EPA REGULATIONS, POLICIES, AND GUIDELINES FOR WATER REUSE – IMPLICATIONS FOR DECENTRALIZED GREYWATER REUSE

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Two basic questions …

How do current EPA regulations, policies and guidance address decentralized greywater reuse?

Do other standards and sources of guidance address decentralized greywater reuse?

EPA has established drinking water standards and water quality standards and criteria focused on various designated uses of surface water, but there are no formal EPA regulations or criteria focused on water reuse in general or specific to decentralized greywater (or is it graywater or gray water or grey water) reuse …

- Drinking water standards and health advisories … https://www.epa.gov/dwstandardsregulations/drinking-water-contaminant-human-health-effects-information
- EPA water quality standards and criteria … https://www.epa.gov/wqs-tech

Recreational Water Quality Criteria

Quality Criteria for Water [The Red Book] – 1976

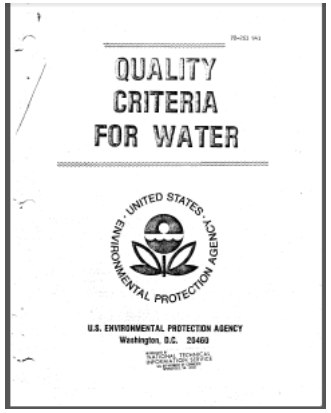
Fecal coliforms … geometric mean of 200 organisms per 100 mL

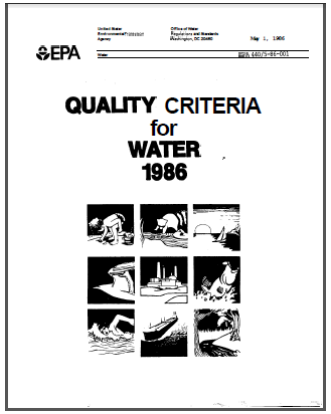
U.S. PHS had previously recommended fecal coliform criteria of 200 cfu per 100 mL

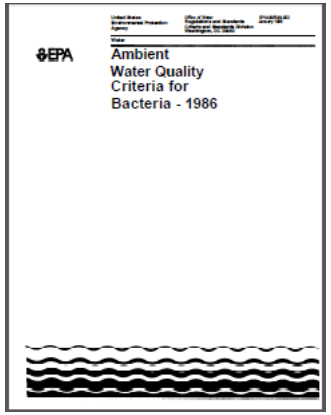
Quality Criteria for Water [The Gold Book] – 1986

Ambient Water Quality Criteria for Bacteria – 1986

Freshwater	…	E. coli	126 per 100 mL, or
		enterococci	33 per 100mL
Marine Water	…	enterococci	35 per 100mL

