

## **Research of Graywater for Use in Residential Applications**

**Original date of publication 12-14-2007**

**Updated: 8-06-2008**

**Modified: 08-12-2010**

### **What is Graywater?**

Graywater comes from many sources. Graywater, gray water, greywater, and grey water all have the same meaning. Sources of graywater vary according to state regulations. Graywater is generally defined as untreated household wastewater that has not come in contact with toilet waste and includes wastewater from bathtubs, showers, clothes washers and laundry tubs. Some states include wastewater from kitchen sinks and dishwashers in their definition if water is not used to wash material soiled with human excreta, such as diapers. Other states consider these sources of black water (containing high concentrations of organic waste). Graywater water quality is determined by risk of application. A low risk application is toilet flushing and subsurface irrigation (not likely to come in contact with humans). High risk application includes laundry and surface irrigation likely to come in contact with humans.

Shower, sink, and laundry water comprise 50-80% of residential waste water. Average amount of graywater produced per person is 25-40 gallons per day (gpd). This may be reused for other purposes, especially landscape irrigation or toilet flushing. Graywater has some constituents that are considered fertilizer for plants. Phosphorous, nitrogen, and potassium are excellent sources of plant food when reusing graywater for irrigation of landscaping and gardens (planter beds). Avoid using cleaning materials that are toxic, such as bleach, salt, dye, boron, or shampoo, which are harmful to plants. Graywater regulations prohibit the use of graywater on edible crops.

Benefits of graywater include using less potable water, sending less waste water to septic tanks or treatment plants, less chemical use, groundwater recharge, offsets water demands for irrigation, plant growth, and raising awareness of the natural waste cycle.

### **Graywater Regulation in Florida**

State regulations for graywater are defined in *Florida Plumbing Codes*. Section 301.3 and requires all plumbing fixtures that received water or waste, to discharge to the sanitary drainage system of the structure. The exceptions are bathtubs, showers, lavatories, clothes washers and laundry trays which may be reused as graywater (Florida Building Codes 2007). After March 1, 2009 the Florida Building Code was updated and specifies graywater may only be used for flushing of toilets and urinals (Florida Building Code, 2009). Subsurface irrigation is no longer included as a permitted use of graywater in the Florida Building Code. Appendix C101.1 to C101.12 covers all requirements for gray water recycling systems in Florida.

Retention time for graywater used for flushing water closets and urinals is a maximum of 72hours. Graywater shall pass through an approved filter and be disinfected by an acceptable method using one or more disinfectants such as chlorine, iodine or ozone (Florida Building Code, 2007). The holding capacity of the reservoir shall be a minimum of

twice the volume of water required to meet the daily flushing requirements of the fixtures supplied with gray water, but not less than 50 gallons (189 L) (*Florida Building Codes 2007*). The graywater is required to be dyed blue or green with a food grade vegetable dye before such water is supplied to the fixtures. The distribution piping and reservoirs must be identified as containing non-potable water by pipe color or with metal tags. Potable water is to be used as a source of makeup water for the graywater system, with the potable water supply protected against backflow.

### Arizona

In Arizona, no project specific permission is needed for homes already built using less than 400 gallons per day of graywater. This applies to most residential uses, but in some counties graywater systems need approval from the Department of Environmental Quality, for the design and construction of a system. Arizona is requiring interior plumbing of stub outs for graywater systems in homes that are issued permits after June 1, 2010. A stub out is installed by capping off pipes, making it easier to connect them to a graywater system in the future. Furthermore, a builder or a homeowner installing a unit in a new home can receive up to a thousand dollar tax credit for the cost of installation of a graywater system for tax years 2007-2011. The Arizona graywater statute is unique because it does not prohibit design specifics; the system can be built in any way, as long as it is functional and meets performance goals. Arizona policy has set a national precedent through development and use of user-friendly comprehensive regulations that can be applied differently on a local government basis. State regulation is based on a three tier system. Tier 1 applies to residential use that uses less than 400 gallon per day. Tier 2 applies to graywater use that is between 400-3000 gallons per day. Tier 3 applies to graywater use of more than 3000 gallons per day. Authorization for Tier 2 and Tier 3 is allowed through a permit process.

