

An Exploratory Unit Cost Comparison of Single-Family Graywater System Water Savings

February 2017

**Addendum to the Alliance for Water Efficiency's Report
*Water Savings & Financial Benefits of Single-Family Package Graywater Systems***

Bill Christiansen, Alliance for Water Efficiency



33 N LaSalle Street, Suite 2275
Chicago, Illinois 60602
(p) 773-360-5100 | (f) 773-345-3636
www.allianceforwaterefficiency.org

Contents

Introduction	1
Graywater System Cost and Savings Assumptions	2
Single-Family Graywater System Water Savings.....	2
Single-Family Graywater System Costs	2
Water Cost and Savings Summary	4
Example Wholesale and Retail Water Rates.....	5
Comparison of Unit Costs	7
Appendix A: Replication.....	15

Introduction

The Alliance for Water Efficiency (AWE) released its *Water Savings and Financial Benefits Associated with Single-Family Package Graywater Systems* report in February 2017. This effort was initiated by AWE's Water Efficiency Research Committee, which identified single-family graywater systems as an area of needed research. Of particular interest was the cost-effectiveness of single-family graywater incentive programs. This document uses the findings of the *Water Savings and Financial Benefits Associated with Single-Family Package Graywater Systems* report to compare the unit cost of water saved with single-family graywater systems to example volumetric wholesale and retail water rates representing eight North American locations. It is intended to articulate an answer to the following question: How do the unit costs of water savings associated with single-family graywater systems stack up against example wholesale water costs and volumetric retail water rates?

The American Water Works Association's *M52 Manual* describes the unit cost of conservation programs, such as dollars per million gallons of water saved, as a relatively simple comparison to the cost of additional supply.¹ The comparison provided herein is indeed intended to be simple, and concise. The unit costs presented in this document are expressed as U.S. dollars per million gallons. This is not meant to ignore acre-feet or megalitres, but to reduce clutter in the tables and charts. Please see the Alliance for Water Efficiency report, *Water Savings and Financial Benefits Associated with Single-Family Package Graywater Systems* for more comprehensive information about single-family graywater systems including a thorough financial analysis.

The unit costs of graywater system savings in this document are calculated using the same methodology found in the AWE Water Conservation Tracking Tool. For simplicity, however, all estimates are in nominal dollars. Therefore, if a reader were to replicate this in the AWE Water Conservation Tracking Tool, interest rates and inflation would be set to zero. The calculations were conducted in a spreadsheet outside of the AWE Water Conservation Tracking Tool to avoid needing detailed service area information for each location. Appendix A contains information that can be used to enter cost and savings assumptions into the Tracking Tool.

This document utilizes graywater savings estimates for a 3-person household from the Alliance for Water Efficiency's report, *Water Savings & Financial Benefits of Single-Family Package Graywater Systems*.

¹ American Water Works Association. (2006). *Water Conservation Programs-A Planning Manual: M52 (Vol. 52)*. American Water Works Association.

Graywater System Cost and Savings Assumptions

Unit costs of water savings were estimated for the four different single-family graywater systems that are included in the Alliance for Water Efficiency report, *Water Savings and Financial Benefits Associated with Single-Family Package Graywater Systems*. The four systems include a shower to toilet unit that diverts graywater from the shower to be used for toilet flushing, and three systems that divert graywater produced indoors to the landscape. The landscape systems include laundry to landscape, branched drain, and pumped systems. For more detail about these various systems please reference AWE's, *Water Savings and Financial Benefits Associated with Single-Family Package Graywater Systems* report. A summary table is included at the end of this section with the various cost and savings assumptions. All cost and savings assumptions are based on the full AWE report unless noted otherwise.

Single-Family Graywater System Water Savings

As previously mentioned, the water savings assumptions used in this document are for a 3-person household. The *Water Savings and Financial Benefits Associated with Single-Family Package Graywater Systems* report provides theoretical savings for a variety of household sizes as graywater production will vary accordingly. The annual water savings assumptions for a 3-person household are as follows:

1. Shower to Toilet System - 7,008 gallons per year
2. Laundry to Landscape System - 5,343 gallons per year
3. Branched Drain Landscape System - 6,576 gallons per year
4. Pumped Landscape System - 11,919 gallons per year

Shower to toilet systems will reduce the amount of water discharged to the sewer and may reduce customer sewer bills if charged volumetrically. This benefit should be included by readers taking a closer look at single-family graywater system cost-effectiveness.

Single-Family Graywater System Costs

This section includes assumptions for the installation costs and annual operating costs for single-family graywater systems. There is also an assumption for the portion of the installation cost that would be paid by the utility² for an incentive program, which was not included in the *Water Savings and Financial Benefits Associated with Single-Family Package Graywater Systems* report.

Installation Cost Assumptions:

1. Shower to Toilet System - \$3,000 for professional installation
2. Laundry to Landscape System - \$1,000 for professional installation, \$185 for DIY installation
3. Branched Drain Landscape System - \$1,750 for professional installation, \$700 for DIY installation
4. Pumped Landscape System - \$6,900 for professional installation, \$2,050 for DIY installation

The utility incentive cost is assumed to be \$750 for shower to toilet systems, \$150 for laundry to landscape systems, \$300 for branched drain systems, and \$450 for pumped systems. There is one known rebate for shower to toilet systems that pays \$1,000 Canadian Dollars (approximately \$750 USD).^{3,4} There are many

² The terms "utility" and "water provider" are used interchangeably in this document.

³ The City of Guelph, Ontario, Canada. Greywater Rebate Program. <http://guelph.ca/living/environment/rebates/greywater/>. Accessed February 2017.

