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# Estimating Benefits of Residential Outdoor Water Conservation: A Step-by-Step Guide[1]

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## Introduction

This publication was developed to assist Extension agents, water-conservation managers, and homeowners in estimating the economic benefits of residential outdoor water conservation. Specifically, it provides guidance that can be used to report impacts related to known residential outdoor water savings: (1) financial savings households can see on their utility bills; (2) savings in water-delivery costs for Florida utilities; and (3) increased water supply for other properties in the neighborhood. This publication also offers an example of an impact statement that Extension agents can modify at the local level.

Conservation and efficiency have been important strategies for protecting Florida's critical water resources. With over 20 million residents, Florida is the third most populous state after California and Texas. The state's population continues to grow at a rate nearly twice the average of the country overall, increasing by 1.4% per year (Florida Legislature Office of Economic and Demographic Research 2013; United States Census Bureau 2015). This rapidly growing population amplifies both indoor and outdoor water demands. Water conservation, which can be defined as the "prevention and reduction of wasteful or unreasonable uses of water" (CFWI 2015, p. 75), is one way to cut per-capita water use and offset the increases in population

Figure 2. UF/IFAS ICS

and water demand. Such offset is important because the water withdrawals needed to meet the growing public demand are depleting the groundwater supplies and reducing spring and in-stream flows and lake levels throughout the state (Marella 2015).

Often, the main barrier for water conservation is the inadequate information about available strategies to conserve and the benefits associated with water conservation. Addressing this barrier is one goal of the UF/IFAS initiative "enhancing and protecting water quality, quantity, and supply" (2013-2023 UF/IFAS Extension Roadmap UF/

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IFAS 2011). Effective outreach programs implemented by UF/IFAS Extension agents and other organizations result in measurable reductions in water use that allow families and communities to contribute to Florida's water-resource protection goals.

It remains imperative to document the value of water conservation. For outreach organizations and water resource managers, estimating the benefits improves overall accountability, helps program marketing and promotion, and ensures broader engagement of community members. The demonstration of programmatic impacts also increases the likelihood of receiving new and continued program funding. For Florida residents, information about the benefits supports decision-making about water use, water conservation, and water-use-efficiency improvements.

## Overview of Water Conservation Benefits

*Reduction in household water and energy bills*. Because water and energy use are closely linked, reducing water use would reduce both water and energy bills. The United States Environmental Protection Agency (EPA 2015a) estimates that the average US household spends more than $1,000 per year on water. Moreover, 25% of the average residential utility bill is spent on heating water for homes with electric water heaters. Families can save an average of $350 per year by switching to water/energy-efficient fixtures in their homes (EPA 2015a).

*Ripple effects of household changes in water and energy use.* The effects of changes in household water use do not stop at the property line. Rather, the effects multiply if one traces them through the water-supply system. For example, treating and delivering water to a residence requires a significant amount of energy. Running a water faucet in a house for 5 minutes requires as much energy as 14 hours of using a 60-watt light bulb (EPA 2015a). Another stunning illustration: The United States uses 25% more energy to "generate electricity for water pumping, treating, heating, cooling, and pressurizing water" than the energy used for lighting in commercial and residential sectors (Sanders and Weber 2012, p. 10). Consequently, reductions in household water use translate into energy cost savings for the household, the water supplier, and the municipality. While comprehensive data for Florida water utilities were not found, a survey of utilities in Illinois showed that energy costs generally ranged between 8% and 15% of the utilities' operating budgets, with a maximum reported of 25% (ISAWWA 2012). In Florida, one of the largest water suppliers, the City of Tampa Waterworks, spends almost $4 million annually for purchasing electricity (5.7% of its annual operation and maintenance costs) (Mo 2012).

The effect of home water and energy savings can be traced even further, linking them to reductions in coal and natural gas use in power production and related greenhouse gas emission savings. A River Network report estimated that in 2005, carbon emissions related to water systems accounted for 5% of all carbon emission in the United States (Griffiths-Sattenspiel and Wilson 2009). Hence, water conservation and efficiency also contribute to reductions in greenhouse gas emissions.

*Deferred need for investments in additional water-supply infrastructure*. The EPA (2015a) estimated that in regions with limited water resources, capital costs needed to ensure new water supply can exceed $10,000 per acre foot (or $30.6 per thousand gallons). Investments in expensive water-supply projects increase public water-supply prices and local taxes. High construction costs are also linked with high costs of operating water-treatment and supply facilities. The Florida Department of Environmental Protection (FDEP 2015) reported that in northeast Florida (specifically, in the area under the jurisdiction of the St. Johns River Water Management District), the costs of water treatment and supply from seawater desalination plants are as high as $8.51 per thousand gallons. This is more than 30 times higher than the costs of treating groundwater, $0.25–$0.27 per thousand gallons. Conserving water can mean delays in construction of expensive reservoirs and treatment facilities, and slowing the increase in our taxes and water prices.