### California

California passed a law in 1992 legalizing graywater use in its cities and counties. Legislation directed the California Department of Water Resources (CDWR) to create standards for the installation and use of graywater systems. On August 4<sup>th</sup>, 2009, California legislation amended those standards with the permissive Chapter 16A, Nonpotable Water Reuse Systems. These new standards divide residential graywater systems into three categories: a clothes washer and/or single-fixture system, a simple system, and a complex system. A simple system exceeds a single-fixture system; it is a graywater system serving a one or two-family dwelling with a discharge of 250 gallons per day or less. A complex graywater system discharges over 250 gallons per day. This allows clothes washer systems, single fixture systems, and simple systems to be installed or altered without a construction permit. Complex systems still require permits, unless exempted by the enforcing agency. The California Building Standards Commission approved revised graywater standards for all three systems and is stated in **Appendix G**, Title 24, Part 5, of the California Code of Regulations. Treated graywater intended for indoor use shall meet the California Department of Public Health criteria, under Title 22 in the California Code of Regulations. The state does not require monitoring, sampling, and treatment of graywater. Municipalities can adopt the state regulations, or ban graywater use all together. By bringing graywater applications mainstream, California estimates a family of four can save 22,000 gallons of water per year.

Presently, state lawmakers are contemplating Senate Bill 518 that would give the California Building Standards Commission authority to adopt building standards for nonresidential graywater systems for indoor and outdoor use. This bill would transfer responsibilities of creating the standards from the state's Department of Water Resources to the Building Standards Commission.

### **Wyoming**

Wyoming has added a Permit by Rule graywater policy to the State of Wyoming Water and Wastewater Rules. No application for a permit or fee is required as long as all the conditions are met. The systems that do not meet the criteria have to submit an application for a permit to the Wyoming Department of Environmental Quality for evaluation.

### **Other States**

New Mexico is following Arizona's lead in implementing statewide regulations for graywater using the tiered approach. The New Mexico Environmental Department (NMED) policy on graywater allows up to 250 gallons per day of graywater to be used without a permit for outdoor use; however, a permit is required for all indoor use.

Texas has implemented a similar policy, allowing the use of 400 gallons per day of graywater without a permit or inspection. However, graywater used for agriculture, commercial and industrial purposes must be treated to minimum standards and tested regularly if the public may come in contact with water.

Utah residents are required to have graywater systems inspected by the state health department in order to receive a permit. The system has to be designed by a certified designer.

Oregon enacted legislation in June 2009 by legalizing the reuse of graywater for flushing toilets. Oregon's state legislature recently passed a bill to expand the use of gray water for irrigation purposes. However, graywater use is prohibited until Oregon's Department of Environmental Quality finishes developing a permit program and rules. The program is expected to be finished by fall 2011.

Maryland passed the 2010 House Bill 224, prohibiting counties from adopting or enforcing a local plumbing code that prohibits a system that recycles graywater. In New York, Appendix 75-A.10 states that home systems shall be designed with a minimum capacity/use rate of 75 gallons per day/per bedroom.

Nevada, Oklahoma, and Colorado, are adding graywater laws, regulations, codes, and guidelines.

### **International**

Even though the U.S. has the greatest number of standards with each state developing its own guidelines, regulations and monitoring programs, water reuse standards are available in other countries worldwide. Many countries follow California's Title 22 for graywater

regulations. The World Health Organization has also developed standards for graywater that are similar to the USEPA guidelines. In Beijing, China, water supply is scarce; therefore they utilize graywater in agricultural and residential irrigation, toilet flushing, and street cleaning. The UK currently has no water quality standards for graywater use.