⁴ Converted using Bank of Canada rate of 0.7517 on October 7, 2016. <http://www.bankofcanada.ca/rates/exchange/daily-converter/>

rebate programs for laundry to landscape systems in the U.S., and others that offer a rebate for additional fixtures connected to a branched drain system.^{5,6,7,8} Incentive amounts do not include any administrative or marketing costs incurred by the water provider to run the program. These values in no way represent a suggested rebate level.

Some water providers offer graywater workshops to rebate recipients, and some may even require attendance to qualify for the incentive. In addition to installation, there are costs associated with operating and maintaining a graywater system.

Graywater System Annual Operating and Maintenance Cost Assumptions:

1. Shower to Toilet System - \$1 per thousand gallons of graywater produced + \$36/year
2. Laundry to Landscape System - \$36/year
3. Branched Drain Landscape System - \$36/year
4. Pumped Landscape System - \$1 per thousand gallons of graywater produced + \$36/year

There may be additional costs not included in this document. As the *Water Savings and Financial Benefits Associated with Single-Family Package Graywater Systems* report states:

“Some jurisdictions require backflow prevention devices to be installed on graywater systems if they are connected to a potable water system. In such cases it is not uncommon for the jurisdiction to require the homeowner to pay the purchase and installation costs of the backflow device as well as the annual or periodic testing or inspection of these devices to ensure they continue to function properly to avoid potential contamination of the potable water supply. Some jurisdictions may also require the homeowner to purchase a permit before installing a graywater system. Where these requirements exist, any associated costs must be included as an operational cost to the homeowner (pg. 5).”

There are three perspectives used in this document when categorizing the costs associated with graywater systems:

1. Total - Total cost of graywater system installation plus annual operating and maintenance costs.
2. Water provider incentive - The amount of the incentive assumed to be provided to the customer for installing a graywater system. This is the portion of the total installation cost incurred by the water provider.
3. Customer cost - The portion of the installation cost paid by the customer (total less the amount of water provider incentive) plus the annual operating and maintenance costs.

⁵ City of Santa Cruz, CA has a \$150 rebate for, “customers who attend the workshop and install a laundry-to-landscape system.” <http://cityofsantacruz.com/departments/water/conservation/graywater>. Accessed October 2016.

⁶ Scotts Valley Water District, CA offers a rebate of \$150 per fixture converted to divert graywater to the landscape. <http://svwd.org/be-water-efficient/rebates/graywater-irrigation>. Accessed October 2016.

⁷ San Lorenzo Valley Water District, CA offers \$150 for each qualified legal greywater connection. Maximum credit amount not to exceed \$750 per account. http://www.slvwd.com/_Grey.htm. Accessed October 2016.

⁸ Soquel Creek Water District, CA offers \$150 per each qualified graywater connection for a maximum of 3 connections. <http://www.soquelcreekwater.org/conserving-water/rebates/graywater-landscape>. Accessed October 2016.

Water Cost and Savings Summary

It is assumed the useful life of a single-family graywater system is 15 years, which is consistent with the *Water Savings and Financial Benefits Associated with Single-Family Package Graywater Systems* report.

Table 1 contains a summary of cost and savings assumptions used herein.

<u>System Type</u>	<u>Installation Cost (DIY)</u>	<u>Installation Cost (Pro)</u>	<u>Utility Incentive</u>	<u>Customer Initial Cost (DIY)</u>	<u>Customer Initial Cost (PRO)</u>	<u>Annual Operating Cost</u>	<u>Annual Water Savings (GPY)</u>	<u>Sewer Savings (GPY)</u>	<u>Useful Life</u>
Shower to Toilet System	NA	\$3,000	\$750	NA	\$2,250	\$43	7,008	7,008	15
Laundry to Landscape System	\$185	\$1,000	\$150	\$35	\$850	\$36	5,343	0	15
Branched Drain Landscape System	\$700	\$1,750	\$300	\$400	\$1,450	\$36	6,576	0	15
Pumped Landscape System	\$2,050	\$6,900	\$450	\$1,600	\$6,450	\$48	11,919	0	15

Table 1: Single-Family Graywater System Cost and Savings Assumptions.

Example Wholesale and Retail Water Rates

Volumetric wholesale water rates were identified for eight wholesale water providers from various regions of North America. These rates are used to provide example variable operating costs incurred by retail water providers that purchase wholesale water. Retail volumetric water rates were also identified from a retail water provider residing within each of the eight wholesale service areas. The retail volumetric rates selected represent a variable cost of water for customers. In the case of tiered retail rates, the price of the block containing monthly consumption of 25,000 gallons was selected. All the graywater systems evaluated in this report (except shower to toilet) reduce water consumption that would otherwise be used for landscape irrigation. *The Residential End Uses of Water, Version 2* study used 25,000 gallons per month to represent, “the average cost during the irrigation season (pg. 51).”⁹

Volumetric wholesale rates for eight wholesale water providers are presented in Table 2 in dollars per million gallons in U.S. dollars.¹⁰ The table is sorted from lowest to highest unit cost. Please check the footnotes for details.

<u>Wholesale Agency</u>	<u>Wholesale \$/MG (USD)</u>	<u>Year</u>
Portland Water Bureau ¹¹	\$1,523	July 2016 - June 2017
Metro Vancouver, British Columbia, Canada (average annual rate) ¹²	\$1,827	2016
North Texas Municipal Water District, Texas ¹³	\$2,530	FY 2017
Tampa Bay Water, Florida ¹⁴	\$2,560	2016
Regional Municipality of Waterloo, Ontario, Canada ¹⁵	\$2,862	2016
Metropolitan Water District of Southern California (full service treated tier 1) ¹⁶	\$2,891	2016
Massachusetts Water Resources Authority ¹⁷	\$3,488	FY 2016
Bay Area Water Supply and Conservation Agency, California ¹⁸	\$5,481	2016-2017

Table 2: Wholesale Water Rates for Eight North America Wholesale Water Providers (in U.S. Dollars)

⁹ Water Research Foundation. (2016). Residential End Uses of Water, Version 2.

