

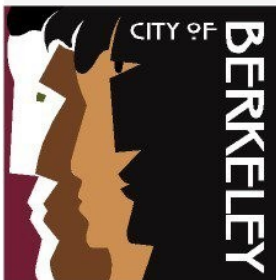
guide

to Conserving Water through Rainwater Harvesting & Graywater Reuse for Outdoor Use

BERKELEY'S

BEST
BUILDERS

A program of the
City of Berkeley
Green Building
Initiative
2010



www.cityofberkeley.info/sustainable

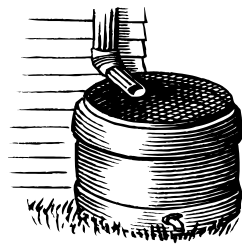
The Guide to Conserving Water through Rainwater Harvesting and Graywater Reuse for Outdoor Use is designed to give homeowners an overview of graywater and rainwater irrigation systems including information on systems that do not require permits. Additionally, this guide gives information on permitting requirements for installing more complicated residential graywater and rainwater harvesting systems.

Save Water and Money by Irrigating with Graywater & Rainwater

Graywater and rainwater systems are alternative plumbing systems that help to conserve our limited water supply. Currently, most of us use clean drinking water straight from the tap to water our gardens. Graywater and rainwater systems give you another water choice for irrigating and can save you money on your water bill. Using non-potable water to irrigate your garden can also help replenish local aquifers and protect the San Francisco Bay. **Graywater and rainwater are different with distinct requirements for system design and permitting.**



Graywater is untreated household wastewater generated from hand washing, laundry and bathing. This wastewater can be diverted from the sewer to irrigate outdoor plants and landscape. Graywater cannot include any wastewater from toilets, kitchen sinks, dishwashers or washing machines laundering soiled diapers or other sources of contamination such as darkrooms. Graywater cannot be stored for more than 24 hours. Graywater is different than potable tap water and requires specific measures for its safe reuse in your garden.



Rainwater harvesting is collected precipitation from rooftops and other above-ground impervious surfaces that is stored in catchment tanks for later use. Rainwater harvesting systems can range from a simple barrel at the bottom of a downspout to multiple cisterns with pumps and filtration. The harvested rainwater is low in sodium and chloramine and fluoride free. Rainwater is different than potable tap water and requires specific measures for its safe reuse in your garden.

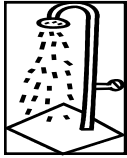
To design your alternative plumbing system you should know:

- How much water is needed for your garden?
- How much water will be produced from your graywater or rainwater systems?
- What type of water do the plants need (rainwater is acidic, graywater is basic)?
- When do you need it (daily, monthly, bi-annually)?
- Where are you going to get it from (shower, sink, roof)?
- How are you going to deliver the water to the garden (pump system, gravity flow)?
- Which distribution system do you plan to use (sub-surface, drip, mulch basin)?

Table of Contents:

Types of Graywater Systems _____	1
Graywater Washing Machine System Requirements _____	2
Types of Rainwater Harvesting Systems _____	4
Rain Barrel System Requirements _____	6
Distribution Methods _____	7
Glossary _____	9
Resources _____	10





Residential Graywater Systems

Graywater systems directly reuse “wastewater” to irrigate your plants. Therefore it is important that you do not use any detergents or bleaches in your sink, bath and laundry that may ultimately be harmful to your plants. To further ensure safety, graywater cannot be used on the edible portions of vegetables and must be used for sub-surface irrigation in order to reduce human contact or ponding. You cannot store graywater so only divert the amount needed to water your garden. All systems must be installed and maintained according to Ch.16A of the California Plumbing Code. (See page 3 for more Code information.)

Types of Graywater Systems:

There are three types of graywater systems that vary in complexity, volume of water produced and permitting requirements. In order to determine which system is right for you, you need to know your irrigation needs, including yard size, soil type, groundwater level and budget. The easiest, most low-tech system uses a washing machine and gravity to move laundry water directly out to the garden.

- Clothes Washer System (no permit required)** Laundry-to-landscape systems divert graywater from the washing machine to your garden without cutting into existing plumbing. Washing machines have internal pumps which can be used to pump water directly out to the garden. No permit is required as long as no pump (other than the washing machine itself) or surge tank is used. See more information on pages 2-3.
- Simple System (Less than 250 gallons a day)** These systems include reusing water from a bathroom sink or shower. Simple systems require permits and involve altering plumbing and can include surge tanks and pumps. For an example of a simple system, see the diagram below.
- Complex System (Greater than 250 gallons a day)** These systems supply a large volume of water. Complex systems rely on pumps, surge tanks, filtration systems and are expensive to install and require ongoing maintenance. Complex systems must be designed by a qualified professional.