### **Canada**

In Canada, six provinces permit some water reuse practices. British Columbia (BC) is the only province with active graywater regulations. Graywater systems are regulated by the BC Ministry of Health Act-Sewerage System Regulations. They do not issue operating permits for single-family graywater water systems. In Ontario due to increasing competition and demand for potable water, the province is researching graywater technologies to offset competition for new potable water sources. The Province is conducting a Residential Graywater Reuse Feasibility Study. Graywater systems were installed in thirty single-family homes to collect shower and bath water to reuse in toilets. The results thus far have shown a 26% reduction in potable water use or 17 gallons per household per day.

### **Australia**

Presently, Australia has graywater regulations and policies in the majority of its states and territories. Currently, the Government is participating in the National Rainwater and Graywater Initiative, providing \$500 rebates to households installing graywater systems. Homeowners are given three options for water quality standards. First, the lowest standard is manual bucketing where graywater is collected and placed on garden beds. Subsequently, primary treatment is graywater passed through a sedimentation tank or a filter before it is placed into a system. Lastly, the highest quality of graywater is secondary treatment; graywater is passed through an aerated treatment system, and then placed on garden beds by sprays or drippers.

However, regulations and permitting vary from state to state. In Australia's Capital, Canberra, no permit is required for graywater diversion devices in single family residences, but multi-family and commercial properties are required to submit an application of approval. Additionally, the Australian Capital Territory Government does not approve graywater treatment systems. In the same way, New South Wales, graywater diversion devices can be installed without approval, but must follow plumbing regulations. Domestic graywater treatment systems for residents have to be accredited by the New South Wales Health Department, and then the local council must approve the installation. The accreditation of the treatment system lasts five years. The Northern Territory graywater regulations are run by the Northern Territory Government Agencies. Their responsibilities include product inspection and responsibility for approval and installation. No permit is required for graywater diversion devices. Prior to installation of graywater treatment systems the Department of Health and Community Services must be notified of the installation, which is completed by a licensed plumber. Queensland, South, and Western Australia require permits and approval before graywater systems or diversion devices are installed; the bucketing method does not require a permit. Victoria does not require a permit for

diversion and bucketing graywater, but should be used in accordance with Environmental Protection Authority (EPA) regulations. For permanent graywater treatment systems a permit is required prior to installation, and has to be EPA approved with a certification of approval. The maximum treatment for a graywater system is 1,300 gallons of graywater a day. Tasmania is the only Australian state to regulate the quality of the graywater; which must be treated before it can be re-used indoors or outdoors.

### **The Future of Graywater**

Case studies are being conducted to accommodate future growth of the populations while reducing the demand for freshwater through the use of graywater. Future research should identify long term affects of graywater use outdoors, cost effective methods, and possible water policies that would support graywater reuse. Recent research ongoing in Guelph, Ontario is studying reuse of graywater in residential homes. The feasibility study will evaluate system costs, benefits, barriers, opportunities, energy savings, maintenance, and requirements of graywater systems.

This research is valuable for future growth of the city while conserving water. The future of graywater also lies in 'grayscaping' where a real estate developer, Wayne Haese, coined the term in San Diego, Ca. He is promoting a community graywater recycling system with automatic graywater irrigation systems. This would lessen the cost to homeowners by 50 percent. San Diego County Water Authority is also developing a program to offer incentives to developers to install separated waste streams. Similarly, architects and builders are also working on building whole house graywater systems.