¹⁰ Canadian values were converted using Bank of Canada rate of 0.7517 on October 7, 2016.

<http://www.bankofcanada.ca/rates/exchange/daily-converter/>

¹¹ City of Portland, Oregon. Ordinance No. 187773. Wholesale rate is for Tualatin Valley Water District as Portland has different rates for providers. <https://www.portlandoregon.gov/water/article/536040>

¹² Metro Vancouver, British Columbia, Canada. (2016). Budget in Brief. Used average annual rate.

¹³ North Texas Municipal Water District website. Water Rates effective October 2016. <https://www.ntmwd.com/water-rates/>. Accessed July 2016.

¹⁴ Tampa Bay Water, Florida. Tampa Bay Water Board Approves 2016 Budget.

<http://www.tampabaywater.org/newsroom/agency-news/ArtMID/3314/ArticleID/353/Tampa-Bay-Water-Board-Approves-2016-Budget-.aspx>. Accessed July 2016.

¹⁵ Regional Municipality of Waterloo, Ontario, Canada website. Billing, Rates & Meters.

<http://www.regionofwaterloo.ca/en/aboutTheEnvironment/billingratesandmeters.asp>. Accessed July 2016.

¹⁶ Metropolitan Water District of Southern California website. Financial Information.

<http://www.mwdh2o.com/WhoWeAre/Management/Financial-Information#tab2-target>. Accessed July 2016.

¹⁷ Massachusetts Water Resources Authority website. Finances and Community Charges.

<http://www.mwra.state.ma.us/finance/intro.htm>. Accessed October 2016.

¹⁸ Bay Area Water Supply and Conservation Agency website. San Francisco RWS Wholesale Rates.

<http://bawsca.org/water/rates/wholesale>. Accessed July 2016.

Residential volumetric water rates for eight retail water providers are presented in Table 3, expressed as dollars per million gallons in U.S. dollars. The associated wholesale water provider is also included. This table is sorted by wholesale provider to match the order of Table 2. As already described, in the case of a tiered rate structure the block containing 25,000 gallons/month was selected.

<u>Wholesale and Retail Agency</u>	<u>Retail Rates \$/MG (USD)</u>	<u>Note on Volumetric Rate</u>	<u>Year</u>
Portland Water Bureau - <u>Tualatin Valley Water District, Oregon</u> ¹⁹	\$7,741	Tier 2 of 2	Effective 11/2016
Metro Vancouver, British Columbia, Canada - <u>City of Vancouver, British Columbia, Canada</u> ²⁰	\$3,255	Peak Season Uniform	2016
North Texas Municipal Water District - <u>City of Garland, Texas</u> ²¹	\$8,780	Tier 3 of 3	Effective 10/2016
Tampa Bay Water, Florida - <u>Hillsborough County, Florida</u> ²²	\$6,160	Tier 3 of 4	Effective 6/2016
Regional Municipality of Waterloo, Ontario, Canada - <u>City of Waterloo, Ontario, Canada</u> ²³	\$4,951	Uniform	2017
Metropolitan Water District of Southern California - <u>City of Santa Monica, California</u> ²⁴	\$8,610	Tier 3 of 4	2016
Massachusetts Water Resources Authority - <u>Boston Water and Sewer Commission, Massachusetts</u> ²⁵	\$7,592	Tier 5 of 6	2016
Bay Area Water Supply and Conservation Agency, California - <u>City of Palo Alto, California</u> ²⁶	\$11,791	Tier 2 of 2	Effective 7/2016

Table 3: Example Volumetric Water Rates for Eight North America Retail Water Providers in U.S. Dollars.

¹⁹ Tualatin Valley Water District, Oregon website. Residential Water Rates. <https://www.twwd.org/customer-services/residential-water-rates.aspx>. Accessed November 2016.

²⁰ City of Vancouver, British Columbia, Canada website. Metered utility rates for water, sewer, and energy. <http://vancouver.ca/home-property-development/metered-rates.aspx>. Accessed July 2016.

²¹ City of Garland, Texas website. Water Rates. <https://www.garlandtx.gov/gov/rz/utilities/water/rates.asp>. Accessed October 2016.

²² Hillsborough County Florida website. Water Rates and Fees. <https://www.hillsboroughcounty.org/library/hillsborough/media-center/documents/public-utilities/water-rate-schedule.pdf>. Accessed January 2017.

²³ City of Waterloo, Ontario, Canada website. Water Service Rates. http://www.waterloo.ca/en/living/rates_water.asp. Accessed July 2016.

²⁴ City of Santa Monica, California website. Water and Sewer Rates. <https://www.smgov.net/Departments/PublicWorks/ContentWater.aspx?id=7743>. Accessed July 2016.

²⁵ Boston Water and Sewer Commission, Massachusetts website. Rates. <http://www.bwsc.org/SERVICES/rates/rates.asp>. Accessed July 2016.

²⁶ City of Palo Alto, CA. General Residential Water Service Utility Rate Schedule W-1. <http://www.cityofpaloalto.org/civicax/filebank/documents/8097>

Comparison of Unit Costs

The graywater savings estimates presented in this document are assumed to occur evenly over a 15-year period. The annual operating and maintenance costs that will be incurred in the future were expressed in nominal terms (i.e., not adjusted for inflation). The wholesale and retail water prices being used for comparison reflect present day costs, and future escalation rates were not applied. As per the introduction, this is a simple comparison.