In part, the high cost of water desalination can be attributed to the significant amount of energy required for the treatment process itself. For example, Kipp Searcy et al. (2011) examined Tampa Bay Water's electricity use for treating water from different sources. They showed that in 2008/09, when Tampa Bay Water included seawater desalination with traditional ground- and surface-water treatment in its water-supply mix, their electricity expenditures increased by 138%, even though the desalinated water accounted for less than 20% of total annual production. The study also showed that, on average, indirect carbon dioxide emissions were 18 times higher for seawater desalination than for groundwater treatment (measured as carbon dioxide equivalent per million gallons of potable water produced).

*Potential water-quality benefits*. Over-irrigation and excessive use of fertilizers on residential lawns contribute to pollution problems in rivers, lakes, streams, and springs. Together with adverse effects on water flows and levels,

water pollution changes the delicate balance of organisms and microorganisms living in the water bodies. Such degradation of aquatic ecosystems diminishes water-based recreational opportunities and alters the flow of other services received from nature (referred to as "ecosystem services," including water purification, climate regulation, and biodiversity support).

Water-use efficiency and water conservation, along with other changes in residential landscapes (e.g., following the 9 principles of Florida-Friendly Landscaping) can reduce pollution runoff and improve water quality in nearby streams, lakes, and springs. Natural resource economists offer a variety of methods for estimating the value of improvements in water quality in monetary terms. For example, Russel et al. (2013) related the benefits of water-quality improvements (from reducing nitrogen pollution) to the costs of nitrogen removal. As a conservative estimate, the study used $8.16 per pound of nitrogen to value the service of nitrogen removal provided by green spaces. Note, however, that this value should be used with caution because the actual value of the services can be larger or smaller, depending on the local ecosystems and their use.

*Approval of permits for water suppliers*. In Florida, water suppliers must submit applications for water-conservation plans—and have those plans approved—to receive "consumptive use permits" (CUPs). These CUP applications are reviewed by Florida's five Water Management Districts and are intended to balance water withdrawals with the need to protect water resources, restore spring and stream flows and lake levels, or prevent reductions in spring and stream flows and lake levels. In the absence of residential water-conservation programs and associated savings, water suppliers would face additional challenges in securing permits for their public-supply water withdrawals (Olexa et al. 2015).

These examples show that water conservation and efficiency can result in not only immediate financial gains, but numerous other individual, household, and community benefits as well. To summarize, the benefits of water conservation are as follows:

- Financial savings for individuals, families, and communities from reduced water and energy costs and delayed need for investments in costly water infrastructure
- Protection of drinking-water resources (aquifers, rivers, streams, and lakes) and reduced vulnerability to droughts
- Environmental benefits from reduced pollution runoff, protection of water sources, and avoided carbon emission and natural resource extraction

## Measuring Water Conservation Benefits

Behavior changes followed by improved social, economic, and environmental status resulting from an Extension program are the most difficult to bring about and also the most difficult to evaluate (Harder 2013; Lamm et al. 2011). However, UF/IFAS has been encouraged to focus on reporting behavior changes and associated SEE condition changes to improve the quality of evaluation activities (Lamm et al. 2011). The impacts of UF/IFAS water-conservation programs are easily observed at the local level. Extension professionals statewide collect outcomes in the form of gallons of water saved as a result of their programs. Some may have access to actual water-use data through partnerships with local communities or utilities. Others may make estimates through known savings associated with specific behaviors (Boyer and Dukes 2015).

While there are many benefits of residential water conservation that are evident or can be measured directly, some benefits are hard to estimate. For the remainder of this publication, we focus on financial savings households can see on their *water* utility bills; savings in water-delivery costs for Florida utilities; and increased water supply for other properties in a neighborhood. Furthermore, we focus on *outdoor, residential* water savings only. In Florida, landscape irrigation typically accounts for a significant proportion of total household water use. For example, Haley et al. (2007) found that irrigation accounted for two-thirds of total water use of single-family homes in central Florida. Up to 50% of water used for landscape irrigation can be wasted due to inefficient irrigation systems and methods (EPA 2015b), so there is significant potential for water conservation and improving outdoor water-use efficiency. Overall, outdoor water savings can range from 15% to 65% or more (AWE 2015).