Permitting Requirements:

System Type	Plumbing Permit	Electrical Permit	Building Permit	Zoning Requirements
Clothes Washer System	No*	No	No	None
Simple (<250 gallons)	Yes	Yes, if pump	No**	Check with Zoning for storage system requirements for your neighborhood.
Complex (>250 gallons)	Yes	Yes, if pump	No**	

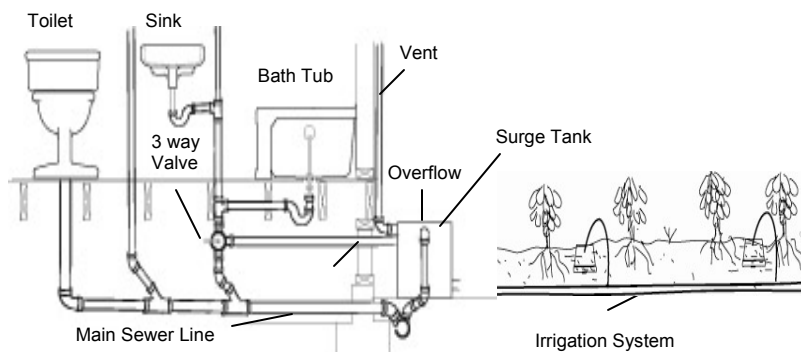
* A permit shall not be required for a clothes washer system that does not cut or alter the existing plumbing piping as long as it is in compliance with the Graywater System Requirements (2007 California Plumbing Code Section 1603A.1). See page 3 for more information. Clothes washer systems with a tank and/or pump will require a permit.

** If the tank height is greater than twice the width of the base and over 5000 gallons, a building permit, plans and calculations for foundation and anchoring of tank are required.

Sample Simple System Drawing:

This system shows graywater being diverted from the sink and bathtub to a row of plants via an irrigation system. Toilet water can not be used for graywater and must exit the house through the main sewer line.

This system also shows a surge tank for temporarily holding back large drain flows (for 24 hours or less), a 3-way valve to switch between the graywater system and the sewer system and a vent to allow for air circulation.





Graywater Clothes Washer System: Laundry-to-Landscape

No permit is required for a clothes washing machine, providing all system design and code requirements are met as outlined in Chapter 16A of the 2007 California Plumbing Code (see page 3). Permits are required for systems that include tanks or pumps.

Washing machine systems are the least complicated type of graywater system. They are great for gardens with minimal irrigation needs, are low-cost, easy to install, and require very little maintenance.

Designing a Clothes Washer System:

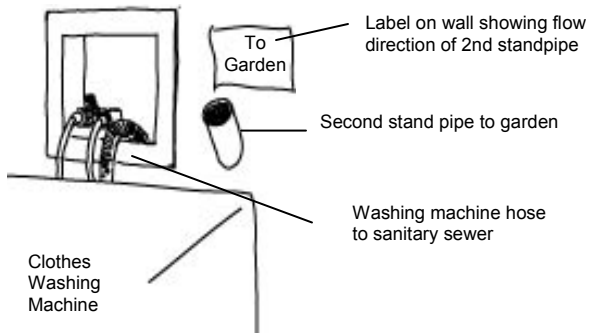
- Attach washing machine discharge hose to either a 3-way valve to switch between a graywater system and the sewer or a second standpipe. Graywater must be capable of being reconnected to the sewer.
- Graywater then travels out to the garden. A mulch basin with 2" cover is the simplest system for distribution and irrigation (see distribution descriptions & diagrams on page 7).
- Clearly label flow direction to sewer or yard. Once outside the building, the discharge must drain directly to the disposal field by hose or pipe. Piping at five foot increments & at hose connection point is to be permanently labeled: **"CAUTION: NONPOTABLE WATER, DO NOT DRINK"**
- All graywater must be used the same day it was produced.

For a complete list of clothes washer graywater system code requirements see page 3.