How were the unit costs presented in this document calculated, and what do the wholesale and retail water rate examples represent?

Graywater System Water Savings Unit Cost Estimates

- I. Total Graywater Savings Unit Cost – Total cost of graywater system installation plus 15 years of annual operating and maintenance costs, divided by water savings expressed in million gallons.
 - a. Water Provider Cost of Graywater Unit Water Savings – Cost of water provider graywater system incentive, divided by water savings expressed in million gallons.
 - b. Retail Customer Cost of Graywater Unit Water Savings – Customer cost of graywater system installation (total minus water provider incentive) plus 15 years of annual operating and maintenance costs, divided by water savings expressed in million gallons.

Unit Cost of Water from a Wholesale and Retail Customer Perspective for Eight Example Service Areas

- I. Wholesale Rates – Example volumetric wholesale water rates expressed in U.S. dollars per million gallons. This represents the variable cost of water for a retail water provider purchasing water from a wholesale water supplier.
- II. Retail Water Rates – Example volumetric retail water rates for residential customers expressed in U.S. dollars per million gallons. These costs represent volumetric water rates paid by the end user at a specified tier (if there are tiers). The tier was selected based on 25,000 gallons of monthly usage to represent peak season water use and to establish a method for selecting a tier (based on REUS2 as already described). Therefore, it is intended to represent the unit cost of the water that would be saved by customers installing graywater systems. Some of the example utilities have uniform rates and some have several tiers. This is identified in Table 3. These values only represent volumetric cost at a specified level of consumption and not a total monthly water cost for the customer. Base charges and other fees are not included. Therefore, this should not be used to compare total water service costs among these or other water providers.

The remainder of this section presents five sets of table and chart pairs. It is a lot of information from different perspectives and can be perplexing. Readers are encouraged to draw their own conclusions but general descriptions and observations follow this paragraph. Every table and chart in this section is sorted from smallest to largest unit cost. Table rows and chart bars representing graywater systems have a light gray color fill, and rows and bars representing water costs have a blue color fill.

Table 4 and Figure 1 on page 9: This table lists the unit cost of water savings in dollars per million gallons for each graywater system. It uses the total installation cost of a graywater system and the annual operating and maintenance costs. This demonstrates which systems are expected to save the most water for the least amount of money based on the cost and savings assumptions in Table 1.

Table 5 and Figure 2 on page 10: Table 5 contains the name of a wholesale and retail water provider or graywater system in the left column. The right column contains the unit cost related to the total installation and operating cost of a graywater system (like Table 4), or the retail customer unit cost of water. In this example one graywater system (laundry to landscape DIY) is estimated to generate savings at a lower unit cost than one agency's retail unit cost of water. Other than this instance, water savings achieved with single-family graywater systems have a higher cost than the retail price of water with the assumptions used. This suggests that it is typically more expensive to generate water savings with single-family graywater systems than it is for residential retail customers to purchase water, based on the example rates.

Table 6 and Figure 3 on page 11: Table 6 and Figure 3 compare wholesale water purchase costs to the total unit cost of graywater savings. In this example wholesale water unit costs are all less expensive than the unit costs of graywater savings.

Table 7 and Figure 4 on page 12: Table 7 and Figure 4 compare wholesale water purchase costs to the unit cost of graywater savings based on water provider incentives. This table and chart pair get a bit more interesting and suggest that some graywater system incentive programs could be cost-effective from the water provider perspective, at the rebate levels used in this document. That does not mean it would be cost-effective from the customer perspective. The incentive levels do not include utility administrative and marketing costs.

Table 8 and Figure 5 on page 13: Table 8 and Figure 5 compare the cost retail customers pay for water against the costs customers would pay for water saved with single-family graywater systems if provided an incentive from their utility. The unit cost of laundry to landscape systems with DIY installation were lower than the retail cost of water for five water providers.

<u>Graywater System Type</u>	<u>Graywater Total \$/MG</u>
Laundry to Landscape (DIY)	\$9,046
Branched Drain (DIY)	\$12,571
Pumped System (DIY)	\$15,493
Laundry to Landscape (Pro)	\$19,215
Branched Drain (Pro)	\$23,216
Shower to Toilet System	\$34,675
Pumped System (Pro)	\$42,621

Table 4: Unit Cost of Water Savings for the Total Cost of Various Graywater Systems. Expressed in Dollars per Million Gallons. Sorted lowest to highest. Savings based on a 3-Person Household.