## Reporting Water Savings

UF/IFAS Extension programs result in a reduction in program attendees' water use and water bills. The following metrics using calculated gallons of water saved per year based on Estimated Water Savings Potential of Florida-Friendly Landscaping from Boyer and Dukes (2015) can be used to assess the impacts of these Extension programs. Please note the following when calculating gallons of water conserved per year:

- Water-savings figures associated with the adoption of multiple behavior changes are unavailable. As a conservative estimate, we recommend calculating savings based on the single behavior change that results in the greatest water savings.
- Additionally, several water-savings estimates are presented in ranges. For consistency, we recommend using the mean of these ranges for reporting.
- Estimated water savings are most accurate when calculated with the known square footage of irrigated landscape. When unknown, we recommend using the average of 4,400 square feet.

## Household Financial Savings (per 1000 Gallons of Water)

Water prices vary among water suppliers, and unit water prices increase with increases in water use (referred to as "inclining block rate pricing" or "inclining water-rate structures"). To accurately estimate water-bill reductions for the audiences reached by an Extension program, Extension agents need information about (1) baseline water use prior to the Extension program; (2) water-use reduction that can be attributed to the effect of the Extension program; and (3) water prices used by the water supplier. In some instances, a reduction in water bills can be estimated directly using water bills provided by attendees or water utilities. Extension agents and specialists can work together to collect and evaluate the information.

**Example:** A southeast Florida Extension agent finds that among 200 Florida-Friendly Landscaping program participants, 72 reduced their irrigation from 3 days per week to 2 days per week as a result of attending a program. This change results in a savings of 10,483 gallons per 1,000 irrigated square feet per year (Boyer and Dukes 2015). The cumulative irrigated square footage of the 72 participants is 295,200 square feet. Therefore, the total water savings among the 72 participants is 3,094,582 gallons per year [(295,200 sq. ft. * 10,483 gallons per 1,000 sq. ft.) / 1,000 sq. ft.].

To simplify the task while still allowing for reasonable estimates, we suggest using the water prices in Table 1, which are defined for five major regions in Florida. Note that the geographical regions are based on the jurisdictions of Florida's five Water Management Districts (Figure 1). Prices are based on data from Raftelis Financial Consultants' survey (2016), the most comprehensive available survey of Florida water rates. The report summarizes water and wastewater bills for 187 Florida public utilities with a specific focus on water bills for the water-use levels of 4,000 and 8,000 gallons per month. For this report, we use the price per thousand gallons of water, which was estimated as the difference between water bills for 4,000 and 8,000 gallons divided by 4. Using this approach with these data, the statewide average water price for the utilities included in the report by Raftelis Financial Consultants (2016) is $3.31 per 1,000 gallons.

The prices reported in Table 1 provide conservative estimates of actual financial savings. In reality, the audiences targeted by Extension programs can use significantly more than 8,000 gallons per month and, hence, pay higher prices. For example, Boyer and Dukes (2015) rely on the assumption of outdoor irrigation of 2,649 gallons per 1,000 square feet per month. Assuming a 4,400 square-foot yard, monthly outdoor irrigation for such a household is 11,655 gallons per month. Furthermore, for indoor water use of 4,521 gallons per month (Davis and Dukes 2014), such a household would be using approximately 16,000 gallons per month in total, which is significantly larger than the 4,000 or 8,000 per month used in this publication.

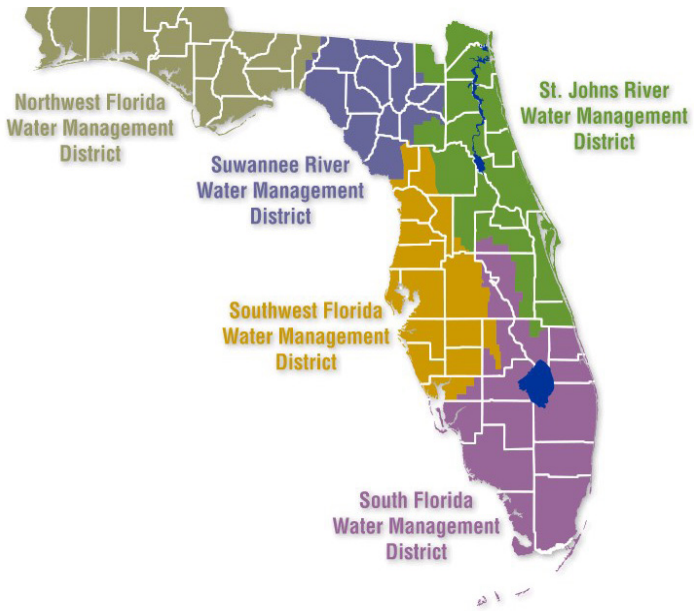


Figure 1. Area of jurisdiction for the five Florida water management districts
Credits: SJRWMD (2016)

To calculate the annual financial savings among Extension clients, divide the total gallons of water saved (per year) by 1,000, and multiply by the corresponding region's average cost per thousand gallons.

