Guidance for Performance, Application, Design, and Operation & Maintenance

Tier Two and Three Greywater Subsurface Irrigation Systems

Chapter 246-274 WAC

September 2011

Washington State Department of Health
Division of Environmental Health
Office of Shellfish and Water Protection

Guidance for Performance, Application, Design, and Operation & Maintenance

Tier Two and Three Greywater Subsurface Irrigation Systems
Chapter 246-274 WAC

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Preface

The Washington State legislature recognizes the need to conserve ground and surface water supplies, reduce the cost of treating wastewater and use sustainable building practices to conserve potable water. In 2006, enacted legislation required the Washington State Department of Health to adopt rules for subsurface greywater irrigation by December 31, 2010. The rule, Chapter 246-274 WAC (http://apps.leg.wa.gov/wac/default.aspx?cite=246-274), establishes requirements that provide building owners with simple, cost-effective options for reusing greywater for subsurface irrigation. The chapter is intended to encourage water conservation and to protect public health and water quality.

Greywater is carriage water generated through water-use fixtures and appliances, except toilets and urinals, which contain chemicals, bacteria, virus, and other pathogens. The amount of chemicals, bacteria, virus, and other pollutants varies depending on what goes down drain. Greywater from a kitchen has the largest amount of pollutants while greywater from bathrooms and clothes washing machines is typically less. When people manage what goes down the drain, the amount of chemicals and pathogens can be reduced significantly. The new rules require the design and management of the subsurface greywater irrigation system take into account the source of the greywater and does not allow more greywater to be applied than what can be taken up by plants and lost to evaporation.

This guidance document has been developed for statewide application. Regional differences may, however, result in application of subsurface greywater irrigation systems in a manner different than what is presented here. In some counties, allowances that are provided for in this document may be restricted. In all cases, the local health officer has full authority in the application of WAC 246-274 together with local jurisdictional rules. If any provision of this guidance is inconsistent with local jurisdictional rules, regulations, ordinances, policies, procedures, or practices, the local standards take precedence. Application of the guidance presented here is at the full discretion of the local health officer.

Local jurisdictional application of these guidance standards may be:

1) **Adopted as part of local rules, regulations or ordinances -** When these guidance standards, either as they are written or modified to more accurately reflect local conditions, are adopted as part of the local rules, their application is governed by local rule authority.
2) **Referred to as technical guidance in the application of the technology -** These guidance standards, either as they are written or modified to more accurately reflect local conditions, may be used locally as technical guidance.

Application of these guidance standards may occur in a manner that combines these two approaches. How these standards are applied at the local jurisdictional level remains at the discretion of the local health officer and the local board of health.

The standards presented here are provided in typical rule language to assist those local jurisdictions where adoption in local rules is the preferred option.

Other information is presented in text boxes with a modified font style to easily distinguish it from the recommended guidance standards.

Introduction

The new state-wide greywater reuse rules adopted in December 2010, Chapter 246-274 WAC, allow greywater to be diverted from buildings for seasonal subsurface irrigation when flows are less than 3,500 gallons per day. Using greywater for irrigation can reduce the use of potable water, improve people's awareness of harmful chemicals used, and promote water conservation. There are many ways to maximize water conservation, using greywater for irrigation is just one option. To learn more about water conservation, go to http://devwww6/ehp/dw/drought/droughthome.htm.

As defined by rule, a greywater subsurface irrigation system conveys greywater to provide subsurface irrigation for plants only during the growing season, it is not defined as, nor is it considered, an on-site sewage system. WAC 246-274 is specific to greywater subsurface irrigation systems while Chapters 246-272A, 246-272B, and 246-272C WAC are applicable to on-site sewage systems, including soil dispersal components for greywater.

The use of a greywater subsurface irrigation system designed under WAC 246-274 standards may not serve as an alternative to an approved on-site sewage system or connection to an approved public sewer for greywater disposal at any building, including buildings using waterless toilets. Because greywater irrigation systems under this rule are designed for temporary use and loading rates not greater than the water needs of plants, taking in account loss to evaporation, they are designed differently than on-site sewage systems. The permanent wastewater system, including a greywater on-site system, must be designed to handle normal variations of wastewater strength year round and have a surge capacity to handle a variety of water use scenarios.

