WATER RELIABILITY COALITION

Greywater Recycling Backgrounder
October 2016

What is Greywater and Greywater Recycling?

Greywater is the name given to untreated wastewater that has not come into contact with bathroom or kitchen waste. Greywater may be collected from bathroom sinks and washing machines, as well as from showers and baths.[1] Due to health concerns, water used in toilets or kitchen sinks is not considered greywater and may not be recycled as such.[2] Greywater may be used for irrigation purposes, excluding the irrigation of the edible portions of plants and vegetables that are meant for consumption, as well as toilet flushing in some cases. Because it is not feasible to deliver non-potable water to individual homes, use of greywater can be an effective alternative.

Greywater vs Purple Pipe Reclaimed Water: Purple Pipe Water is treated but non-potable reclaimed wastewater, including treated sewage water. This water, which is treated and delivered by a water agency, is distributed in purple pipes to demark its status as non-potable. Greywater differs from purple pipe water in that it does not include water from toilets or kitchens as a possible source, and is treated and used onsite.

An average family can produce approximately sixty thousand gallons of recyclable greywater per year.[3] Once a greywater system is installed in a home, this water can be redirected to into an irrigation system, thereby reducing the amount of potable water used for irrigation purposes.

How Does Greywater Recycling Work?

Typically, recycling greywater requires the use of either a pump or gravity based system to divert greywater from bathroom sinks, showers, bathtubs and washing machines into a greywater surge tank, rather than into the sewage or septic systems. This surge tank holds the greywater for a short period of time until it is released for irrigation or other approved uses. If excess amounts of greywater are being created then the diverter must be switched off to allow the excess water to enter the sewage/septic system. The most common irrigation systems associated with greywater are drip irrigation and the mini leach field.[4]

[1] City of San Diego Public Utilities Department. "Residential Graywater: An Irrigation Alternative." <https://www.sandiego.gov/sites/default/files/legacy/water/pdf/recycled/graywaterflyer.pdf>.
[2] City of San Diego Public Utilities Department. "Residential Graywater: An Irrigation Alternative <https://www.sandiego.gov/sites/default/files/legacy/water/pdf/recycled/graywaterflyer.pdf>.
[3] City of San Diego. Public Utilities Department. Water and Wastewater. *Graywater Factsheet.* 2014
[4] City of San Diego Public Utilities Department. "Residential Graywater: An Irrigation Alternative <https://www.sandiego.gov/sites/default/files/legacy/water/pdf/recycled/graywaterflyer.pdf>.

It is important that greywater is not stored in surge tanks for a long period of time, as the nutrients within stored greywater may begin to breakdown and cause odors within 24 hours.[5] The storage of greywater is not typically necessary as greywater is created on a daily basis.

In some instances greywater may be released directly onto an approved use. Examples of these simple systems include sinks that are connected directly to the toilet tank for flushing purposes, or from washing machines that are connected directly to a hose that is directed toward irrigable areas.

When deciding which sources to use for greywater recycling it is important to remember that certain soaps and detergents can be harmful to plants or have environmental consequences. Since greywater is typically untreated, other than basic filtering for particle waste, it is important that the materials being used in the creation of greywater be considered. For example, there are several soaps and laundry detergents that are biodegradable, are reasonably priced, and do not make greywater unsuitable for irrigation purposes.

What are the Benefits of Greywater Recycling?

Reusing greywater has several benefits, including reducing the use of potable water for purposes that do not require potable water, such as irrigation and toilet flushing. This reduction of potable water use results in both economic and environmental benefits, including lowered water bills, due to less potable water purchased, and increased water sustainability.

Recycling greywater also diverts wastewater away from treatment plants, reducing the amount of stress placed on infrastructure designed to transport and treat wastewater, while also limiting the amount of treated wastewater that is expelled into the environment as waste.[6]

Residential greywater recycling also better informs people about their household water supply, providing an opportunity for people to learn more about where their water comes from and other ways to lower their water footprint.[7]

How Much Does Greywater Recycling Cost?

The cost of installing and operating a greywater recycling system on a residential property varies depending on the type of system that is installed. Simple systems such as a laundry drum, which collects water from a washing machine in a large drum and then uses a garden hose to disperse water, can be purchased and installed for less than $100.[8]

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[5] "Greywater FAQ -." *Greywater Action*. <http://greywateraction.org/greywater-faq/>.
[6] "Uses and Benefits of Graywater." *Wholly H2O*. <http://www.whollyh2o.org/graywater/item/348-uses-and-benefits-of-graywater.html>
[7] "Uses and Benefits of Graywater." *Wholly H2O*. <http://www.whollyh2o.org/graywater/item/348-uses-and-benefits-of-graywater.html>
[8] "Greywater System Examples -." *Greywater Action*. <http://greywateraction.org/greywater-system-examples/>.