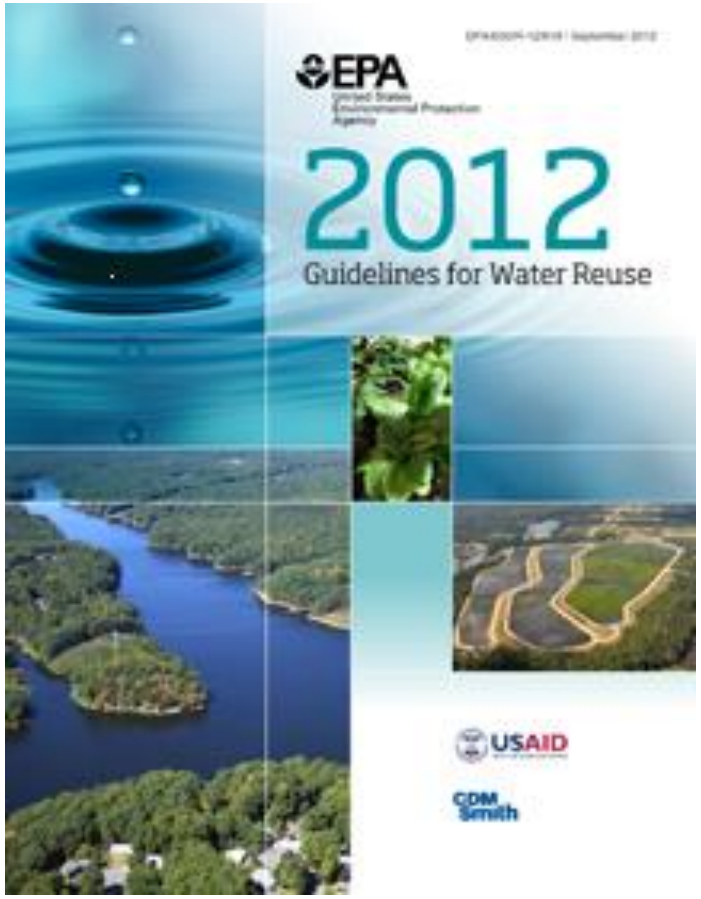






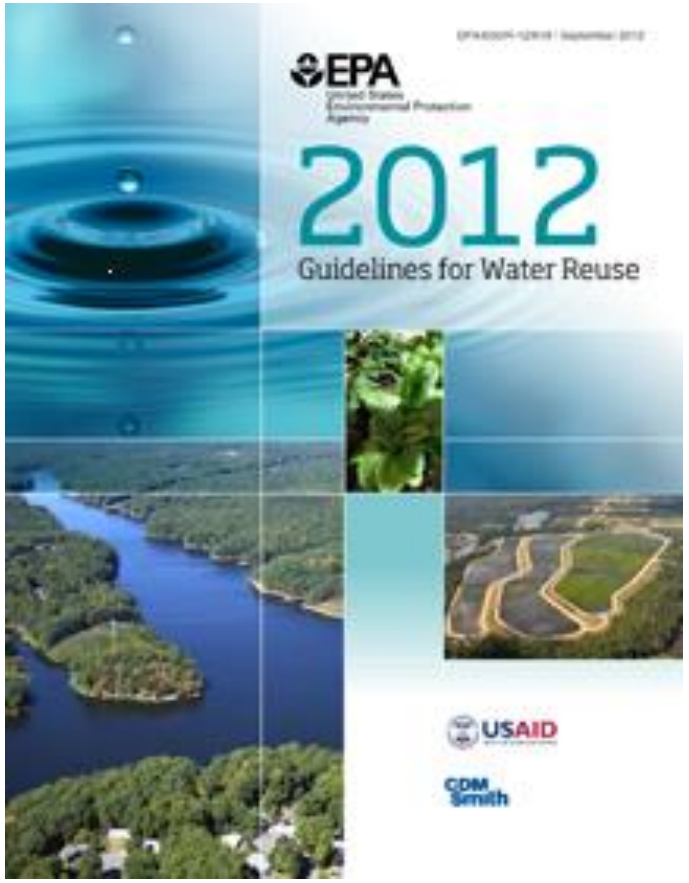
2012 Recreational Water Quality Criteria

CRITERIA ELEMENTS	**Recommendation 1** Estimated Illness Rate 36/1,000		**Recommendation 2** Estimated Illness Rate 32/1,000	
Indicator	GM (cfu/100 mL)	STV (cfu/100 mL)	GM (cfu/100 mL)	STV (cfu/100 mL)
Enterococci (marine & fresh)	35	130	30	110
E. coli (fresh)	126	410	100	320



"https://nepis.epa.gov/Adobe/PDF/P100FS7K.pdf"

However, the **2012 EPA *Guidelines for Water Reuse*** document does provide recommended minimum requirements for a series of water reuse practices and refers quite a lot to "Graywater" and "Greywater" reuse, especially in **Chapter 2: Planning and Management Considerations** and most intensively under **2.3.2.1 Individual On-site Reuse Systems and Graywater Reuse** (p.2-32 – 2-35) and throughout **Chapter 5: Regional Variations in Water Reuse**.



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Includes recommended minimum requirements for …

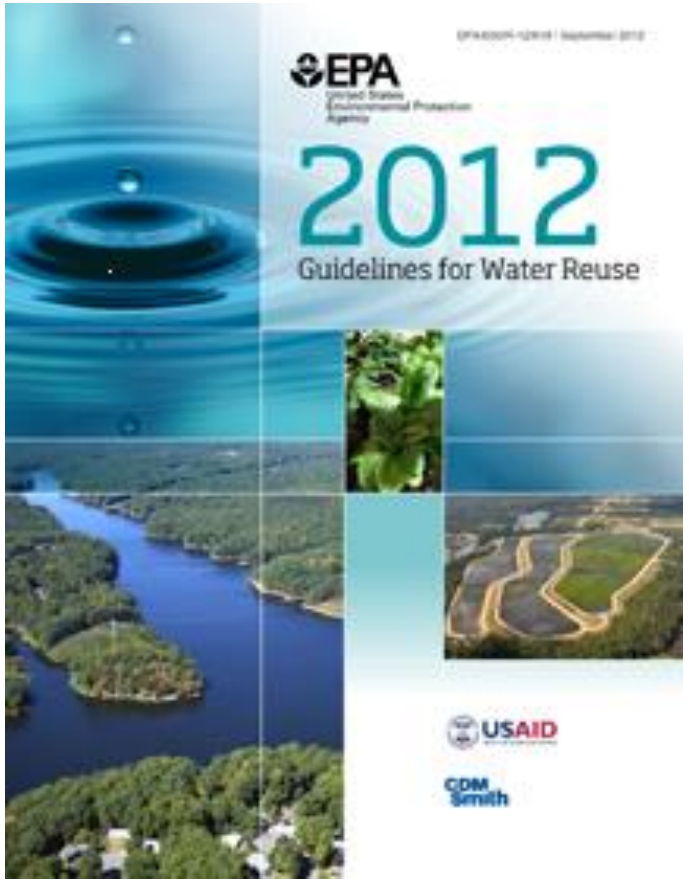
- Urban Reuse – Unrestricted … and Restricted
- Agricultural Reuse – Food Crops … and Processed Food Crops and Non-food Crops
- Impoundments – Unrestricted … and Restricted
- Environmental Reuse
- Industrial Reuse
- Groundwater Recharge – Nonpotable Reuse
- Indirect Potable Reuse (IPR)

Have been applied by some states to graywater and harvested stormwater.