### **Graywater Treatment Systems Available**

Multiple graywater treatment package systems have been developed and include:

#### **Graywater Systems Available in North America**

- **AQUS™** system by WaterSaver Technologies is U.S. based and can reduce metered water usage in a two-person household by about 10-20 gallons a day- or approximately 5,000 gallons a year. The AQUS conserves water and helps save money on water consumption charges and wastewater treatment or sewer fees. This system costs \$295.00 plus shipping. For more information: [www.watersavertech.com](http://www.watersavertech.com)
- The **Brac Greywater Recycling System** was designed in Canada and is built for residential use. This system reuses graywater saving approximately one third of home water consumption. It can be purchased in the U.S. from private retailers. Costs range from \$2000.00 to \$3000.00 plus shipping. The system is covered by a two year warranty. For more information: [www.bracsystems.com/home.html](http://www.bracsystems.com/home.html)

- The **ReWater® system** captures, filters, and reuses shower, tub, bathroom sink, and laundry water. This equates to about 50% of all water use inside a residence. ReWater systems are available in the U.S. and have been used in the West for awhile. ReWater Systems, Inc. warrants all parts of the ReWater System to be free of manufacturing defects for a period of two years from the date of purchase, with a ten year warranty on the filter vessel and collection tank. For more information: <http://www.rewater.com/>
- The **Nutricycle System, LLC** is a U.S. based system. This is a fully automated system utilizing graywater to irrigate flower beds, requires no maintenance or handling of residuals. The system is designed to facilitate nutrient recycling for any sized facility, by accepting water from sinks, showers, baths, and laundry. Nutricycle systems can provide graywater treatment systems to residential locations, as well as commercial and public facilities. Prices depend on specifications of each location i.e. number of bedrooms, number of toilets, the floor plan, maximum daily use etc. Residential prices are \$6,000 and \$12,000. For more information: <http://www.nutricyclesystems.com/index-1.htm>
- The **Natural Home** greywater recycling kit is a non-electric irrigation reuse kit. Graywater from the home is piped to a buried vault that settles out debris and grease, and then empties the clarified greywater to planterbeds or irrigation systems. The system is \$795, with free shipping and consultation. This system is only offered in the lower 48 states, and does not ship to Canada or Mexico. For more information: <http://www.thenaturalhome.com/greywater.html>
- The **Aqua2use** greywater diversion device is an easy to install filtration system that uses a multi-chamber plug flow concept with four filters to trap high volume of impurities without clogging the system. According to company documents this system can be installed above ground, half-submerged in ground, or underground, for convenience. It reuses treated greywater for lawns and gardens. The system cost is \$770 and it is estimated to save a family of four 38,000 gallons annually. The company is U.S. based and offers Arizona residents a 25% tax credit for installing their system. The product is shipped internationally. **Aqua2use** also offers the **Water legacy Greywater System WL55**, that uses greywater to flush toilets. It consists of a water filter, 55 gallon storage tank, and a UV and hydrogen peroxide disinfection system. This device is \$3,000, and excludes shipping. For more information: <http://www.greywater-systems.com/aqua2use.htm> or <http://www.greywater-systems.com/waterlegacy.htm>

#### Graywater Systems Available in Europe

- **AquaCycle of PONTOS** provides safe water treatment to a constantly high quality. It works with the new SmartClean technology: a four-phase-water treatment with UV-light sterilization. The recycled water conforms to the European Directive 76/160EWG for Recreational Water. This product is offered by Hansgrohe in Germany. More info: [www.pontosquacycle.com/pontos/en/company/pontos.html](http://www.pontosquacycle.com/pontos/en/company/pontos.html)

- **Ecoplay** is a water management system which collects and cleans bath and shower water so it can be reused for flushing the toilet. Ecoplay systems are based out of the Netherlands. For more information: <http://www.ecoplay.nl/en/index.html>