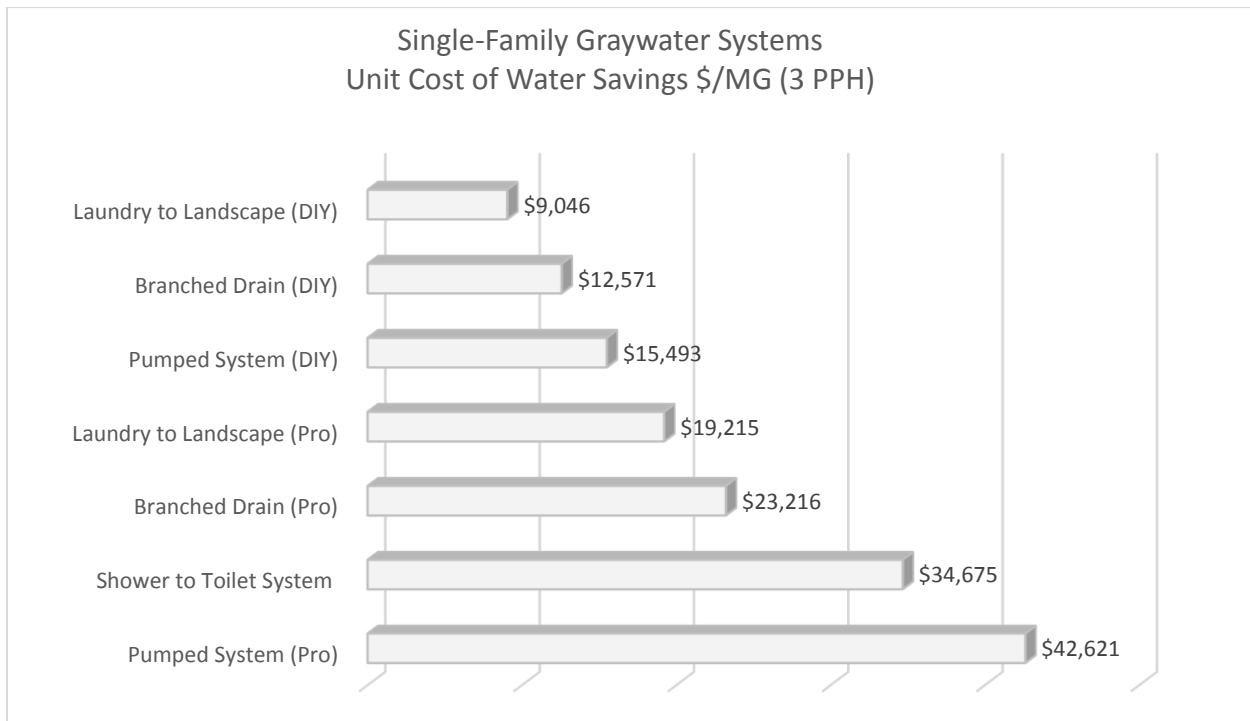


Figure 1: Unit Cost of Water Savings for the Total Cost of Various Graywater Systems. Expressed in Dollars per Million Gallons. Sorted lowest to highest. Savings based on a 3-Person Household.

<u>Wholesale and Retail Agency or Graywater System Type</u>	<u>Retail Customer Rates or Graywater Total \$/MG</u>
Metro Vancouver, British Columbia, Canada - City of Vancouver, British Columbia, Canada	\$3,255
Regional Municipality of Waterloo, Ontario, Canada - City of Waterloo, Ontario, Canada	\$4,951
Tampa Bay Water, Florida - Hillsborough County, Florida	\$6,160
Massachusetts Water Resources Authority - Boston Water and Sewer Commission, Massachusetts	\$7,592
Portland Water Bureau - Tualatin Valley Water District, Oregon	\$7,741
Metropolitan Water District of Southern California - City of Santa Monica, California	\$8,610
North Texas Municipal Water District - City of Garland, Texas	\$8,780
Laundry to Landscape (DIY)	\$9,046
Bay Area Water Supply and Conservation Agency, California - City of Palo Alto, California	\$11,791
Branched Drain (DIY)	\$12,571
Pumped System (DIY)	\$15,493
Laundry to Landscape (Pro)	\$19,215
Branched Drain (Pro)	\$23,216
Shower to Toilet System	\$34,675
Pumped System (Pro)	\$42,621

Table 5: Unit Cost of Water Savings for the Total Cost of Various Graywater Systems Compared to Retail Water Rates. Expressed in Dollars per Million Gallons. Savings based on a 3-Person Household.