By using a diversion valve, building owners determines when it is beneficial to use the greywater for irrigation and when to divert to the approved wastewater system. They are required to divert to the approved wastewater system when; soils are saturated or frozen, there is a blockage, plugging, or backup of the system, the maximum allowed gallons per day is reached, or when soiled clothes will be washed. Soiled clothes include vomit, blood, dirty diapers, pet waste, and all other types of body fluid.

Plumbing modifications, including the addition of diversion valves inside buildings, are regulated by the Washington State Building Code. The use of a small tank and an overflow pipe that flows to the approved wastewater system provides a means to handle surge events and limit the amount of greywater used for irrigation.

WAC 246-274, Greywater Reuse for Subsurface Irrigation, applies only to subsurface irrigation outside of the building. It does not apply to surface irrigation, confined uses such as patio containers, and containers in a greenhouse, landscape ponds and constructed wetlands (unless listed as an approved treatment product), rainwater collection (harvesting), indoor reuse, and reclaimed water. The growing season may be extended by the use of a greenhouse when the greywater is distributed evenly below the ground and the requirements in Chapter 246-274-415 WAC are met.

Greywater can contain harmful bacteria, viruses, parasites, fats, oils, detergents, soaps, salts, and a variety of other chemicals. Greywater from the laundry and bathrooms typically contain fewer harmful pollutants than greywater generated in the kitchen and utility sinks. By using a graduated set of tiers to address harmful pollutants, health and environmental protection is maintained while providing cost effective options for the reuse of greywater.

Greywater from bathroom/lavatory basins (sinks), showers, and tubs and clothes washing machines typically contain less pathogens, chemicals, and fats, oil, and grease. Flows from these sources are defined as **light greywater**. Light greywater may be reused through systems designed using the criteria for Tier one and two. The lowest risk system, a greywater system that uses less than 60 gallons per day of light greywater is called a Tier one greywater irrigation system. A Tier one system does not use a pump or store any greywater and comes from a single family residence (an exception is available for a business or multifamily residence). Information about Tier one greywater subsurface irrigation systems is available at http://www.doh.wa.gov/ehp/ts/WW/greywater/greywater.htm. A Tier two greywater irrigation system uses a pump(s) and/or stores light greywater for less than 24 hours.

Greywater from nonlaundry utility sinks and the kitchen, including sinks and the dishwasher, typically contain more pathogens, chemicals, and fats, oil, and grease. Flows from these sources are defined as **dark greywater**. Dark greywater may be reused through systems designed using the criteria for Tier three. A Tier three system requires an approved treatment component to treat dark greywater, light greywater stored for longer than 24 hours, light greywater to be used to irrigate a green roof, or any greywater used in a public location such as a playground, school, church, or sports field.

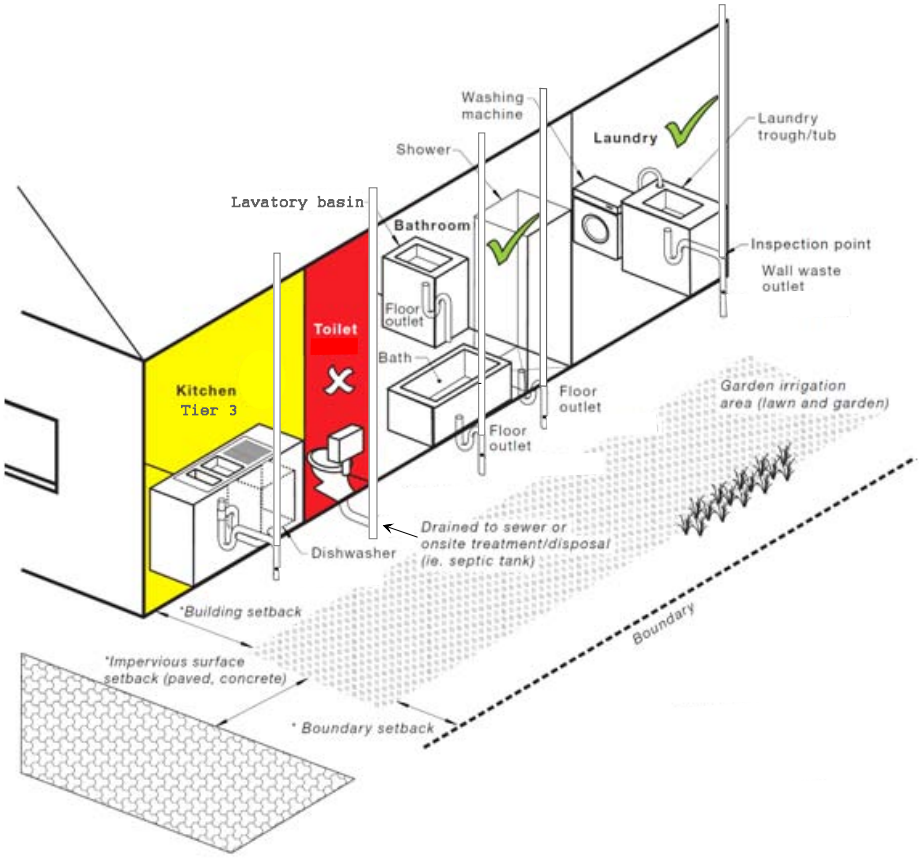
To learn more about the constituents of greywater, go to http://www.doh.wa.gov/ehp/ts/WW/greywater/WWGWTechIsu.pdf.