Table 4-4 Suggested guidelines for water reuse

Reuse Category and Description	Treatment	Reclaimed Water Quality [2]	Reclaimed Water Monitoring	Setback Distances [3]
Urban Reuse				
Unrestricted The use of reclaimed water in nonpotable applications in municipal settings where public access is not restricted.	▪ Secondary([4]) ▪ Filtration([5]) ▪ Disinfection([6])	▪ pH = 6.0-9.0 ▪ ≤ 10 mg/l BOD [7] ▪ ≤ 2 NTU [8] ▪ No detectable fecal coliform /100 ml [9,10] ▪ 1 mg/l Cl_2 residual (min.) [11]	▪ pH – weekly ▪ BOD - weekly ▪ Turbidity - continuous ▪ Fecal coliform - daily ▪ Cl_2 residual – continuous	▪ 50 ft (15 m) to potable water supply wells; increased to 100 ft (30 m) when located in porous media [12]

- pH = 6.0-9.0
- ≤ 10 mg/l BOD [7]
- ≤ 2 NTU [8]
- No detectable fecal coliform /100 ml [9,10]
- 1 mg/l Cl_2 residual (min.) [11]



"https://nepis.epa.gov/Adobe/PDF/P100FS7K.pdf"

References the **2011 NSF/ANSI Standard 350** ***Onsite Residential and Commercial Water Reuse Systems*** [assures water is treated to safe level for specific reuse, non-potable applications – e.g., surface or subsurface irrigation, toilet/urinal flushing, decorative fountains, etc.] and the **2011 NSF/ANSI Standard 350-1** ***Onsite Residential and Commercial Graywater Treatment Systems for Subsurface Discharge***

https://www.nsf.org/newsroom_pdf/ww_nsf_ansi350_qa_insert.pdf

SCOPE OF STANDARDS

STANDARD 350: ON-SITE RESIDENTIAL AND COMMERCIAL WATER REUSE TREATMENT SYSTEMS	
Building Types	Residential, up to 1,500 gallons per day Commercial, more than 1,500 gallons per day and all capacities of commercial laundry water
Types of wastewater treated (influent)	Combined black and graywater Graywater Bathing water only Laundry water only
Uses of treated water (effluent)	Nonpotable applications, such as surface and subsurface irrigation and toilet and urinal flushing
Ratings	Two classifications that vary slightly in treated water quality: Class R: single-family residential Class C: multifamily and commercial Systems are further described by the type of wastewater treated (combined, graywater, bathing only or laundry only).

TABLE 6 SUMMARY OF DRAFT NSF STANDARD 350 EFFLUENT CRITERIA FOR INDIVIDUAL CLASSIFICATIONS

Parameter	Class R		Class C	
	Overall test average	Single sample maximum	Overall test average	Single sample maximum
$CBOD_5$ (mg/L)	10	25	10	25
TSS (mg/L)	10	30	10	30
Turbidity (NTU)	5	10	2	5
E. coli[2] (MPN/100 mL)	14	240	2.2	200
pH (SU)	6–9	NA[1]	6–9	NA
Storage vessel disinfection (mg/L)[3]	≥0.5–≤2.5	NA	≥0.5–≤2.5	NA
Color	MR[4]	NA	MR	NA
Odor	Non-offensive	NA	Non-offensive	NA
Oily film and foam	Non-detectable	Non-detectable	Non-detectable	Non-detectable
Energy consumption	MR	NA	MR	NA

[1] NA = Not applicable
[2] Calculated as geometric mean
[3] As chlorine. Other disinfectants can be used.
[4] MR = Measured and reported only