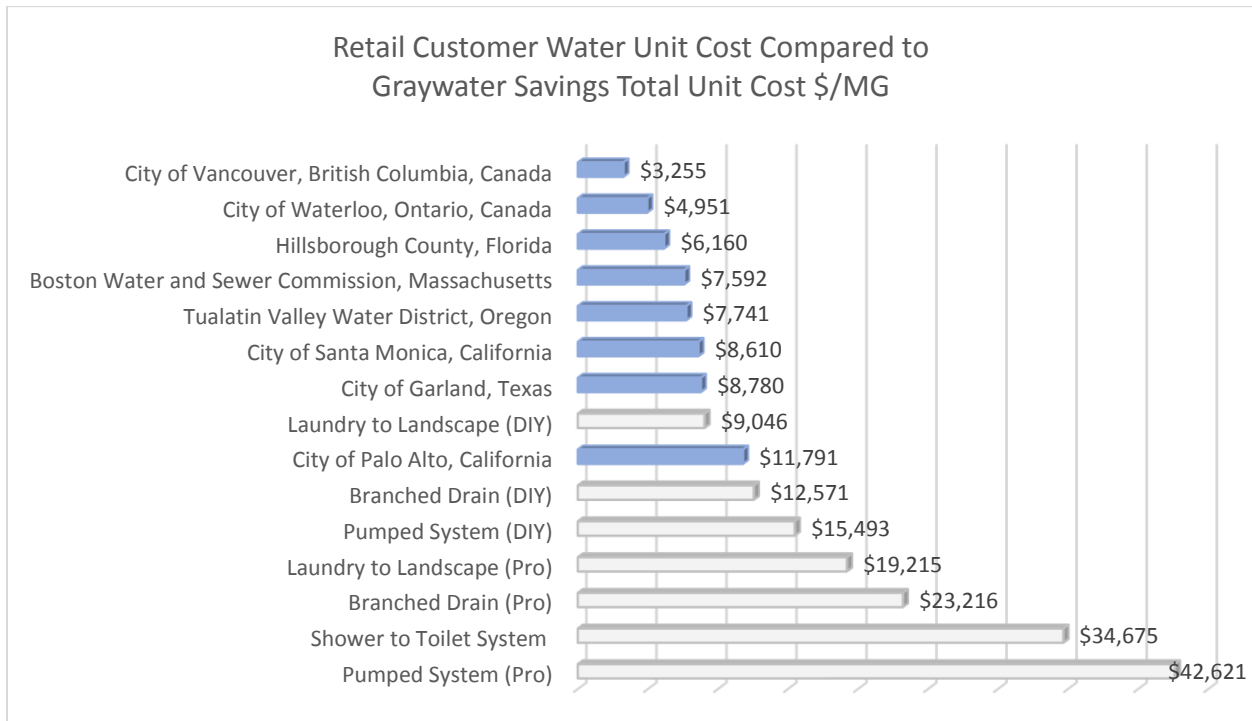


Figure 2: Unit Cost of Water Savings for the Total Cost of Various Graywater Systems Compared to Retail Water Rates. Expressed in Dollars per Million Gallons. Savings based on a 3-Person Household.

<u>Wholesale Agency or System Type</u>	<u>Wholesale Rates or Graywater Total \$/MG</u>
Portland Water Bureau	\$1,523
Metro Vancouver, British Columbia, Canada (average annual rate)	\$1,827
North Texas Municipal Water District	\$2,530
Tampa Bay Water, Florida	\$2,560
Regional Municipality of Waterloo, Ontario, Canada	\$2,862
Metropolitan Water District of Southern California (full service treated tier 1)	\$2,891
Massachusetts Water Resources Authority	\$3,488
Bay Area Water Supply and Conservation Agency, California	\$5,481
Laundry to Landscape (DIY)	\$9,046
Branched Drain (DIY)	\$12,571
Pumped System (DIY)	\$15,493
Laundry to Landscape (Pro)	\$19,215
Branched Drain (Pro)	\$23,216
Shower to Toilet System	\$34,675
Pumped System (Pro)	\$42,621

Table 6: Unit Cost of Water Savings for the Total Cost of Various Graywater Systems Compared to Wholesale Water Rates. Expressed in Dollars per Million Gallons. Savings based on a 3-Person Household.

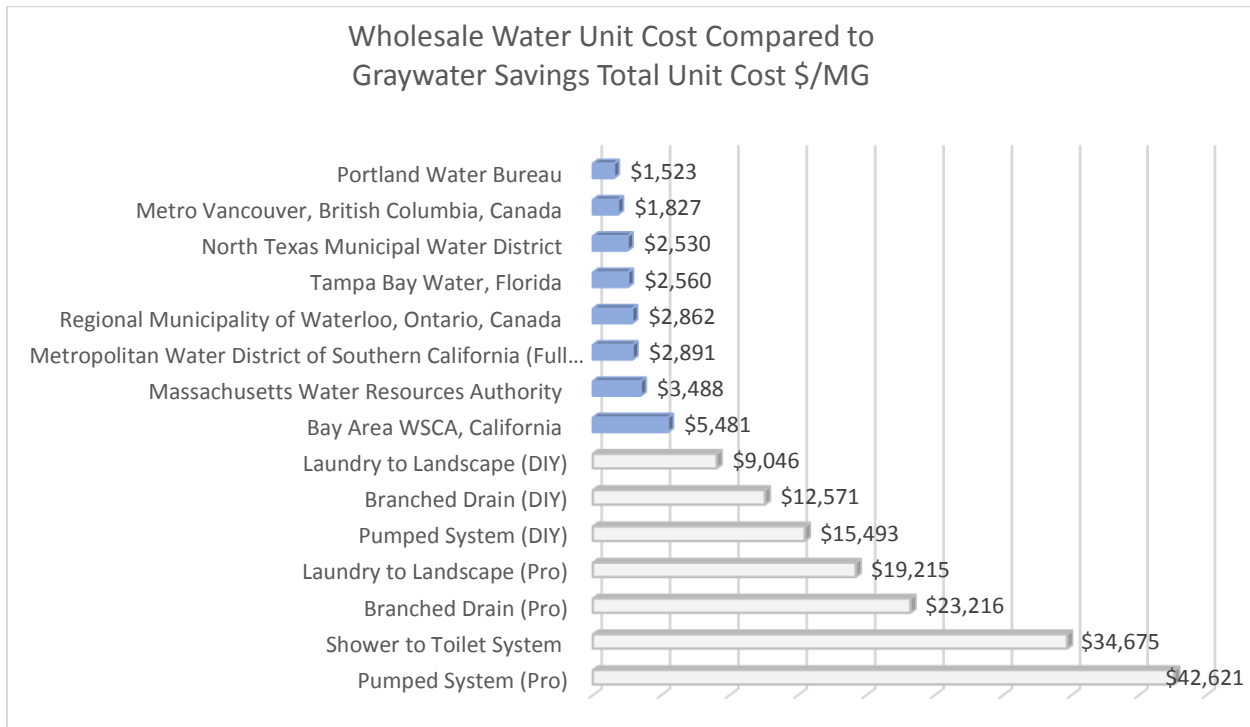


Figure 3: Unit Cost of Water Savings for the Total Cost of Various Graywater Systems Compared to Wholesale Water Rates. Expressed in Dollars per Million Gallons. Savings based on a 3-Person Household.