This guidance document outlines technical issues to assist with the design and permitting of Tier two and three greywater systems. It is intended to provide information on how to design, build, and maintain Tier two or three greywater subsurface irrigation systems.

Table 1. Tiered Greywater Subsurface Irrigation System Characteristics

Project Type	Source of Greywater	Storage	Quantity	Treatment and Distribution
Tier one	LIGHT GREYWATER • Lav/Bathroom Basins (sinks) • Showers • Bath tubs • Clothes washing machines	None	Less than 60 gallons per day per irrigation system - limit 2 per building	No treatment - Gravity
Tier two		Less than 24 hours per day	Less than 3,500 gallons per day	No treatment - Even distribution (typically by pressure)
Tier three	DARK GREYWATER • Nonlaundry utility sinks • Kitchen sinks and dishwasher washer • All greywater combined that has not come in contact with wastewater from a toilet or urinal	No limit	Less than 3,500 gallons per day	Treatment Required - Even distribution (typically by pressure) Treatment is required when light greywater is used in a public location such as a playground, school, church, or park.

Figure 1. Potential Greywater Drainage Access Points for a Single Family Residence



To keep greywater irrigation from impacting the neighbors and harming the environment a list of limitations is included in Table 2.

Table 2. Limitations to Consider

Local regulations	These rules are implemented through local codes. Check with the county to determine local requirements. The local code will determine if Chapter 246-274 WAC is allowed or if greywater subsurface irrigation systems are permitted using Chapter 246-272A WAC.
Environmentally sensitive area	Check with the county to determine specific restrictions.
Not allowed by the local drinking water or wastewater authority	Check with your drinking water and sewer utility for restrictions.
Washing clothes that are contaminated by feces such as dirty diapers and soiled clothes	Not allowed
Ponding and using more greywater than evapotranspiration rates	Not allowed
Irrigating edible plants	Greywater must not come in contact with the edible portion of a plant.
Use during non-growing seasons	Greywater subsurface irrigation use is limited to times when plants are taking up water. Typically this is during the late spring, summer, and early fall. An exception may be for use inside a green house.
Detergents and soaps	Care must be taken to choose soaps and detergents that won't harm the plants and soil.
Use of toxic substances, cleaning chemicals, or hazardous household products derived from the waste from a water softener, waste from activities such as cleaning vehicle parts, washing greasy or oily rags or clothing, rinsing paint brushes, or disposing of waste solutions from photo labs or similar hobbies or home occupation activities, or from home maintenance activities	Not allowed
When used on a lot that uses an on-site sewage system	• For buildings using an on-site sewage system, the use of a greywater subsurface irrigation system does not change the design, capacity, or reserve area requirements, or any other requirement applicable to on-site sewage systems under Chapters 43.20.050, 70.118B RCW, or Chapters 246-272A, 246-272B, or 246-272C WAC. • The design flow of the greywater system must be less than 300 gallons per day. The total flow of greywater diverted must not adversely affect the functioning of the on-site sewage system.
Site Considerations	• Type 7 soils (Sandy clay, clay, silty clay, and strongly cemented firm soils, soil with a moderate or strong platy structure, any soil with a massive structure, and any soil with appreciable amounts of expanding clays) are not suitable for greywater reuse. • The location of the system must meet the minimum horizontal setback requirements in Chapter 246-274-405 WAC. (See Horizontal Setback Table in Appendix E) • The irrigation field may only be located on slopes less than 30%. • Greywater contains chemicals that are alkaline. Acid loving plants do not do well when watered with greywater. Choosing the right kinds of plants is important.