https://www.nsf.org/newsroom_pdf/ww_nsf_ansi350_qa_insert.pdf

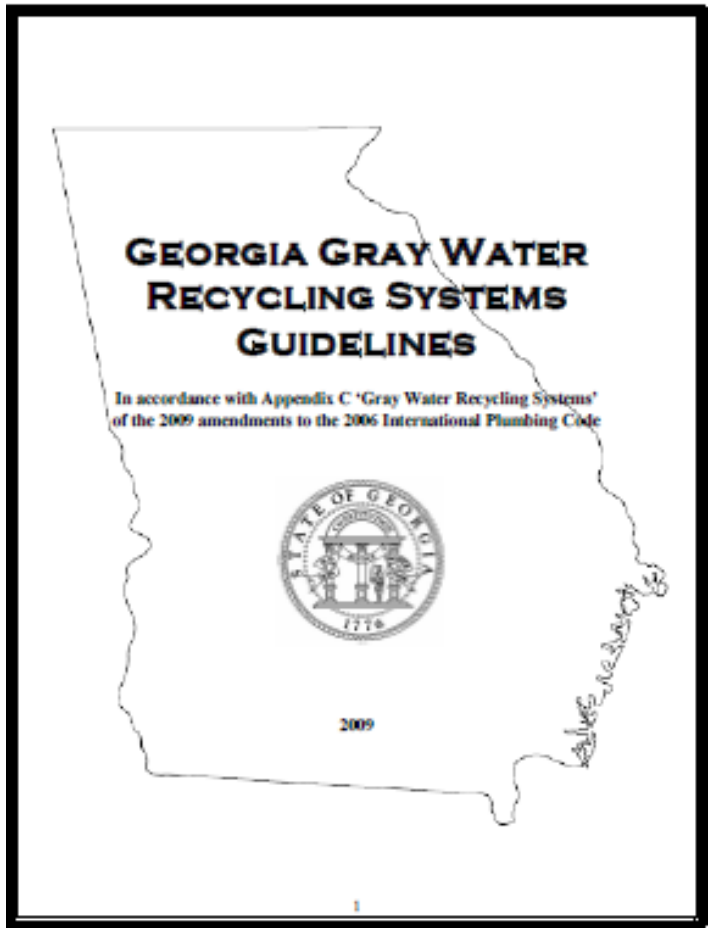
SCOPE OF STANDARDS

NSF/ANSI STANDARD 350-1: ON-SITE RESIDENTIAL AND COMMERCIAL GRAYWATER TREATMENT SYSTEMS FOR SUBSURFACE DISCHARGE	
Building Types	Residential, capacities up to 1,500 gallons per day Commercial, capacities more than 1,500 gallons per day and all capacities of commercial laundry water
Types of wastewater treated (influent)	Combined black and graywater Graywater Bathing water only Laundry water only
Uses of treated water (effluent)	Subsurface irrigation only
Ratings	Single effluent quality with no classifications Systems are further described based on the type of influent (graywater, bathing only, laundry only).

TABLE 7 SUMMARY OF DRAFT NSF STANDARD 350-1 EFFLUENT CRITERIA FOR INDIVIDUAL CLASSIFICATIONS

Parameter	Test Average
$CBOD_5$ (mg/L)	25 mg/L
TSS (mg/L)	30 mg/L
pH (SU)	6–9
Color	MR[1]
Odor	Non-offensive
Oily film and foam	Non-detectable
Energy consumption	MR

[1]MR = Measured and reported only



There are states with specific requirements for graywater reuse, such as the **2009 Georgia Gray Water Recycling Systems Guidelines – In accordance with Appendix C 'Gray Water Recycling Systems' of the 2009 amendments to the 2006 International Plumbing Code** that covers graywater recycling systems for the use of flushing water closets and urinals or subsurface irrigation, if treated according to their Code Standards.

http://www.dca.state.ga.us/development/constructioncodes/programs/downloads/GeorgiaGrayWaterRecyclingSystemsGuidelines_2009.pdf

Where gray water is used for flushing toilets and/or urinals, effluent quality must be improved. High amounts of suspended solids will interfere with the operation of the plumbing fixtures and make disinfection difficult. Because of the potential exposure to gray water by people and pets, any disinfection treatment should reduce the number of illness causing pathogens. After disinfection, total coliform bacteria should be reduced to 500 cfu/100 ml. or less. Fecal coliforms levels should be less than 100 cfu/100 ml. Treated gray water effluent which will be used for subsurface irrigation must meet the requirements found in the Division of Public Health's *Manual for On-site Sewage Management Systems.*

Recommended Minimum Water Quality Guidelines For Design of Recycling Gray Water Systems	
Turbidity (NTU)	**10 NTU (nephelometric turbidity unit)**
Total Coliform Bacteria	**500 cfu/100ml (colony forming units per 100 milliliter)**
Fecal Coliform Bacteria	**100 cfu/100ml (colony forming units per 100 milliliter)**

Some Other States with **Greywater (Graywater) Reuse** Req's

Arizona DEQ, **Water Quality Division: Permits: Reclaimed Water**
http://legacy.azdeq.gov/environ/water/permits/reclaimed.html
Using Gray Water At Home - http://legacy.azdeq.gov/environ/water/permits/download/graybro.pdf

California Dept. of Housing and Community Development (HCD)
http://www.hcd.ca.gov/codes/state-housing-law/preface_et_emergency_graywater.pdf

New Mexico, Environment Department, Liquid Waste (Septic Tank) Program
https://www.env.nm.gov/fod/LiquidWaste/graywater.html

Oregon DEQ Water Quality, Water Reuse Program -
http://www.deq.state.or.us/wq/reuse/graywater.htm
http://www.deq.state.or.us/wq/pubs/factsheets/reuse/11WQ029GraywaterRules.pdf- Fact Sheet