<u>Wholesale Agency or System Type</u>	<u>Wholesale Rates or Utility Graywater Incentive \$/MG</u>
Portland Water Bureau	\$1,523
Metro Vancouver, British Columbia, Canada (average annual rate)	\$1,827
Laundry to Landscape (DIY)	\$1,872
Laundry to Landscape (Pro)	\$1,872
Pumped System (DIY)	\$2,517
Pumped System (Pro)	\$2,517
North Texas Municipal Water District	\$2,530
Tampa Bay Water, Florida	\$2,560
Regional Municipality of Waterloo, Ontario, Canada	\$2,862
Metropolitan Water District of Southern California (full service treated tier 1)	\$2,891
Branched Drain (DIY)	\$3,041
Branched Drain (Pro)	\$3,041
Massachusetts Water Resources Authority	\$3,488
Bay Area Water Supply and Conservation Agency, California	\$5,481
Shower to Toilet System	\$7,135

Table 7: Unit Cost of Water Savings for the Utility Incentive Provided for Various Graywater Systems Compared to Wholesale Water Rates. Expressed in Dollars per Million Gallons. Savings based on a 3-Person Household.

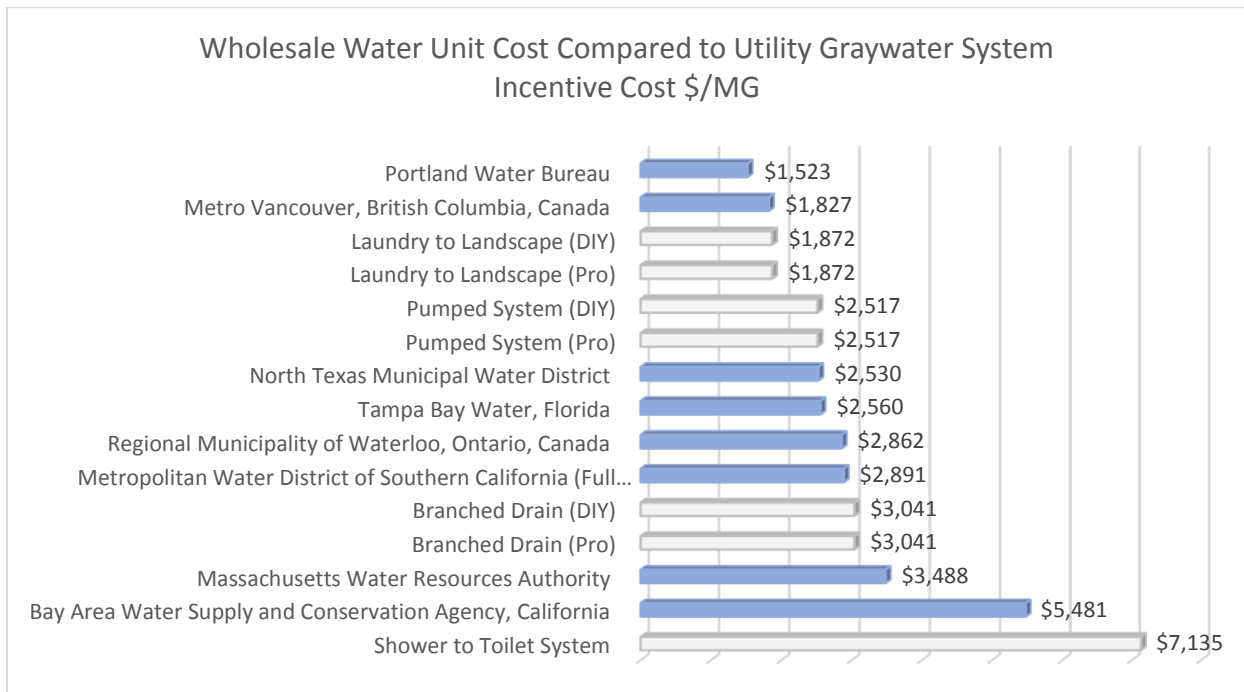


Figure 4: Unit Cost of Water Savings for the Utility Incentive Provided for Various Graywater Systems Compared to Wholesale Water Rates. Expressed in Dollars per Million Gallons. Savings based on a 3-Person Household.

<u>Wholesale and Retail Agency or Graywater System Type</u>	<u>Retail Customer Rates or Graywater Customer Cost \$/MG</u>
Metro Vancouver, British Columbia, Canada - City of Vancouver, British Columbia, Canada	\$3,255
Regional Municipality of Waterloo, Ontario, Canada - City of Waterloo, Ontario, Canada	\$4,951
Tampa Bay Water, Florida - Hillsborough County, Florida	\$6,160
Laundry to Landscape (DIY)	\$7,174
Massachusetts Water Resources Authority - Boston Water and Sewer Commission, Massachusetts	\$7,592
Portland Water Bureau - Tualatin Valley Water District, Oregon	\$7,741
Metropolitan Water District of Southern California - City of Santa Monica, California	\$8,610
North Texas Municipal Water District - City of Garland, Texas	\$8,780
Branched Drain (DIY)	\$9,530
Bay Area Water Supply and Conservation Agency, California - City of Palo Alto, California	\$11,791
Pumped System (DIY)	\$12,976
Laundry to Landscape (Pro)	\$17,344
Branched Drain (Pro)	\$20,174
Shower to Toilet System	\$27,540
Pumped System (Pro)	\$40,104

Table 8: Unit Cost of Water Savings for Customer Costs for Various Graywater Systems Compared to Retail Water Rates. Expressed in Dollars per Million Gallons. Savings based on a 3-Person Household.