Designs for greywater subsurface irrigation systems, as defined by Chapter 246-274 WAC, come in many shapes and sizes. Using pumps designed for greywater or sewage combined with subsurface drip irrigation system provides the greatest opportunity for saving water. Subsurface drip systems are usually more expensive than gravity systems and require more maintenance, however, due to their ability to apply the greywater evenly, more plants can be watered using the same volume of water. Learn more about subsurface drip systems in the RS&G for Subsurface Drip Systems.

Something to consider when designing a sustainable building not hooked up to a sewer system. An on-site sewage system designed under Chapter 246-272A WAC recycles water by treating and returning the effluent below the ground. When an on-site sewage subsurface drip system is utilized, nutrients can be taken up by the plants. To maximize water reuse, consider using a subsurface drip system to handle all the "wastewater" from the building. By doing so, you can take the "waste" out of wastewater.

1. Performance Standards

1.1. Treatment Level

1.1.1. A treatment component, by definition means a technology that treats greywater according to Chapter 246-274-400 WAC in preparation for subsurface irrigation of plants. By definition a filter to screen solids is not considered a treatment component.

1.1.2. The treatment component for a Tier three greywater subsurface irrigation system must be capable of meeting the threshold requirements of 25 mg/L $CBOD_5$ and 30 mg/L TSS for treated effluents in NSF/ANSI 350-1 and NSF/ANSI 40 prior to irrigating plants with the greywater. The NSF Product and Service Listing is available at http://www.nsf.org/Certified/Wastewater/.

1.1.3. A public domain treatment technology may be used to treat dark greywater if the department has developed recommend standards and guidance (RS&G) for the technology and the RS&G indicates the technology is expected to achieve the treatment performance requirements in subsection 1.1.2. The sizing of treatment technologies used to treat greywater for subsurface irrigation is based on the design flow requirements in subsection 3.7.

1.2. Operational Performance

1.2.1. By design, installation, and operation, a greywater subsurface irrigation system must not contaminate ground or surface waters, expose the public to untreated greywater or be a source of nuisance odors.

1.2.2. A greywater subsurface irrigation system may be used only during the growing season. The growing season may be extended with the use of a greenhouse so long as the plants irrigated within the greenhouse continue active growth.

1.2.3. A greywater subsurface irrigation system must not allow greywater to surface in any way, including through ponding or runoff. During system operation,

greywater must remain below the ground so that people and animals do not come into contact with it.

1.2.4. The irrigation rate may not be greater than the evapotranspiration rate of the irrigation field. Irrigation rates must not exceed the maximum allowable soil loading rates in Chapter 246-274-415 (3) WAC.

1.2.5. The system must be designed, installed and managed to provide to the greatest extent possible, even distribution and unsaturated subsurface flow. (Note: Systems that are consistent with these standards are expected to provide even distribution and unsaturated subsurface flow).

Experience from areas that have used greywater for subsurface irrigation such as Australia have, "shown that poorly developed greywater systems will saturate the soil, cause odors, blockages and become a burden (both financial and time) due to constant maintenance requirements." From the Code of Practice for the Reuse of Greywater in Western Australia (http://www.public.health.wa.gov.au/cproot/1340/2/COP%20Greywater%20Reuse%202010.pdf).

1.3. Treatment Product Listing

1.3.1. NSF International evaluates and lists proprietary treatment products for treating light greywater based upon the manufacturer demonstrating product conformance with requirements in NSF Standard for Wastewater Treatments Systems, On-site residential and commercial graywater treatment systems for subsurface discharge, NSF/ANSI 350-1.

