30] Acker, L., Klein, G. *Benefits of Demand-Controlled Pumping*. Home Energy. September/October 2006.
[31] Assumes 8.64 gallons/load and 0.12 loads/person per Mayer , P., DeOreo, W. et al 2000, 2003, and 2004.
[32] ENERGY STAR Frequently Asked Questions on Dishwashers. <energystar.custhelp.com/cgi-bin/energystar.cfg/php/enduser/std_adp.php?p_faqid=2539&o_created…>accessed 2/15/08.
[33] Ibid.
[34] Assumes 39.36 gallons/load and 0.39 loads/person per Mayer , P., DeOreo, W. et al 2000, 2003, and 2004.
[35] Assumes 24.15 gallons/load and 0.35 loads/person per Mayer , P., DeOreo, W. et al 2000, 2003, and 2004.

Table 3. Expected Hot Water Savings from WaterSense Labeled New Homes

Indoor Feature	Expected Water Savings	Percent Hot Water	Expected Hot Water Savings
Bathroom faucets	1.7 gpd	70	1.2 gpd
Hot water delivery systems	2.5 gpd	100	2.5 gpd
Dishwashers	0.9 gpd	100	0.9 gpd
Clothes washers	17.9 gpd	28	5.0 gpd
Total	23 gpd		9.6 gpd

Cost Effectiveness and Payback Period

WaterSense estimates that the incremental costs associated with the criteria of this specification will range from $800 to $3,000 (see Table 3). This analysis is based on the potential incremental costs associated with building a WaterSense labeled new home versus a new home constructed to comply with basic requirements and practices.[36]

Table 3. Estimate of Incremental Costs Associated with the Specification

WaterSense Criteria	Incremental Cost Estimate
Service pressure – pressure regulating valve	$0 - $150[37]
WaterSense labeled HETs	$0 - $100[38]
WaterSense labeled faucets	$10[39]
Efficient hot water delivery systems	$0 (core plumbing)[40] -$200 (manifold)[41] $2,000 (recirculating system)[42]
ENERGY STAR dishwashers (if installed)	$30[43]
ENERGY STAR clothes washers (if installed)	$270[44]
Turf and mulching	$300[45]
3rd party certification of home	$400[46]
Total	$800 to $3,000

The average homeowner of a WaterSense labeled new home will realize $60.60 savings on water and wastewater costs annually due to lower indoor water consumption (see Calculation 12).

Calculation 12. Annual Water and Wastewater Cost Savings

10,000 gallons/yr · $6.06/1,000 gallons[47] = $60.60/yr

Factoring in the accompanying energy savings, the average household with electric water heating may save an additional $58.71 (618 kWh/yr · $.095/kWh[48]), for a combined annual

[36] Assumes home has 2.5 bathrooms, 1 kitchen, 0.36 acre lot (15,682 ft^2); and total landscapable area of 12,280 ft^2.

[37] Price based upon retail list prices of products found on various retailer Web sites. The range assumes some houses are already constructed with the valves in place.

[38] Price range based upon retail list prices of products found on various retailer Web sites.

[39] Assumes the cost of a WaterSense labeled aerator is $4 and a standard 2.2 gpm aerator is $1.

[40] Assumes the incremental cost would negligible due to reduced piping costs.

[41] Assumes a baseline hot water delivery systems is trunk and branch with copper piping with materials and labor $1,100. Assume manifold system with PEX with materials and labor is $920. Source: NAHB Research Center PATH Field Evaluation. *Evaluation of Residential Water Distribution Piping Installation: Time, Cost, & Performance Comparison PEX & Copper*. September 2006.

[42] Assume increased cost of $1,000 to $2,000 due to increased piping requirements (up to 1/3 more piping required), pump costs, and additional labor for the installation of the additional electrical components. Source: Telephone conversations with the Plumbing Manufacturers Institute.

[43] Price based upon retail list prices of products found on various retailers' Web sites.

[44] Price based upon retail list prices of products found on various retailers' Web sites.

[45] Assume a unit cost of $1.50/ft^2 for a traditional landscape and $1.55/ft^2 for a water-efficient landscape based on limited data on Xeriscape landscaping. These costs may vary greatly across different parts of the country.

[46] Telephone conversation with the Residential Energy Services Network (RESNET).

[47] Raftelis Financial Consulting. Water and Wastewater Rate Survey. American Water Works Association. 2006.

[48] Average Retail Price of Electricity to Ultimate Consumers by End-Use Sector, Energy Information Administration. www.eia.doe.gov/cneaf/electricity/epa/epa7p4.html.

savings of approximately $119.31. The average household with natural gas water heating may save an additional $42.49 (3.07 Mcf/yr · $13.84/Mcf[49]), for a combined annual savings of approximately $103.

The average payback period for an average WaterSense labeled home would range between 6 and 25 years for those with electric water heating and 7 to 29 years for those heating with natural gas (see Calculations 13 and 14). These payback periods will improve if outdoor water use savings are also realized.

Calculation 13. Average Payback Period (Electric Water Heating)
$800 incremental cost for home/$120 cost savings/yr = 6.7 years
$3,000 incremental cost for home/$120 cost savings/yr = 25 years

Calculation 14. Average Payback Period (Natural Gas Water Heating)
$800 incremental cost for home/$103 cost savings/yr = 7.8 years
$3,000 incremental cost for home/$103 cost savings/yr = 29 years

IV. Request for Comments and Data

At this time WaterSense is interested in receiving comments on

- Any and all aspects of the proposed Specification;
- The performance and water savings of water-efficient homes; and
- The use of best management practices to manage stormwater runoff from single-family homes. The objective of stormwater management is to maintain the quality and quantity of stormwater runoff to pre-development levels using structural or non-structural devices to temporarily store or treat stormwater runoff.

49 Short-Term Energy Outlook, Energy Information Administration. <www.eia.doe.gov/steo>