### **Graywater Systems Available in Australia**

- The **Aqua Reviva** is a graywater treatment system. Design allows graywater to be used to the full extent of the law and makes the machine completely self-contained. The system is built so that if it malfunctions, it will divert water directly to the sewer. This system is being offered in Australia. For more information: <http://www.aquareviva.com.au/>
- The **Perpetual Water - Home® System** is a fully automated treatment system that saves and reuses up to 67% of household water, for use in the garden or back through the home. This product is offered in Australia. For more information: <http://www.perpetualwater.com.au/>
- The **Nylex Greywater Diverta** captures greywater for immediate reuse of shower, bathroom sinks, laundry sinks, and washing machines. This product helps in reducing demand for main water supply. It costs ~\$187.00 plus shipping and taxes. <http://www.enviro-friendly.com/nylex-greywater-diverta.shtml>
- The **Home Water Bowser Graywater Wheelie Bin** allows you to capture water from your washing machine or can be used for rainwater collection. Its cost ranges from \$429.00 to \$479.00. This system comes with a four meter inlet hose for the washing machine and a twenty meter outlet hose for watering the garden. <http://www.enviro-friendly.com/grey-water-bowser.shtml>
- The **Eco-Care Grey Waste Water Diverter System** diverts greywater where you need it through a pump. It costs ~\$890.00 plus delivery. Eco-Care fully complies with EPA and DHS guidelines. If the system is not used in 24 hours, the tank automatically dumps the waste water. <http://www.enviro-friendly.com/eco-care-grey-water.shtml>
- The **NETA H2grO Graywater Diverter System** is designed for when you need more than the standard 50 mm. inlet, and you want the unit to go in the ground. It diverts water to your garden for irrigation. Price ranges from ~\$2090.00 for the manual system to \$3300.00 for the electric diverter. <http://www.enviro-friendly.com/how-h2gro-works.shtml>

- The **Gator Pro Greywater Diverter System** diverts greywater into the system, activating a pump that dispenses water only where it is needed. The system uses a multi-stage filtration that can clean thousands of gallons of greywater before the filters need cleaning. The Gator Pro costs \$895-\$1,044 depending on upgrades, excludes shipping cost. For more information: <http://www.enviro-friendly.com/gator-pro-grey-water.shtml>
- The **Greywater Gardener 230** is an automatic water reuse system hooked up to the plumbing in the shower and sink, and transfers the water to a compact surge capsule outside the house. Once the water is in the capsule it releases the greywater directly into the soil. The **Gardener 230** has a tank capacity of 61 gallons and provides service for over 30 years. The standard **Greywater Gardener 230 Garden 80 kit** is \$3,695 and requires assembly. A ready to use **Gardner 230** starts from \$5,995. The price includes installation by a licensed plumber. \$500 rebates are available in Victoria, Queensland and New South Wales. New South Wales also offer another \$500 rebate for eligible participants through their Water Savings Fund. For more information visit: <http://www.waterwisesystems.com/products/greywater-gardener-230/running-costs>

### Maintenance

Maintenance and upkeep of graywater systems is the user's responsibility. Maintenance contracts can be set up with system manufactures if the user does not want to manage upkeep of the system. Small amounts of disinfectants, based on specific system recommendations, need to be added to graywater systems to disinfect water collected; graywater held for more than three hours contains more harmful bacteria than sewage. Systems with or without automatic disinfectant injection should be emptied according to manufacture suggestions if stored water is unused for an extended period. This helps reduce pathogens. The statute and regulations prohibit use of organic chemical solvents, toxic or hazardous chemicals, or petroleum products to de-clog or degrease the system.

### Plumbing and Health Codes



The International Association of Plumbing and Mechanical Officials (**IAPMO**) certify to standards, as well as write American National Standards Institute-(**ANSI**) accredited plumbing and mechanical codes, the Uniform Plumbing Code (**UPC**) and the Uniform Mechanical Code (**UMC**). **IAPMO** tests and inspects graywater systems to verify compliance to the requirements of applicable codes and standards. Even though products

are listed as compliant by **IAPMO**, local government's health codes may require specific approval of graywater systems on a case by case basis. The State of Florida, Department of Health has standards for onsite sewage treatment and disposal. Graywater is considered in these Florida standards. Graywater systems implemented in Florida must follow Chapter **64E-6**, Florida Administrative Code. Graywater regulations also require the water to be a specific standard; testing protocols allow agencies to test the water quality.

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## APPENDICES

City of Guelph Residential Greywater Reuse Feasibility Study

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