1.3.2. A Tier three greywater subsurface irrigation system incorporating a proprietary treatment product to treat light greywater must be included on the current NSF list of products certified to meet NSF/ANSI Standard 350-1. Greywater treatment systems certified and listed for meeting Standard NSF/ANSI 350 are also acceptable because they meet and exceed the requirements of NSF/ANSI Standard 350-1.

1.3.3. The scope of NSF/ANSI 40 contains minimum requirements for residential wastewater treatment systems having single, design discharge points. Dark greywater has similar characteristics as "residential source" septic tank effluent, therefore, an irrigation system incorporating a proprietary treatment product to treat dark greywater must be included on the current NSF list of products certified to meet NSF/ANSI 40.

1.3.4. The use of screens and filters is considered pretreatment and not subject to treatment testing requirements. The design, use, and maintenance of screens and filters must meet product specifications including those for the pump(s) and distribution network, including the manufacturer's dripline requirements.

Actual performance for any site or system may vary, depending on variation in raw water supply (such as in alkalinity and hardness), greywater constituents and patterns of use. These standards are intended to address public health and environmental issues only. The long term sustainability of the irrigation of plants is the responsibility of the owner and design professionals.

2. Application Standards

2.1. Approved Systems and Products

2.1.1. For systems designed to use dark greywater, light greywater stored for longer than 24 hours, light greywater to be used to irrigate a green roof, or any greywater used in a public location such as a playground, school, church, or sports field, a treatment component meeting the requirements in subsection 1.3 is required.

2.1.2. For a system designed to use a tank or treatment device within the building footprint, the local health officer may permit the system once it leaves the building. The plumbing systems within a building must be permitted by the authority having jurisdiction for plumbing inside of a building. The design for the system outside of the building must be based on the characteristics of the greywater as determined by the designer of the greywater subsurface irrigation system.

2.1.3. The Washington State Department of Health does not approve or register greywater irrigation field components.

2.1.4. The irrigation field components must be designed to:

2.1.4.1. Handle greywater or sewage without clogging. Irrigation components designed for potable water will clog and become unusable.

2.1.4.2. The design must be able to provide even distribution throughout the irrigation field. Maximum length of each lateral must be in accordance with manufacturer's recommendations to insure equal distribution (maximum allowable flow variance between any two emitters in a distribution zone is 10%).

2.1.4.3. Be resistant to root intrusion.

Subsurface dripline products currently listed on Washington State's List of Registered On-site Treatment and Distribution Products have been reviewed for the criteria listed in subsection 2.1.4. Other irrigation field components may be permitted based on the discretion of the local health officer.

2.2. Permitting

2.2.1. Permitting and installation of greywater subsurface irrigation systems are subjected to the requirements in Chapter 246-274 WAC and local codes. An installation permit obtained from the local health officer is required prior to installing a Tier two or three greywater irrigation system. Check with the local

health jurisdiction for specific requirements. The Department of Health's web site has a list of each county along with where to learn more about their rule http://www.doh.wa.gov/ehp/ts/WW/greywater/greywater.htm.

2.2.2. Greywater subsurface irrigation systems may be used with new construction and existing dwellings. A plumbing permit is needed when internal household plumbing is modified to route any portion of the household greywater to the greywater irrigation system. See Chapter 51-56 WAC for more information.

2.2.3. Greywater irrigation system components may be located close to a building. Check with local codes to determine considerations related to building codes. For example, when the tank is located next to the building, the local building code may specify criteria when the tank is within a minimum distance.

2.2.4. Greywater subsurface irrigation systems, designed under Chapter 246-274 WAC, are limited to seasonal use to irrigate plants. The list of limitations included in Table 2 help keep greywater irrigation from impacting the neighbors and harming the environment. Greywater subsurface irrigation systems are not designed to be used as a year round wastewater system. An approved on-site sewage system or connection to an approved public sewer system is required. This includes when a greywater on-site sewage system is used in conjunction with buildings using waterless toilets.

A system used in a commercial setting or multi-family residence using Tier one criterion may be permitted or registered by the local health jurisdiction. The installation permit gives the local health jurisdiction the opportunity to review the design for consistency with the Tier one checklist.

2.3. Siting Conditions

2.3.1. Greywater subsurface irrigation systems are designed to irrigate gardens and landscapes. They may be located in sites that meet minimum requirements described in Chapter 246-274 WAC. Site conditions, suitable soil requirements, setbacks and other location requirements are the identified in Chapter 246-274 WAC.