More complex systems such as electronically controlled 3-way diverter valves that re-direct shower water to a surge tank can cost closer to $500, while high end systems with built-in filters and automated pump systems can cost thousands of dollars for materials and installation.[9]

Maintenance of in-home greywater systems costs are approximately $500 a year and may vary depending on manufacturer. As with any plumbing, pipes and diverters may need to be replaced over time.

Greywater Permits in San Diego

Permits are only required for certain greywater system installations. In the City of San Diego, any system that discharges less than 250 gallons of greywater per day for the purpose of outdoor irrigation, collects greywater from clothes washing machines and does not require a separate pump to be installed does not require a permit.[10] These systems must still adhere to the regulations laid out in Chapter 16 of the California Plumbing Code, which include:

- The prohibition of greywater ponding
- The requirement that greywater be contained and used on the site where it was generated
- The requirement, for greywater that is released above ground, that there be at least 2 inches of mulch, rock, or soil, or a solid shield covering the release point.

For systems that do not meet the criteria above, notably systems which connect to bathroom fixtures such as showers and sinks, a plumbing permit is required to be secured from the City of San Diego's Development Services Department. In addition to providing the department with all plans, including a plot plan and greywater system plan, applicants must submit to a plan review and a minimum of two plumbing inspections.[11]

State and Local Regulations

One of the challenges that installers of greywater systems often face is that, while state regulations are clear on the allowable uses for recycled greywater and what types of systems are permissible, local regulators are often unclear on how greywater installation regulations should be enforced. This phenomenon often leads to greywater installation companies having to spend time educating local regulators on how greywater is regulated by the state and what is permitted.[12] In general, all greywater installations in the state of California are governed by Chapter 16 of the California Plumbing Code, and

[9] "Greywater FAQ -." *Greywater Action*. <http://greywateraction.org/greywater-faq/>.
[10] City of San Diego Development Services. "Residential Graywater Systems." City of San Diego, July 2014. Web. <https://www.sandiego.gov/sites/default/files/legacy/development-services/pdf/industry/infobulletin/ib208.pdf>.
[11] For complete details on greywater permit requirements, please see https://www.sandiego.gov/sites/default/files/legacy/development-services/pdf/industry/infobulletin/ib208.pdf.

[12] Informational Surveys Completed by Industry Experts

local regulators are unable to enact their own greywater regulations unless they are able to demonstrate a need.[13]

California Greywater Legislation

A number of legislative changes have paved the way for increased greywater installation in California. These include:

1992 – AB3518 (Sher): The first significant greywater bill in the State of California that required the Department of Water Resources, in consultation with the Department of Health Services, to adopt standards for the installation of greywater systems in residential buildings and authorized the installation of greywater systems in these buildings, based on the city or county's determination that the proposed system complies with the adopted standards. The bill also gave cities or counties the authorization to adopt more stringent standards or to prohibit greywater systems.[14]

1995 – AB313 (McDonald): Allowed for greywater to be used in subsurface irrigation and in commercial buildings. This bill required the inclusion of drip systems as an approved method of subsurface irrigation. Under AB 313, cities, counties or local agencies had the ability to adopt standards that prohibited the use of greywater or greywater standards that are more restrictive than the standards adopted by the Department of Water Resources.[15]

2007/2008 – SB1258 (Lowenthal): Required that the California Building Standards Code adopt standards for the construction, installation and alteration of greywater systems for indoor and outdoor use. This act terminated the authority of the Department of Water Resources to manage greywater standards. Under SB 1258 cities, counties or other local agencies may adopt ordinances or resolutions that prohibit the use of greywater or develop standards that are more restrictive than those set forth in the California Building Standards Code.[16]

2011 - AB849 (Gatto): Eliminated the ability of cities or counties to entirely prohibit the use of greywater and prohibited cities or counties from adopting greywater standards that are more restrictive than the California Building Standards Code. Cities and counties are permitted to adopt greywater standards that

[13] "AB 849 Assembly Bill - Bill Text." *California Legislative Information*. <http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120AB849>.
[14] Cortés, Rosario. *A Legacy of Recycled Water Legislation: 1990-2003* (2003): *Water Reuse Association - California Section*. Web. <http://web.stanford.edu/group/narratives/classes/08-09/CEE215/Projects/greendorm/water/GraywaterCD/greywater/calegacy.pdf>.
[15] "AB 313 Assembly Bill - CHAPTERED." *California Legislative Information*. <http://www.leginfo.ca.gov/pub/95-96/bill/asm/ab_0301-0350/ab_313_bill_951016_chaptered.html>.
[16] SB 1258 Senate Bill - CHAPTERED." *California Legislative Information*. 22 July 2008. <http://www.leginfo.ca.gov/pub/07-08/bill/sen/sb_1251-1300/sb_1258_bill_20080722_chaptered.html>.