Clothes Washer System Drawings:

Two examples of methods to divert graywater to the garden

Second Standpipe Method

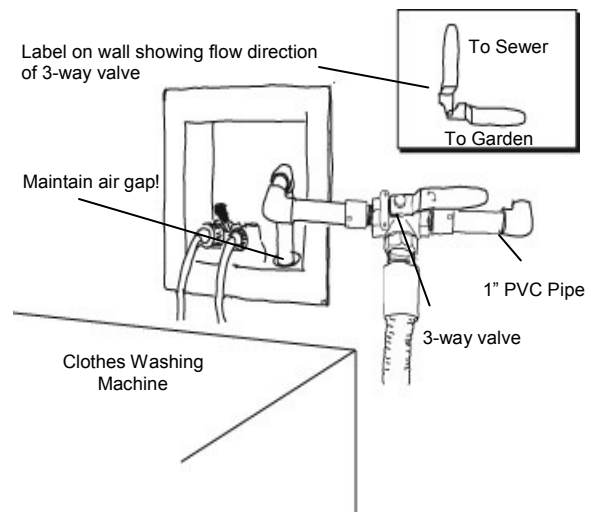


The second standpipe is installed in the wall or through the floor before it goes out to the garden. The clothes washing machine hose is moved by hand from the normal building sewer connection to the irrigation system standpipe.

Graywater Tips for Success

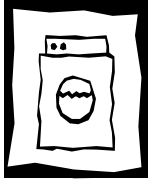
- Shade and acid loving plants don't like graywater.
- Ingredients in washing machine detergents such as bleaches, salts or borax may not be good for your garden. Use plant safe alternatives.
- To ensure proper operation, regularly monitor and maintain all pipes and irrigation equipment for clogging, overflow, ponding, odors and other issues.

Three-Way Valve Method



A three-way valve and piping are assembled to switch between the normal building sewer connection and the irrigation system. A vacuum breaker or backflow device may be required for proper operation depending on site elevations. Consult a plumber or graywater specialist.

Remember: Graywater is not like rainwater; it cannot be stored!



Graywater Clothes Washer System: Laundry-to-Landscape

The text below is taken from the 2007 California Plumbing Code Chapter 16A. No permit is required for a clothes washer graywater system providing all system design and code requirements are met as outlined below.

California Plumbing Code: www.hcd.ca.gov/codes/shl/2007CPC_Graywater_Complete_2-2-10.pdf

Clothes Washer System Requirements from 2007 California Plumbing Code:

1. Registration of your system with the City of Berkeley Building Department is not required.
2. The design shall allow the user to direct the flow either to the irrigation or disposal field or the building sewer. The direction control of the graywater shall be clearly labeled and readily accessible to the user.
3. The installation, change, alteration or repair of the system does not include a potable water connection or a pump and does not affect other building, plumbing, electrical or mechanical components including structural features, egress, fire-life safety, sanitation, potable water supply piping or accessibility.
Note: The pump in a clothes washer shall not be considered part of the graywater system.
4. The graywater shall be contained on the site where it is generated.
5. Graywater shall be directed to and contained within an irrigation, mulch basin, or disposal field.
6. Ponding or runoff is prohibited, and shall be considered a nuisance.
7. Graywater may be released above the ground surface provided at least two (2) inches (51mm) of mulch, rock or soil or a solid shield covers the release point. Other methods which provide equivalent separation are also acceptable.
8. Graywater systems shall be designed to minimize contact with humans and domestic pets.
9. Water used to wash diapers or similarly soiled or infectious garments shall not be used and shall be diverted to the building sewer.
10. Graywater shall not contain hazardous chemicals derived from activities such as cleaning car parts, washing greasy or oily rags or disposing of waste solution from home photo labs or similar hobbyist or home occupational activities.
11. Exemption from construction permit requirements of this code shall not be deemed to grant authorization for any graywater system to be installed in a manner that violates other provisions of this code or any other laws or ordinances of the City of Berkeley.
12. All systems shall have a maintenance manual. The manual is to remain with the building throughout the life of the system and indicate that upon change of ownership or occupancy, the new owner or tenant shall be notified that the structure contains a graywater system.

Proper system design, maintenance and use are the responsibility of the system owner, not the City of Berkeley.



Residential Rainwater Harvesting Systems

The state of California does not have explicit code language for rainwater harvesting. The City of Berkeley developed rainwater harvesting permitting requirements which can be accessed at: www.cityofberkeley.info/planning

Rainwater Overview

Berkeley averages roughly 20 inches of rain a year. That rainwater currently flows off your roof, into a storm drain and out to the San Francisco Bay. Rainwater harvesting systems collect precipitation from rooftops and other above-ground impervious surfaces and store the water in catchment tanks for later use. Rainwater harvesting systems can range from a simple barrel at the bottom of a downspout to multiple cisterns with pumps and filtration. Stored water can be used for non-potable purposes such as irrigating gardens or even flushing toilets.