2.3.2. The irrigation field must not be used on slopes greater than 30%.

2.3.3. Greywater subsurface irrigation systems regulated under Chapter 246-274 WAC may be designed to irrigate a greenhouse when the greywater is distributed evenly below the ground and the requirements in Chapter 246-274-415 WAC are met.

2.3.4. For a site that has a potable water irrigation system installed, a backflow preventer approved by the local health officer is required (http://www.doh.wa.gov/ehp/dw/Publications/lawn_irrigation.pdf). To ensure the required inspection is complete, prior to approving the greywater irrigation permit, include proof of the annual inspection of the backflow prevention assembly. The irrigation lines from a potable water system are considered, a "pressurized water supply line" and therefore the ten foot minimum setback applies. The local health officer may approve a greywater irrigation system

transport line within ten feet of a water supply line if the transport line is constructed in accordance with section C1-9 of the Department of Ecology's Criteria for Sewage Works Design (Orange Book).

2.4. Influent Characteristics

2.4.1. Greywater characteristics vary greatly and are dependent on building users to manage what goes does down the drain. Typical greywater characteristics are listed in Table 3. The design of the system must be commensurate with the influent characteristics, as defined by Chapter 246-274 WAC.

2.4.2. Warning signs must be visible at each fixture from which greywater is diverted at a nonresidential building. The signs must notify the employees and the public that water from the fixture is reused for subsurface irrigation of plants and that chemicals and other hazardous material may not be poured down the drain. This information will help to ensure the characteristics of the greywater remain at residential strength.

2.4.3. The diversion valve must be readily accessible and clearly labeled to allow the building user to control the direction of flow.

Table 3. Greywater Characteristics

Parameter	Unit	Dark[1] Greywater (range)	Dark[1] Greywater (mean)	Light[2] Greywater (range)	Light[2] Greywater (mean)
pH	Units	6.6-8.7	7.5		
Conductivity	mS/cm	325-1140	600		
Sodium	mg/L	29-230	70		
Total alkalinity	mg/L	125-382	158		
Total suspended solids	mg/L	45-330	115	7-200	35
Turbidity	NTU	22->200	100		
BOD5	mg/L	90-290	160	26-130	65
Nitrate	mg/L	<0.1-0.8	0.3		
Ammonia	mg/L	<1.0-25.4	5.3		
Total phosphorus	mg/L	0.6-27.3	8		
Fecal coliform	CFU/100 mL	104-106	105	10-105	

[1]Dark Greywater Characteristics Adapted from Canadian Guidelines for Household Reclaimed Water for Use in Toilet and Urinal Flushing, 2010

[2]Light Greywater Characteristics Adapted from Ottoson and Stenstrom, 2003, Eriksson, 2003, Howard, 2005, Crook, et al., 2009

2.5. Installation

2.5.1. Before beginning the construction of a Tier two or Tier three greywater subsurface irrigation systems, a person proposing the installation of the system shall provide information to, and obtain a permit to install from, the local health officer. The information provided must include the required items listed in Chapter 246-274-425 WAC.

2.5.2. Only on-site system installers approved by the local health jurisdiction may install greywater irrigation systems. The installer must obtain specific training in greywater

irrigation systems installation prior to offering to install greywater irrigation systems. Installation instructions and recommendations vary from one manufacturer to another. Installation knowledge and skill may be product specific. Installers are responsible for obtaining proper training before attempting to install greywater irrigation systems.

Training about installation of greywater subsurface irrigation systems may be obtained from the manufacturer, distributor, experienced practitioners, or the Northwest On-site Wastewater Training Center.

2.5.3. The local health officer may allow the resident owner of a single-family residence, not adjacent to a marine shoreline, to install the system for his or her residence when the system reuses no more than three hundred gallons per day of greywater.

2.6. Testing / Inspection

2.6.1. Greywater irrigation system must be inspected for labeling, water tightness, and be tested to ensure proper operation of the system including pumps, alarms, pressure and flow, and as specified by the manufacturer.

2.6.2. For system components installed above the ground, a visual evaluation shall be performed during inspection for signs of any leakage. Above-ground tanks must be filled with water to the overflow line prior to and during inspection. All seams and joints must be left exposed and the tank must remain watertight.