differ from those in the California Building Standards Code based upon local climatic, geological or topographical conditions.[17]

2013 – National Sanitation Foundation (NSF) 350 Standard Adopted: NSF 350 provides a nationally recognized but locally accepted standard for onsite recycled water. The standard, which was added to Chapter 16 of the California Plumbing Code, establishes a consistent regulatory framework for appropriate material use, design and performance quality for onsite water reuse treatment systems.[18]

Local Legislative Actions

In addition to the state legislative actions listed above, several local municipalities or agencies have enacted legislation aimed at encouraging the use of onsite recycling. Some of the strongest examples of these policies can be found in the Marin Municipal Water District[19] and the County and City of San Francisco[20], which require reuse in new homes and in new commercial buildings, respectively.

New Development vs Retrofit:

Simple greywater systems that work with laundry appliances may be easily installed both in new developments and as retrofits. Because laundry fixtures typically provide easy access to associated plumbing, installation can be cost effective and easily completed. Washing machines also already include a pump which is suitable for propelling greywater to irrigable areas, provided there is not much uphill pumping required.

For complex/complete systems which tap into shower and bath plumbing, it is often not feasible or cost effective to install a retrofitted greywater system.[21] Homes that are built on a slab, or homes where the master shower is located on the second floor, are especially unsuitable for retrofits due to the lack of access to necessary plumbing lines. In these situations it is necessary to cut into the slab or tear out walls to access the plumbing. If a major remodel or work that requires the slab be cut into is already planned, then it may be feasible to perform a greywater retrofit at the same time.

Similarly, complete greywater irrigation systems that include underwater irrigation and filter installment may not be cost effective as a retrofit project.[22] Installing these involves digging up large portions of irrigable areas such as lawns, which is not cost effective when considering the benefits gained from

[17] "AB 849 Assembly Bill - Bill Analysis." *California Legislative Information*. 16 June 2011. <http://www.leginfo.ca.gov/pub/11-12/bill/asm/ab_0801 0850/ab_849_cfa_20110616_114523_sen_comm.html>.
[18] Onsite Water Reuse. "NSF/ANSI 350 and 350-1: Onsite Water Reuse." *NSF RSS*. National Sanitation Foundation. Web. <http://www.nsf.org/services/by-industry/water-wastewater/onsite-wastewater/onsite-reuse-water-treatment-systems>.
[19] "Marin Municipal Water District, Ordinance No. 429." 1 Feb. 2016. Web. <https://www.marinwater.org/DocumentCenter/Home/View/3540>.
[20] "San Francisco Health Code, Ordinance No. 109-15, Amended." 15 June 2015. Web. <http://sfwater.org/modules/showdocument.aspx?documentid=7467>
[21] "FAQ." *ReWater Systems*. <http://rewater.com/faq/>.
[22] "FAQ." *ReWater Systems*. <http://rewater.com/faq/>.

installing a greywater system. Again, this may become more cost effective if landscape remodeling is already planned.

Opportunities and Challenges

Despite several key additions to the California legislation, there is still an apparent lack of understanding at the local level of how greywater should be regulated and permitted. This lack of understanding was brought up by various members of the greywater industry during preparation of this report. During these conversations, it was often mentioned that this lack of understanding leads to attempts by some local regulators to over-regulate greywater systems based on the state legislation. AB849 (listed above) was instituted as a safeguard against over-regulation by local regulators, although a lack of understanding of California's greywater requirements at a local level still impedes the spread of more greywater installations in many areas.

In many localities, there is a lack of incentives for installing greywater systems in new buildings. When choosing to install a greywater system in a new development, the cost is borne by the developer or builder. While it may be possible to pass these costs on to a future buyer, it might also be the case that buyers are not interested in the additional costs associated with greywater installation and future maintenance. As such, builders are reluctant to install onsite recycling systems without an added incentive such as reduced system capacity fees, especially if competitors are not installing greywater systems in their new developments.

This issue has been partially addressed in a number of municipalities with requirements that all new buildings of a certain type (either residential, commercial or both) include onsite water recycling systems. However, without an offset to costs for developers, this contributes to even higher development costs in California, where building homes and commercial property is already very expensive. Some municipalities require new developments to be pre-plumbed with greywater recycling capability. Municipalities and water agencies may also consider providing rebates or other types of financial incentives (e.g., tax credits similar to those available for solar installations) to either builders or property buyers to help offset the cost of installing onsite water recycling systems in new properties.