Types of Rainwater Harvesting Systems:

There are two main types of rainwater harvesting systems that vary in complexity, volume of water stored and permitting requirements. In order to know which system is right for you, you need to determine your irrigation needs including yard size, soil type, groundwater level, current rainfall and your budget. The easiest, most low-tech system is a rain barrel attached to your downspout that has a spigot and hose out to your garden.

- **Rain Barrel (Less than 100 gallons —no permit required)** A rain barrel system is a simple rainwater collector that captures and stores a portion of the runoff from a roof downspout. A hose attached to the bottom of the rain barrel can be used to irrigate your garden. A rain barrel will only capture a small fraction of the rainwater that flows off your roof, the rest of the runoff will still need to drain to a safe overflow location. See more information on page 6.
- **Cisterns (Greater than 100 gallons)** Cisterns are larger systems that can hold much more water and may include pumps to move the rainwater to the garden. More complex systems can involve plumbing and electrical work, soil excavation or other structural work. For rainwater collection projects of this scale, consult a professional to review design, construction and safety considerations. Permits and zoning certificates are required for cistern systems. **For a complete list of requirements for cistern systems, see the City of Berkeley's website at: www.cityofberkeley.info/planning**

Permitting Requirements:

System Type	Plumbing Permit	Electrical Permit	Building Permit	Zoning Requirements
Rain Barrel (<100 gallons)	No	No	No	None
Cistern (<360 gallons)	Yes	No	No	Requires zoning certificate
Cisterns (>360 gallons)*	Yes	No	Yes	Requires zoning certificate
Cisterns >5000 gallons & >2:1 height to width OR Cisterns above grade (raised) OR below grade (underground)*	Yes	No	Yes	Cisterns on or above grade require zoning certificate (none required for underground cisterns)
Cisterns within a building	Yes	No	No	None
Pumps added to any system		Yes		

**Engineered drawings and calculations may be needed for anchoring of cisterns, seismic loading and, anticipated loading, depending on placement, seismic design category and size of cistern on a case by case basis.*



Residential Rainwater Harvesting Systems

The California Plumbing Code has no approved standards for rainwater harvesting systems. Rainwater catchment systems over 100 gallons require permits and approval from the City of Berkeley Building Department. In order to get a permit for a cistern (over 100 gallons), applicants must submit a plan that meets or exceeds requirements for health and safety. An Alternative Methods and Materials Request (AMMR Form) must accompany the permit application. Use ARCSA/ASPE standards to help design your system (see resources page 10).

Untreated rainwater

Exterior Subsurface Irrigation- Rainwater can be used to water all your outdoor plants— including edible plants and gardens. Consider using a first-flush device that diverts the first inch of rain which may contain contaminants from roof for use in edible gardens. Untreated rainwater from permitted systems must be used sub-surface. Information about irrigation can be found in the distribution section on page 7 & 8.

Treated rainwater

Exterior and Interior Nonpotable Uses— Treated rainwater can be used outside for activities such as above surface irrigation and car washing or indoors for toilet flushing and laundry, subject to environmental health review. For rainwater treatment standards, see: www.cityofberkeley.info/planning

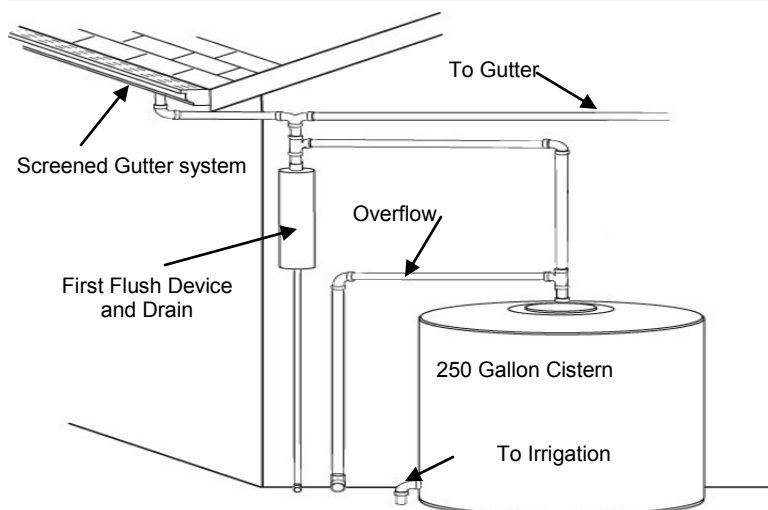
To ensure health and safety, all rainwater systems must be:

- Labeled non-potable
- Discharging overflow to a safe location
- Stored in a structurally sound cistern or barrel
- Screened to prevent mosquito breeding
- Secured to ensure all child safety precautions are taken to prevent drowning
- Cleaned annually with a non-toxic cleaner such as vinegar

Rainwater cannot be used as drinking water in Berkeley.