Arizona DEQ, **Water Quality Division: Permits: Reclaimed Water**

http://legacy.azdeq.gov/environ/water/permits/reclaimed.html

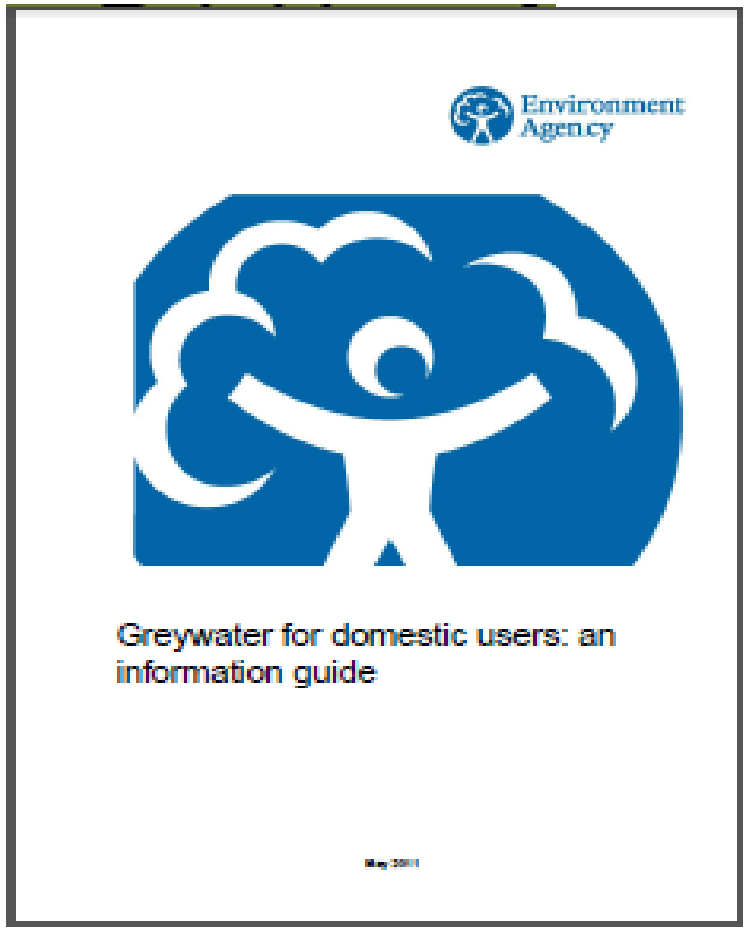
Using Gray Water At Home - http://legacy.azdeq.gov/environ/water/permits/download/graybro.pdf

Utah Administrative Code … Environmental Quality/Water Quality … Rule R317-401. Graywater Systems

http://www.rules.utah.gov/publicat/code/r317/r317-401.htm

Washington State Dept. of Health - Wastewater Management - **Greywater Reuse**

http://www.doh.wa.gov/CommunityandEnvironment/WastewaterManagement/GreywaterReuse



UK Environment Agency

Greywater for domestic users: an information guide

May'2011

How clean does the water need to be?

While stringent standards guard drinking water quality in the UK, **there are no regulatory standards for the quality of non-potable water**. Many groups have called for appropriate standards for non-potable water to overcome concerns about potential health hazards and to bolster public confidence in using non-potable water. However, the enforcement of such standards would be difficult as most systems are independently owned and maintained.

http://www.sswm.info/sites/default/files/reference_attachments/ENVIRONMENT%20AGENCY%202011%20Greywater%20for%20Domestic%20Users.pdf

The tables provide an indication of the water quality that a well designed and maintained system is expected to achieve for the majority of operating conditions.

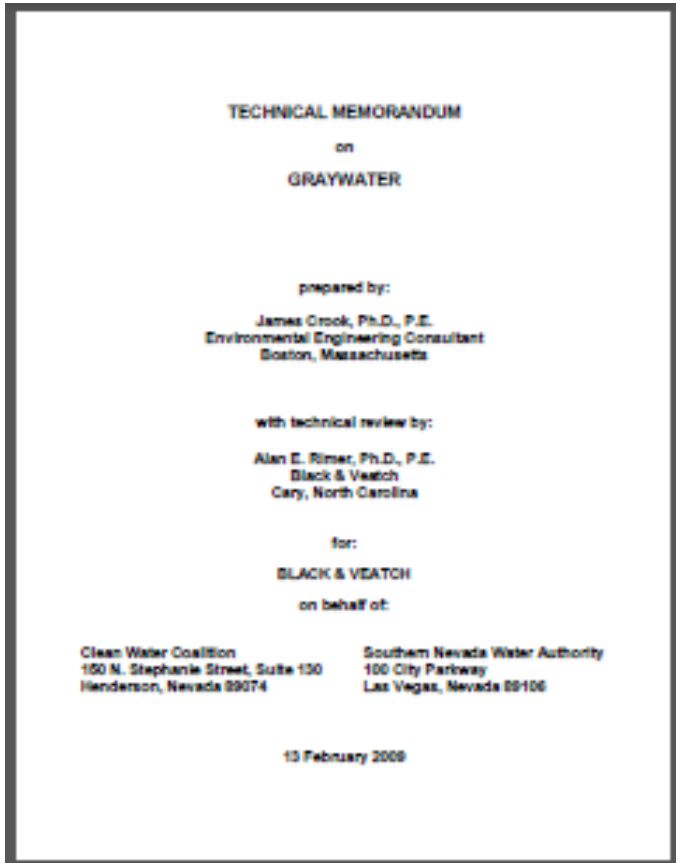
Table 1 – Guideline values (G) for bacteriological monitoring