**Example:** A south Florida Extension agent finds that the total water savings among 72 participants is 3,094,582 gallons per year. This is valued at $10,676 in financial

savings among the 72 clients over the course of a year [(3,094,582/1,000)*$3.45]. This would translate into an average of $148.28 per household per year [$10,676/72 clients], or an average of $12.36 per household per month [$148.28/12 months].

## Reduction in Wastewater Fees for Residential Families

Water conservation can provide significant financial benefits to customers if they result in reductions in both water and wastewater charges. Changes in wastewater charges are primarily associated with Extension programs targeting indoor water use. However, 37% of Florida water utilities' wastewater charges are based on the total volume of water use, including both indoor and outdoor water use (Raftelis Financial Consultants 2016). In these cases, calculated wastewater bill savings should be added to the water savings estimates discussed above.

For Extension programs that reduce indoor water use and for the programs implemented in the areas where water providers charge wastewater fees based on the *total* residential water use, the wastewater prices that can be used to estimate the financial savings attributed to water conservation are summarized in Table 2. These unit prices are based on average wastewater bills as reported by Raftelis Financial Consultants (2016). Specifically, we use the differences between the average wastewater bills for 8,000 and 4,000 gallons per month divided by 4 to estimate the charges per thousand gallons of wastewater. Using this approach with these data, the statewide average wastewater price is $4.72 per 1,000 gallons.

To calculate the annual financial savings associated with wastewater use (bill) reduction among Extension clients, divide the total gallons of water saved (per year) by 1,000, and multiply by the appropriate region's average cost per thousand gallons of wastewater.

**Example:** A northeast (St. Johns) Florida Extension agent surveys 30 Extension program participants who reported adopting new irrigation best management practices as a result of attending an Extension program. Respondents report a total wastewater savings of 289,900 gallons per year. This is valued at $1,351 in annual wastewater costs ([289,900 gallons saved/1,000 gallons] * $4.66). This would translate into an average of $45.03 per household per year ($1,351/30 clients), or an average of $3.75 per household per month ($45.03/12 months). This value is added to household water bill savings, as calculated above.

## Reduction in Water-Supply Costs

FDEP (2015) describes costs of supplying water (sourcing, treatment, delivery, and distribution) from traditional and alternative water supplies. These costs range from $0.27 to $8.51 per thousand gallons of water. The wide range of costs is due to the differences in technologies needed to treat water from various sources (such as groundwater and seawater), as well as the differences in sizes of the water-treatment plants throughout the state. To simplify the task of evaluating Extension program impacts, we use the average water-supply costs reported by EPA (2004). According to this source, nationwide average tap-water treatment and delivery costs are approximately $2 per thousand gallons. After adjusting for inflation using the producer price index (United States Department of Labor 2015), this translates into $2.60 per thousand gallons.

To calculate the annual reduced financial costs among utility companies, divide the total gallons of water saved (per year) by 1,000 and multiple this value by $2.60. Note that this estimate does not account for a possible *increase* in average water-delivery cost with a reduction in water delivered. Hence, this estimate should be used with caution.

**Example:** A southeast Florida Extension agent finds that the total water savings among 72 participants of an Extension program is 3,094,582 gallons per year. This is valued at $8,046 in annual water-treatment and delivery costs for local water utilities ([3,094,582 gallons saved /1,000 gallons] * $2.60).

## Water Supply for Other Properties in the Neighborhood

To provide additional context for the value of water savings from implementation of water efficiency and conservation practices, the volume of water used in a household using best management practices for water conservation can be compared with the volume of water needed to supply a typical household. DeOreo et al. (2016) studied water use for 23,749 single-family residential houses selected from 23 utilities nationwide and found that average annual water use per household ranged from 44,000 to 175,000 gallons per household per year, with an average of 88,000 gallons per household per year (or 7,333 gallons per household per month). Using this estimate, Extension agents can calculate the number of households that could be supplied with water as a result of conservation programming efforts.

To calculate the increased water supply to other households, take the calculated annual water savings, in gallons, and divide by 88,000. The result you receive is the number of

households that can be supplied with "conserved" water for one year.