For a complete list of City of Berkeley Rain Harvesting Permit Requirements, please see the website at: www.cityofberkeley.info/planning

Sample Rainwater Harvesting System:



System Size:

The size of your system depends on how big your roof is, how much rainwater storage you have, and how you intend to use the water.

A rough rule of thumb is that you can collect 600 gallons of water for every 1,000 sq.ft of roof area for every inch of rain.



Rainwater Harvesting System: Rain barrels

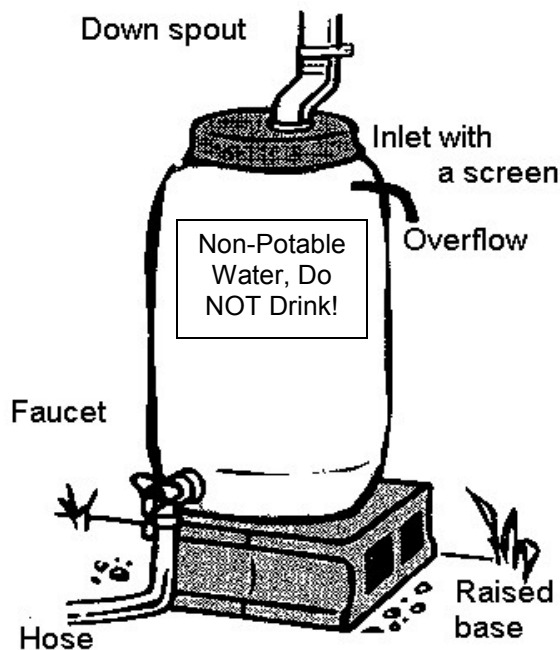
No permit or city approval is needed for rain barrel systems of 100 gallons or less per vessel, provided the following requirements are met:

Requirements:

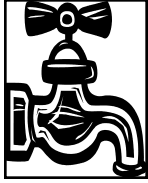
- Rain barrels shall be sited at grade on a sound and level surface at or near gutter downspouts.
- Water collected shall be used for irrigation only.
- Rain barrel openings shall be screened with a fine mesh (.05 inch x .05 inch) to prevent mosquitoes from entering.
- Gutters serving rain barrels shall be debris screened.
- Large openings shall be securely fastened to prevent accidental drowning.
- No pumps, connections to domestic water or interior use are permitted.
- Rain barrels shall be located a minimum of 3 feet from the property line.
- Overflow or discharge from rain barrels may not discharge across the public right-of-way or adjacent property, or in any way create a nuisance.
- Collection vessel(s) for each existing downspout shall not exceed 100 gallons in the aggregate.
- Rain barrels and gutters shall be cleaned annually.
- Rainwater from rain barrels is not required to be treated.
- Use of rainwater collected from rain barrels is not limited to sub-surface irrigation.

Note: Rain catchment systems over 100 gallons or over 100 gallons in aggregate per downspout will be considered cisterns subject to the permitting requirements.

Sample Rain Barrel System Drawing:



- Your rain barrel should have a spigot/faucet so that you can access the water, an overflow pipe, a sealed and screened lid with an opening to attach your downspout and screens on all vents. Label all rainwater harvesting pipes and barrels with: "Non-Potable Water, Do NOT Drink".
- All rainwater collection systems must have an overflow to a safe disposal location (stormwater drain or rain garden).
- If you intend to water edible plants with your rainwater, consider installing a first flush diverter, which disposes of the first inch of rain and ensures that you harvest only the cleanest rainwater.
- Rain barrel must be secured on a firm, level surface so that it will not tip over. It can be raised slightly to help with gravity flow irrigation.
- The barrel should be a food grade container, made to hold liquid.



Distribution Methods for Residential Graywater and Rainwater

Although rainwater and graywater systems are different and have distinct characteristics and permitting requirements, they have similar distribution methods and allowable uses.