Parameter	Spray application	Non-spray application			System type
	Pressure washing, garden sprinkler use and car washing	WC flushing	Garden watering	Washing machine use	
Escherichia coli (number/100mL)	Not detected	250	250	Not detected	Single site and communal domestic systems
Intestinal (enterococci number/100mL)	Not detected	100	100	Not detected	Single site and communal domestic systems
Legionella pneumophila (number/100mL)	10	N/A	N/A	N/A	Where analysis is necessary
Total coliforms (number/100mL)	10	1000	1000	10	Single site and communal domestic systems

Table 3 – Guideline values (G) for general system monitoring

Parameter[A]	Spray application	Non-spray application			System type
	Pressure washing, garden sprinkler use and car washing	WC flushing	Garden watering	Washing machine use	
Turbidity NTU	<10	<10	N/A	<10	All systems
pH (pH units)	5 - 9.5	5 - 9.5	5 - 9.5	5 - 9.5	Single site and communal domestic systems
Residual chlorine (mg/L)	<2.0	<2.0	<0.5	<2.0	All systems where used
Residual bromine (mg/L)	0.0	N/A	0.0	N/A	All systems where used

[A] In addition to these parameters, all systems should be checked for suspended solids and colour. The treated greywater should be visually clear, free from floating debris and not objectionable in colour for all uses. Colour is particularly relevant for washing machine use.



TECHNICAL MEMORANDUM

on

GRAYWATER

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13 February 2009

A forty page TECHNICAL MEMORANDUM ON GRAYWATER dated 13Feb2009 by Dr. James Crook and Black & Veach for the Clean Water Coalition and the Southern Nevada Water Authority (Las Vegas) …

- Graywater use is increasing in the U.S., where as many as 7% of households report some use of graywater, many, particularly in rural areas, without obtaining regulatory permits or approval.

http://www.nwri-usa.org/pdfs/CrookTechnicalMemorandumonGraywater.pdf

TECHNICAL MEMORANDUM ON GRAYWATER …

Untreated graywater is used for outside irrigation of turf, plants, or crops. Untreated graywater systems may be as simple as collecting and dispersing the water on single-family residential premises by buckets or may include much more sophisticated collection, piping, and dispersal systems with surge or storage tanks and coarse screening or filtering to remove particulate matter. The amount of graywater produced in a home varies from place to place, ranging from about 20 to 60 gallons/capita/day (50 to 150 gallons/household/day). Most homeowners do not use all of the available graywater produced in their homes, and actual quantities of graywater used are generally considerably less than the amount of graywater produced.

http://www.readbag.com/bahmansheikh-pdf-files-graywater-wra-wef-awwa-final

A fifty page **WHITE PAPER ON** GRAYWATER prepared by Dr. Bahman Sheikh for AWWA, WEF and the WateReuse Assoc. published in 2010 is focused on …

1) Characterize the most important issues associated with graywater reuse and identify the policy implications of each;
2) Assess the potential impacts of rising trends in graywater use on the water recyling industry; and
3) Develop a regulatory and policy framework that will allow the industry to take the appropriate actions to protect the integrity of the recycled water product and brand.

Provides a rather thorough review of graywater reuse practices and requirements. The section on **Indoor Reuse of Graywater (Toilet Flushing)** suggests that …

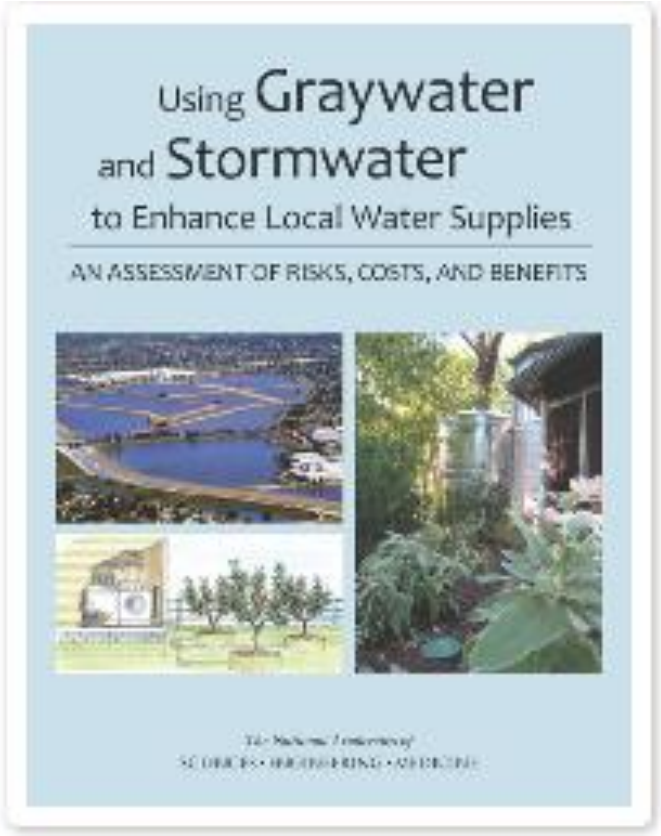
> Graywater used for toilet flushing indoors must be treated to standards similar to those of reclaimed water: filtration and disinfection of secondary effluent. By the time such treatment is provided, graywater is already of the same quality as tertiary (or Class A) reclaimed water and is indistinguishable from it. Conveying tertiary treated graywater in purple pipes should not cause conflicts or confusion or pose a public health problem—as long as the treatment system and their operations are in compliance with regulations governing similar uses of recycled or reclaimed water.