**Example:** A southeast Florida Extension agent finds that the total water savings among 72 participants is 3,094,582 gallons per year. This is enough water to supply 35 households with water for one year. (3,094,582 gallons saved /88,000 gallons per household per year).

## Sample Impact Statement

Despite having abundant water resources and plentiful rainfall, Florida's public water supplies are stressed by the 20 million people who live here. By 2025, Florida's population is expected to exceed 22 million residents (UF/IFAS 2011). To meet expected demand, Florida will need 9.1 billion gallons of fresh water per day, a 26.4% increase from current use (UF/IFAS 2011). Moreover, by 2070, it is expected that 15 million new residents will be living in Florida if the 2010 development pattern continues. If current population growth, water-use habits, and irrigation continue, development-related freshwater demand will increase by as much as 100% by 2070 (UF GeoPlan Center 2016). Water demands already exceed supply capacity in some areas of the state. Forecasted population growth and associated water demands must be addressed by the expansion of this water-supply capacity; the conservation of existing water resources is considered an important and complementary solution. UF/IFAS Extension addresses the need to conserve water by conducting educational programming statewide. For example, the Florida-Friendly Landscaping™ program helps residents conserve water by adopting and installing water-conservation practices and technologies in their home landscapes.

In the sample county, the target audience is residents who use irrigation in the home landscape. The popular quarterly *Micro-Irrigation Field Day* and the Florida-Friendly Home Irrigation Lab reached 200 households in 2015. In 2015, 50% (n = 100) of the sample county landscape water-conservation program participants (n = 200) adopted new best management practices for water conservation. These behavior changes will result in the conservation of 5,800,000 gallons of water annually. This is enough water to supply nearly 66 households with water per year; this water savings is valued annually at $96 per participating household and $15,080 in reduced water-treatment and delivery costs for the sample county regional utilities.

Details may be added to the above based on local activities in accordance with the *PDEC Guidelines for Writing Quality Impact Statements for Workload* and the *UF/IFAS Initiative #2 Water-Conservation Workplan*.

## Other Considerations in Water Conservation Assessments

### Prices and the Value of Water

Water suppliers set water prices primarily based on their financial costs. Because of this, price is a poor indicator of the total value (or benefits) that people derive from using water. However, prices have been increasing and are directly related to the financial savings for the families associated with water conservation. Water prices used in this publication should be treated as conservative estimates. The price of bottled water has been suggested as a comparable metric for estimating the value (opportunity cost) of water saved (consumed). For example, in 2014, the Beverage Marketing Corporation reported the average wholesale price for domestic non-sparkling bottled water as $1.20 per gallon (or $1,200 per thousand gallons, compared with $3.31 per thousand gallons for Florida statewide average tap water price) (Table 1) (IBWA 2017). Note that the actual cost consumers are paying at retail locations is even higher. For example, in 2013, an article in *Business Insider* reported an estimate of $7.50 per gallon (or $7,500 per thousand gallon), based on the retail price of 16.9-oz (500 mL) bottles (Boesler 2013).

### Well Water/Reclaimed Water for Irrigation

Some Extension agents work with individuals or families who rely on private wells or reclaimed water to irrigate their landscapes. For such Extension clients, financial savings from outdoor water conservation can be modest. However, water conservation is still an important programming goal because it results in environmental benefits and allows for more water in the aquifers, streams, springs, and lakes for environmental, agricultural, or other important uses. In such cases, agents can focus on reporting water savings in terms of water available for future water supply or alternative uses (see Water Supply for Other Properties in the Neighborhood, above).

## Other Water Conservation Benefits

This document does not report important energy-use reduction, water-quality improvements, or other benefits associated with water conservation. The publication will be revised as better data become available. Examples of additional benefits can be found in the "Success Stories" section of the Florida Friendly Landscaping program at http://fyn.ifas.ufl.edu/professionals/stories.htm.

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Table 1. Unit prices for water from public utilities, by Florida region

| Water Management District | Price ($/thousand gallons) |
|---|---|
| Northwest | $2.77 |
| South | $3.45 |
| St. Johns | $2.92 |
| Suwannee River | $2.75 |
| Southwest | $3.45 |
| Statewide average | $3.31* |
| * Statewide average for the utilities included in the report by Raftelis Financial Consultants (2016) | |

Table 2. Unit prices for wastewater, by Florida region

| Water Management District | Price ($/thousand gallons) |
|---|---|
| Northwest | $5.04 |
| South | $5.03 |
| St. Johns | $4.66 |
| Suwannee River | $4.60 |
| Southwest | $4.41 |
| Statewide average | $4.72* |
| * Statewide average for the utilities included in the report by Raftelis Financial Consultants (2016) | |