In some areas, there may be a perceived conflict between public agencies that are operating wastewater treatment or recycling plants and manufacturers and installers of onsite greywater recycling systems. This conflict stems from the notion that, as greywater recycling becomes more prevalent, there will be less revenue from wastewater treatment fees and less wastewater flow available for wastewater recycling plants which depend on receiving a set amount of wastewater to meet prescribed recycled water delivery targets. While onsite water recycling does have the potential to limit the amount of water that is directed to a wastewater recycling plant, there are other factors to be considered. Onsite water recycling has the added benefit of being less energy intensive (when considering the energy necessary to transport wastewater over large distances to a recycling facility). Greywater recycling also allows for water treated to a non-potable standard to be used in residential areas for actions that do not require potable standards, such as toilet flushing or irrigation.

Design Considerations for Greywater[23]

Wastewater is a mixture of solids and water. In discussing sewer lines, "carry water" is the water that moves solids along in the line. Building Codes mandate ¼ inch drop per horizontal foot, but allow down to 1/8th inch drop with approval of the administrative authority.

Within the past decade, due to new, more efficient plumbing fixtures, the flow rate into sewer systems has been reduced as much as 70%. While the decrease in water usage has achieved state and local conservation goals, an unintended consequence is that older sewage systems designed for much higher flows are failing, in two ways:

1) More frequent sewer or building drain blockages; and
2) biomass created by solids that may not be causing a stoppage, but are dropping out and accumulating in the bottom half of a drain pipe.

The U.S. Environmental Protection Association (USEPA) studied the latter condition several years ago and published a handbook on it for municipal engineers.[24] In brief, anaerobic bacteria act on the biomass, causing the release of the gas hydrogen sulfide (H2S). When H2S comes in contact with the moisture on the walls of concrete and metal sewer mains, sulfuric acid is created which attacks the walls of the pipe, shortening the intended useful life of the piping systems.

Similarly, gray cast iron pipe frequently used for building drains is subject to gradual corrosion, and that process is accelerated if waters are mildly acidic, soft, of high conductivity, and/or contain concentrations of aggressive anions such as sulfate and chloride.[25]

Considering that greywater systems redirect carry water away from building drains connected to solids-producing fixtures like toilets, the prevention of downstream drainage pipe stoppages may become a major concern.

With older systems, this issue may prove difficult to solve. However, it is possible for housing developers to move toward comprehensive greywater systems within a new housing tract served by local sewage disposal facilities coupled with advanced water treatment (AWT) pure water. The net result will be sewer mains that are a fraction of the size of current utility mains made of acid-resistant materials in lieu of cast iron and concrete.

It is therefore technically possible, where the configuration of the home allows, to achieve water conservation for the homeowner using a greywater system, but with the understanding that

[23] The section titled "Design Considerations for Greywater" was authored by Milton Burgess, P.E., FASPE.

[24] Detection, Control, and Correction of Hydrogen Sulfide Corrosion in Existing Wastewater Systems, September 1992, USEPA document no. 832R92001 Authored by Robert P G. Bowker, Gerald A. Audibert, Hemang J. Shah, and Neil A. Webster; reviewed by Lam k. Lim, Robert E. Lee, John A. Redner, Perry L. Schafer and Mile Bealey.

[25] For more information on graphitic corrosion file:///C:/Users/user/Downloads/graphitic_corrosion.pdf

homeowners should be notified of the possibility of the potential unintended consequences described above.

It should also be noted that a study performed in 2011 by the Israel Institute of Technology found that it was unlikely that the rate of sewer blockages will significantly increase due to increased use of greywater recycling as, even though maximum flows and velocities of wastewater traveling through sewer systems will change, it is unlikely that minimum flows will decrease.[26] While the study encourages further investigation into the subject, the report's findings indicate that downstream blockages may not be as much as an issue as previously thought, at least not based on higher concentrated wastewater flows.

Conclusion

Onsite water recycling systems can be an important part of the overall effort towards water sustainability. Based on the evidence that greywater recycling can reduce the use of potable water for irrigation and toilet flushing, as well as limit energy use for wastewater transportation and reuse, the installation of greywater recycling systems should be encouraged at the local level. To ensure that greywater recycling reaches its potential as a member of the water sustainability/conservation suite, there is a need to align the incentives between public agencies that need stable revenue streams, developers that seek to minimize cost mandates in a competitive market, and home buyer demands which now include more sustainable, cost-effective options for purchasing and reusing water.

[26] Friedler, Eran, and Roni Penn. "Study of the Effects of On-Site Greywater Reuse on Municipal Sewer Systems." Grand Water Research Institute, P. 33, Feb. 2011. Web. <http://greywateraction.org/wp-content/uploads/2014/12/Israeli-study-gw-affects-sewers.pdf>.