Two beneficial ways to use graywater and rainwater:

- **Irrigation-** Replaces drinking water for watering plants and lawn
- **Disposal-** Diverts water from sewer or storm drain to recharge ground water

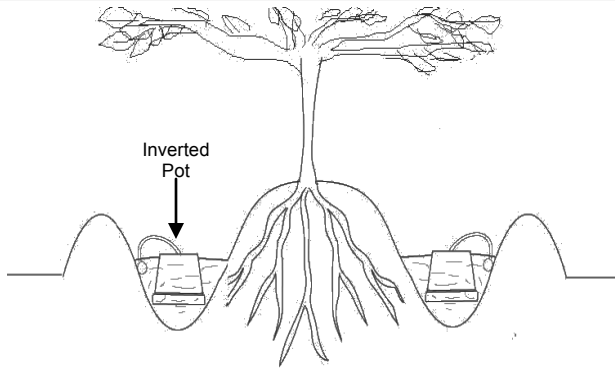
Irrigation: Sub-surface irrigation takes place below the soil surface or in a mulch bed. Sub-surface irrigation is used to minimize human contact with possible harmful contaminants. Sprinklers and surface watering cannot be used with alternate water sources unless the water has been treated to an approved level of disinfection.

Types of Irrigation Systems:

- Mulch Basin– simplest method of irrigation
- Sub-Surface Plant Drip System– more complex system
- Sub-Surface Irrigation for Lawns– more complex design and venting requirements

A good rule-of-thumb is that a square foot of well-drained soil can handle about a half gallon of graywater per week.

Sample Irrigation Systems Drawings:

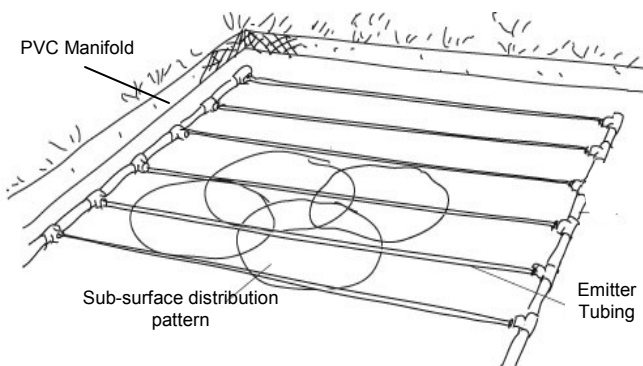
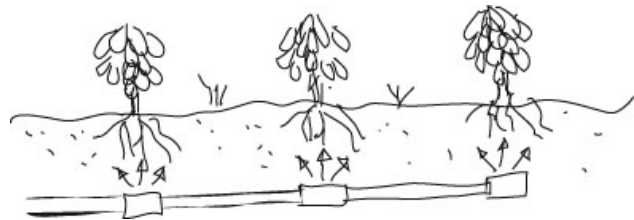


Mulch Basins are trenches located between or around plants filled with mulch designed to prevent ponding or surfacing.

The diagram (to the left) illustrates a branched subsurface irrigation system that waters plants without the use of specialized drip emitters, using tubing for controlled saturation at the roots. Pots are located below the surface of the system to provide air pockets around the tubing to prevent root intrusion. This system is less prone to clogging, but requires more volume for even distribution.

Sub-Surface Plant Drip System

directly irrigates plants at the root system at a regulated low volume. Sub-surface drip emitters must be designed to resist root infiltration and generally require a pump and filter. (See diagram to right)



Sub-Surface Irrigation for Lawns

is a designed assembly that is located below the sod that evenly distributes the alternate water sources and ensures that water does not reach the surface. With no surface wetting this type of irrigation allows for activities on the lawn without direct exposure to the graywater. This system requires sub-surface drip emitters designed to resist root infiltration, a properly sized filter and may also require a pump. (See diagram to left)



Distribution Methods for Residential Graywater and Rainwater

Disposal: Disposal fields help recharge the groundwater system and reduce the load on the waste water treatment system and the San Francisco Bay.

Disposal and Irrigation Tips for Success:

- Distribute graywater and rainwater away from your building foundation to a flat, sub-surface garden area, avoid steep slopes to prevent runoff and erosion.
- Apply thick compost mulches for sub-surface irrigation. The mulch will speed up the natural decomposition of waste residues and help prevent runoff.
- Rotate applications of graywater with rainwater or fresh water to avoid high concentrations of salt build-up in the soil.
- Ongoing maintenance is required for all distributions systems. Maintenance may include regularly replacing mulch and maintaining drip emitters free of root intrusion.

Sample Disposal Field Drawing:

Illustration to the right shows a graywater disposal field— a similar system can be used for rainwater disposal.

Disposal fields must be 5 feet from property lines and buildings, and 100 feet from streams.