which raises the point that indoor uses of graywater will likely need to comply with standards similar to those imposed on indoor use of reclaimed water.

The **Treated Graywater Systems** section indicates that …

Graywater from nontoilet, nonkitchen sources at a high-rise building, a sports stadium, or an apartment house is sometimes collected separately and treated in an onsite wastewater treatment plant separate from the blackwater. Effluent from the onsite treatment system is then utilized as nonpotable recycled water in a manner similar to that for recycled water. The rationale for such systems is the (a) graywater sources within the building provides enough water for the nonpotable water demand in the building and its vicinity and (b) the lower solids loading, BOD loading, and microbial content of graywater make treatment less costly and less energy-intensive. Such systems are common in Japan, especially in cities where developers of new buildings containing over 3,000 m^2 or over 5,000 m^2 (depending on local regulations) of usable space are required to provide onsite treatment and reuse—mainly for toilet flushing. These graywater systems utilize highly sophisticated treatment systems, including membrane biological reactors, and are closely monitored.

Treated graywater systems are not in common use in the United States at the present time; however, the advent of Leadership in Energy and Environment Design (LEED) certification and of other sustainability incentives is expected to increase their utilization in the future. Treated graywater that meets standards and regulations for water reuse is essentially reclaimed water and is not the subject of this paper. However, lesser levels of treatment, especially those provided by homeowners, are common and do not necessarily provide adequate safeguards for those exposed to the water. These simple graywater systems rely on the aerobic topsoil's capability to provide additional treatment by decomposing organic matter and deactivating the microorganisms in graywater.



In 2016, the National Academy Press published the final Water Science and Technology Board report on ***Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits*** that addresses stormwater and graywater serving a range of nonpotable uses, including irrigation, toilet flushing, washing, and cooling, noting that treatment may be needed, resulting in savings of available potable water supplies.

https://www.nap.edu/catalog/21866/using-graywater-and-stormwater-to-enhance-local-water-supplies-an

Graywater Use…

For graywater, substantial water savings are possible when used for toilet flushing and/or in areas with near-year-round irrigation needs (as in the arid southwest) when irrigation demand is well-matched to graywater availability. Based on the committee's scenario analyses, graywater reuse in Los Angeles provides larger potential potable water savings (up to 13 percent) than household-scale stormwater capture (up to 5 percent), because graywater provides a steady water source during summer months with little or no rainfall.

There is substantial variation in on-site graywater [and stormwater] regulations at the state level with respect to design and water quality for household-scale projects, which leads to varying exposures and risk. The lack of authoritative, risk-based guidelines for the design and potential applications of graywater [and stormwater] in the United States is a major impediment to their expanded use.

Graywater [and stormwater] reuse is being incorporated into law in a variety of respects at the federal, state, and local levels, but not quickly enough to keep up with advances in the technology and its use. Several legal and regulatory constraints remain, hindering the capacity for graywater [and stormwater] to significantly expand the nation's water supplies.

Developing rigorous, risk-based guidelines for graywater [and stormwater] across a range of possible uses and exposures could improve safety, build public confidence in the practices, reduce expenditures on unnecessary treatment, and assist communities that lack an existing regulatory framework for on-site water supplies. Such guidelines could be developed by the Environmental Protection Agency, a collaboration of states, or a collaboration of U.S. water organizations working with the Environmental Protection Agency. This guidance could then serve as a basis for developing standards of practice for on-site non-potable water use. Oversight and enforcement of water quality standards for applications with significant exposures is also important but challenging, and local enforcement agencies would benefit from additional guidance on appropriate, cost-effective maintenance, monitoring, and reporting strategies.

http://oasisdesign.net/greywater/law/

Gray Water Policy Center

A compilation of grey water laws, suggested improvements to gray water regulations, legality & greywater policy considerations, sample permits, public health considerations, studies, etc.

For regulators, inspectors, elected officials, building departments, health departments, builders, and homeowners.