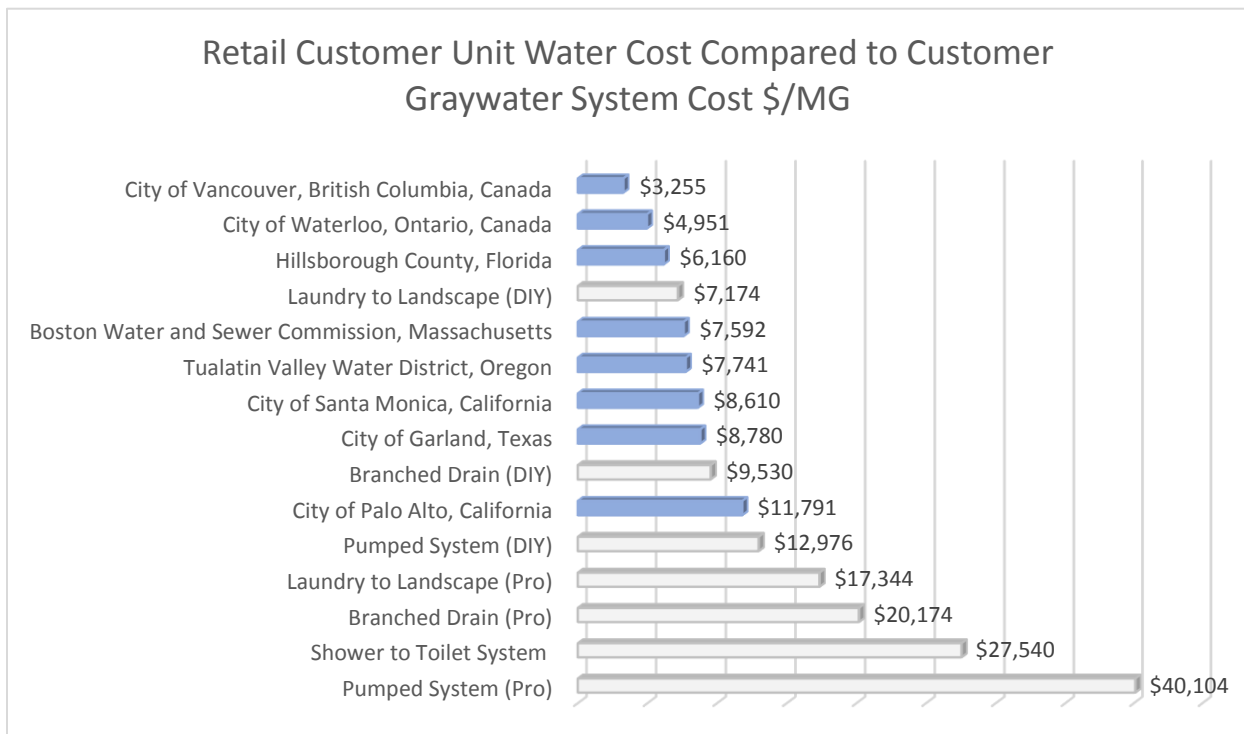


Figure 5: Unit Cost of Water Savings for Customer Costs for Various Graywater Systems Compared to Retail Water Rates. Expressed in Dollars per Million Gallons. Savings based on a 3-Person Household.

When looking at the tables and charts it is important to view them in context of the cost and savings assumptions presented in this document and the perspectives represented. Overall, single-family graywater systems seem to be relatively expensive in terms of the cost required to reduce potable water consumption. In some cases, however, they may be cost-effective for water providers and/or retail water customers.

Single-family graywater system technology will likely evolve and provide more reliable savings at a lower cost in the future. Water rates will likely continue to increase. If this is true, these systems will become more cost-effective over time. As is suggested in the Alliance for Water Efficiency's Report, *Water Savings & Financial Benefits of Single-Family Package Graywater Systems*, more research is needed to better understand the costs and benefits of these systems to support planning decisions.

Appendix A: Replication

Readers wishing to replicate the estimates offered in this document and/or modify assumptions to generate new estimates can do so in a spreadsheet or use the AWE Water Conservation Tracking Tool.

If using the Tracking Tool the following inputs can be made on the Define Activities worksheet:

Activity Name	Savings, Per Unit (gpy)	Savings, Useful Life (yrs)	Utility Costs, Year De-nominated	Utility Costs, Initial Variable (\$/unit)	Participant Costs, Year De-nominated	Participant Costs, Initial (\$)	Participant Costs, Years of On-going (yrs)	Participant Costs, On-going (\$/Yr)	Participant Savings, Sewer (gpy)
Shower to Toilet System	7,008	15	2016	\$750	2016	\$2,250	15	\$43	7,008
Laundry to Landscape (DIY)	5,343	15	2016	\$150	2016	\$35	15	\$36	0
Laundry to Landscape (Pro)	5,343	15	2016	\$150	2016	\$850	15	\$36	0
Branched Drain (DIY)	6,576	15	2016	\$300	2016	\$400	15	\$36	0
Branched Drain (Pro)	6,576	15	2016	\$300	2016	\$1,450	15	\$36	0
Pumped System (DIY)	11,919	15	2016	\$450	2016	\$1,600	15	\$48	0
Pumped System (Pro)	11,919	15	2016	\$450	2016	\$6,450	15	\$48	0

Table A1: Single-Family Graywater System Cost and Savings Assumptions for 3-Person Household.

These assumptions are for a 3-person household. The AWE full report, *Water Savings and Financial Benefits Associated with Single-Family Package Graywater Systems*, contains much more detail including theoretical savings assumptions for various household sizes.

The unit cost estimates in this document are in nominal dollars, which would be the equivalent of setting the inflation rate and interest rate to zero in the Tracking Tool Common Assumptions worksheet (cells D40 and D41). Users can change these values to reflect their agency's financial planning assumptions. In addition to modifying the inflation rate and interest rate, users can compare the benefits of graywater system savings against actual water provider and customer avoided costs, including how those costs are expected to change in the future. Moreover, the Tracking Tool can be used to compare graywater systems to other water conservation strategies.

For more information visit the Alliance for Water Efficiency's Tracking Tool web page:

<http://www.allianceforwaterefficiency.org/Tracking-Tool.aspx>