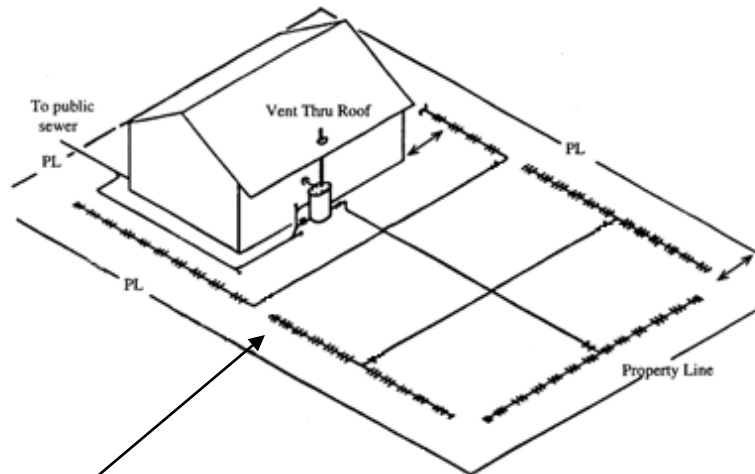
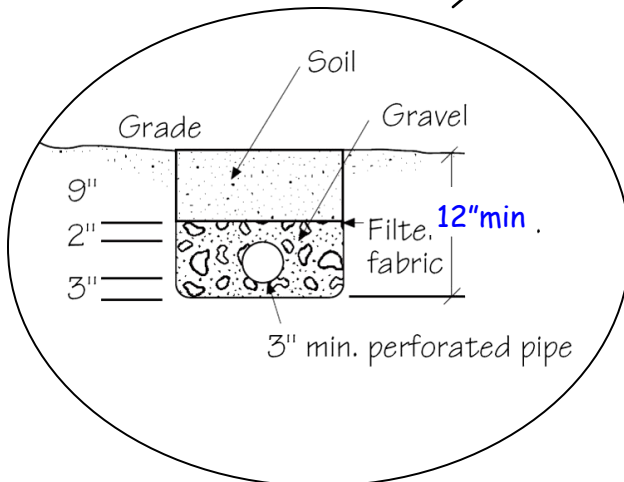


Diagram Credit: State of California Graywater Guide 1995



Piping to disposal field shall be solid pipe sloping 1/4" per foot to the point of connection to the leach field. Minimum 3" perforated pipe is required for disposal fields. Perforated pipe shall be installed level. Filter material and aggregates from 3/4 to 2 1/2" shall be placed in the trench. Aggregate can be clean stone, gravel, slag or similar materials. Leach lines can be up to 100' long and spaced as close as 4' apart.

Glossary of Terms for Graywater and Rainwater Systems

3-Way Valves: diverts graywater from sewer to distribution plumbing or as a shut-off back to sewer.

Blackwater: toilet water that can not be re-used.

Cistern: a storage device for rainwater harvesting system that holds and stores over 100 gallons. Cisterns can be installed above or below ground, depending on site conditions.

Combined Pump, Surge Tank & Filter Assembly: a manufactured unit such as “Aqua2use”.

Complex System: graywater systems that discharge over 250 gallons per day.

Disposal Field: a landscape designed to absorb the graywater or rainwater to prevent ponding or runoff.

Distribution System: piping that carries graywater or rainwater out to the desired landscape for irrigation or disposal.

Downspout: the rain leader from the roof gutter to the rainwater storage vessel or other approved location as provided in the 2007 California Plumbing Code Section 1101.1.

Filter: used to protect drip irrigation from fine particles and clogging of emitters.

Graywater Sources: washing machine, bath/shower, sink (not kitchen sink).

Gutter Screens: to keep debris out of the rain gutters or entering your system.

Holding Tank: temporarily stores graywater until there is sufficient volume to pump.

Irrigation Field & System: the landscape intended to be irrigated by graywater or rainwater, including via a drip irrigation system, mulch basin, or other approved irrigation method.

Labeling: Piping and hose bibs must be labeled with yellow background and black lettering: “CAUTION: NONPOTABLE WATER, DO NOT DRINK”.

Mulch: organic waste material (leaves, prunings, straw, wood chips, etc). Mulch is permeable and allows rapid infiltration of graywater or rainwater into soil.

Mulch Basin: a type of irrigation or disposal field filled with mulch used to prevent ponding or runoff. A mulch basin may include a basin around a tree, a trough along a row of plants.

Operation Manual: for instruction on function, maintenance and safety precautions.