Policy resources

- Guidance for regulators
- Code Writing and Consultation Service
- Model Greywater Ordinance
- Best Practices Informational Handouts, Code Compliance Packages, Workshops etc
- Treatment effectiveness references
- Soil Percolation and Loading Rates, Percolation Tests, and Long Term Acceptance Rate (LTAR)
- General references, studies

Policy examples

- Uniform Plumbing Code
- Connecticut
- Montana
- New Jersey
- New York
- Oregon
- Utah
- Wyoming
- Australia
- International Plumbing Code
- Colorado
- Nevada
- New Mexico
- Massachusetts
- Texas
- Washington
- Vermont
- Jordan

http://www.nwri-usa.org/graywater.htm

Graywater

Historically, "graywater" is defined as water generated from domestic activities, including showering, bathing, and washing laundry (but not from toilets or kitchen sinks, due to the risk of contamination). The use of untreated graywater is limited to subsurface irrigation of outdoor plants.

However, in regions where water supplies are unreliable because of drought, water right conflicts, or other issues, interest exists in making greater use of graywater – considered a reliable local resource – for household and commercial purposes.

To expand the indoor and outdoor uses of graywater in the United States, research is needed on the regulatory, operational, and public health aspects of both treated and untreated graywater.

Graywater – A Potential Source of Water - http://www.ioe.ucla.edu/reportcard/article4870.html
This 2009 Southern California Environmental Report Card was prepared by the UCLA Institute of the Environment.

Graywater is typically wastewater low in turbidity, clear in color, and found from the drainage of bathtubs, showers, bathroom washbasins, clothes washing machines, and laundry tubs. Graywater quality is highly variable because it is source dependent given the variability in household water use. For example, water from clothes washers is high in phosphate content, whereas water from the shower has high turbidity and suspended solids. Residential graywater can be categorized as light graywater or heavy graywater.

Light graywater is wastewater from the shower, bath, bathroom washbasin, and clothes washing machine. Heavy graywater is wastewater from the kitchen sink and dishwasher. According to the revised 2007 California Plumbing Code, heavy graywater is not considered graywater in California. Commercial technologies already exist for processing both light and heavy graywater on-site for non-potable usage. However, the recycling and reuse of graywater requires careful considerations of potential health and environmental risks that can arise due to improper use

At present, given the revised 2007 California Plumbing Code definition of graywater, both heavy graywater and blackwater must be conveyed to and treated by centralized wastewater treatment plants. Only light graywater can be treated on-site for non-potable usage.

Graywater that can be used directly or with a reasonable level of local treatment (i.e., at the point of use) includes clothes washer, shower/bath and faucet (non-kitchen) water constituting about 60% of the total indoor water use in single-family homes (Figure 6).

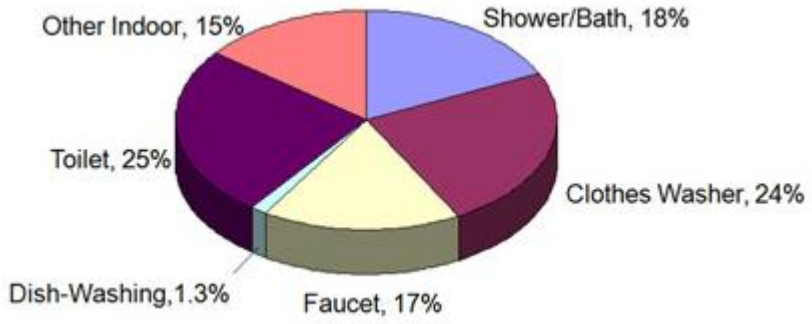


Figure 6. Indoor distribution of water use in a single-family home, based on average per capita indoor consumption data for four cities in Southern California.

Under the revised 2007 California Plumbing Code, Tiers 1 and 2 untreated graywater recycling can be used for subsurface or covered irrigation provided it is not for root crops or food crops with edible parts that contact the soil. According to the Draft 2010 California Plumbing Code, indoor use of Tiers 1-3 for toilet flushing would require water treatment to meet disinfected tertiary recycled water criteria as regulated by the California Department of Public Health. This proposed code implies treated graywater (from small and large volume generators) could be used for unrestricted non-potable use (outdoor and indoor) with the requirement of online water quality monitoring and regulatory oversight that seems to be approaching the level of large-scale centralized water treatment plants.

Three levels of graywater treatment steps are required in order to meet the level of recycled graywater quality for the above stated unrestricted non-potable use: a primary treatment for removal of suspended matter (e.g., sedimentation or filtration), a secondary step for stabilizing organic matter (e.g., biological treatment), and a third step that includes finishing filtration (using membranes or media filters) and disinfection (e.g., UV irradiation). Upgrading the quality of graywater to unrestricted non-potable use may require a significant investment and technical know-how to ensure an effective treatment that will provide adequate public health protection.

http://www.adn.com/alaska-news/rural-alaska/2016/08/08/can-rural-homes-use-the-same-water-over-and-over-a-uaa-project-aims-to-see/

Alaska Dispatch News Thursday, August 11, 2016 Anchorage

Rural Alaska

Can rural homes use the same water over and over? A UAA project aims to see

Author: Tegan Hanlon

Grad students Greg Michaelson and Cara Lucas and Aaron Dotson, a UAA civil engineering associate professor, stand in front of the home and conex in-home water reuse system at UAA on Friday, Aug. 5, 2016, in Anchorage. (Bob Hallinen / Alaska Dispatch News)