Piping: directs the water to your irrigation system.

Pump: pressurizes water through distribution system out to landscape (optional– can be gravity fed).

Rain Barrels: collection devices that hold and store 100 gallons or less of rainwater. Capture flow directly from downspout.

Roof washers & First-Flush Devices: reduces contaminants in the harvested rainwater.

Simple System: a graywater system with discharge of 250 gallons per day or less. Simple systems exceed complexity of clothes washer system and require permits.

Sub-Surface Drip or Irrigation Systems: piping that carries graywater or rainwater out to landscape to be irrigated. Can include drip emitters, mulch basins, etc.

Surge Tank: delays distribution of water by temporarily holding back large drain flows.

Treated Rainwater: rainwater that is treated to meet health and safety requirements. Can include pre-filtration (first-flush), cartridge filtration and disinfection and chlorination. Treated rainwater is required for certain uses including toilet flushing, laundry, car washing, or sprinklers.

Vent: vertical piping that allows sewer gasses to safely release to the atmosphere.

Office of Energy and Sustainable Development (OESD)

A Division of the Planning Department

2120 Milvia Street, Berkeley CA 94704

Phone: 510-981-7410

Email: planning@cityofberkeley.info

Resources for Graywater and Rainwater Systems

City of Berkeley Resources:

City of Berkeley General Information, Customer Service Center:

Dial 3-1-1 within Berkeley or 510-981-CITY

Office of Energy and Sustainable Development

www.cityofberkeley.info/sustainable

Senior Green Building Inspector: 510-981-7457

Email: rrushing@cityofberkeley.info

Permit Service Center

2120 Milvia Street, Berkeley CA 94704

www.cityofberkeley.info/planning

General Information: 510-981-7500

Faxed Permit Applications: 510-981-7505

Appointment Scheduling: 510-981-7502

Land Use Planning (Zoning)

www.cityofberkeley.info/planning

Zoning: 510-981-7410

Building & Safety

www.cityofberkeley.info/planning

General Information: 510-981-7440

Inspection Request Line: 510-981-7444

Email: buildingandsafety@cityofberkeley.info

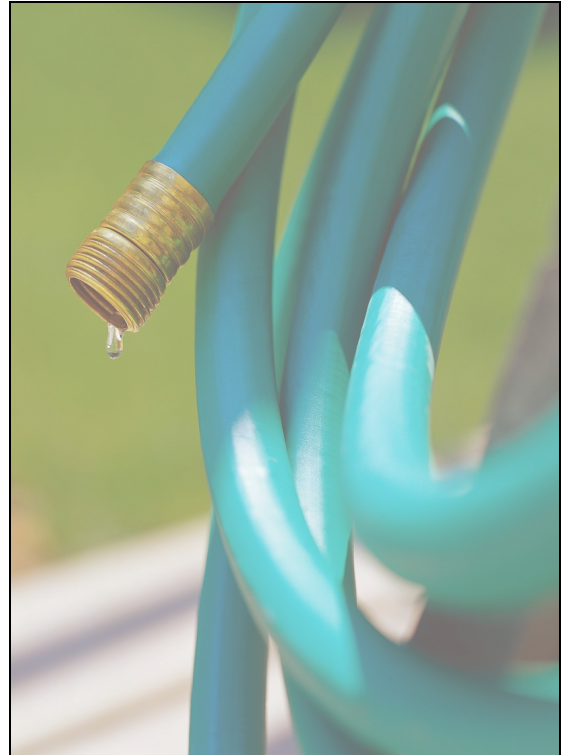
Public Works

www.cityofberkeley.info/pw

Stormwater: 510-981-6394

Sewer Laterals: 510-981-6423

Refuse & Recycling: 510-981-7270



Additional Resources:

Codes and Guidelines:

- California Plumbing Code for Graywater Chapter 16A:
www.hcd.ca.gov/codes/sh/2007CPC_Graywater_Complete_2-2-10.pdf
- California Department of Water Resources: www.water.ca.gov/wateruseefficiency
- City of Berkeley Guidelines for Rainwater: www.cityofberkeley.info/planning

Rebates:

- East Bay Municipal Utility District (EBMUD): www.ebmud.com

How to Guides:

- Oasis Design: www.oasisdesign.net/greywater
- Greywater Alliance: www.greywateralliance.org
- ARCSA/ASPE Rainwater Catchment Design and Installation Standards:
<http://www.arcsa.org/rainwater-10-09>
- StopWaste Bay Friendly Gardening: www.stopwaste.org