3. Design Standards

3.1. Designer Qualifications

3.1.1. Tier two and Tier three greywater subsurface irrigation systems must be designed by an on-site sewage treatment system designer licensed under Chapter 18.210 RCW or a professional engineer licensed under Chapter 18.43 RCW who is knowledgeable in irrigation system design.

3.1.2. The local health officer may allow a resident owner of a single-family residence, not adjacent to a marine shoreline, to design a system for his or her residence when the system reuses no more than three hundred gallons per day of greywater.

Greywater irrigation systems are subsurface irrigation systems that use only greywater as their source. The ideal designer will have knowledge in both on-site sewage system designs and irrigation system design. Very few people have both skill sets. One option is for the licensed designer or engineer to design the system components and subcontract with an irrigation specialist to design the irrigation field.

3.2. Submittal

At a minimum the site characterization and information provided must include descriptions of the following:

3.2.1. A map of the property that includes the topography, slope, landscape, location of the proposed system components, property lines, impermeable surfaces,

underground utilities, surface water, wells and abandoned wells, restrictive layers, the on-site system and reserve area, if serviced by an on-site sewage system.

3.2.2. A description of the soil types for the top 36 inches of the proposed landscape or garden area. If soil augmentation will be used, include a description of the soil to be used for augmentation.

3.2.3. A description of the proposed system including a characterization of the greywater, proposed communication methods to let users know the greywater goes directly to the landscape, the design and factors used for the required equation from Section 3.7 Components / Sizing.

3.2.4. For greywater subsurface irrigation systems conveying greywater from a nonresidential source, documentation must be provided that shows the greywater consists only of domestic type flows and does not include any other type flows. The designer must show how chemicals and other hazardous materials will be kept out of the greywater.

3.3. Greywater Characterization

Greywater contains chemicals and pathogens that need to be taken into account when designing a greywater water subsurface irrigation system. Greywater can contain solid particles that will clog pipes, pathogens that can make people sick, and chemicals that can cause odors and harm plants. It is important to design the system based on the influent characteristics of the greywater from the proposed sources, taking into account the source, such as a family residence vs. a commercial building. To learn more about the constituents and characteristics of greywater, go to http://www.doh.wa.gov/ehp/ts/WW/greywater/WWGWTechIsu.pdf.

3.4. Site Characterization

The soil and site characterization must be consistent with Chapter 246-274-420 WAC.

3.5. Materials

3.5.1. Manufacturers of greywater irrigation system components must warrantee their products to be suitable for greywater.

3.5.2. The system, including all joints, seams, and components, must be water-tight.

3.5.3. Diversion valves located outside buildings must meet the requirements of NSF/ANSI 50 and be easily accessible.

3.5.4. Tanks must be constructed of solid, durable materials not subject to excessive corrosion or decay and must be watertight. Steel or wood tanks are not allowed. Acceptable materials include:

3.5.4.1. Concrete for cast-in-place tanks; and

3.5.4.2. Concrete, fiberglass, polyethylene or other solid, durable, watertight material that does not corrode or decay for prefabricated tanks.

3.5.5. The use of a tank that is listed by the department according to Chapter 246-272C WAC reduces the need for local review of structural integrity. Tanks that are 500 gallons or larger should be included on the most current list.

3.5.6. All tanks must have proper ventilation.

3.5.7. All tanks must have an overflow drain that is designed with an accessible check valve to protect the tank against sewer line backflow.

3.5.8. Above-ground tanks must be installed on a level, stable footing. Check with the local building codes for specifications for above ground tank footings.

3.5.9. Piping materials must meet the following minimum specification:

3.5.9.1. At a minimum, the material must meet ASTM D2241 Class 160 or equivalent.

3.5.9.2. For schedule 40 and schedule 80 PVC, use ASTM D1785.

3.5.9.3. All subsurface drip irrigation supply lines must be consistent with the piping material requirements in the RS&G for Subsurface Drip Systems.

3.5.10. The above-ground pipes and tanks must be labeled with the words: "CAUTION: NONPOTABLE WATER, DO NOT DRINK."

3.5.11. The capacity and disk or mesh size of the filter, along with all other components, including control valves, air-vacuum relief valves, and controllers must meet specifications of the manufacturer.

3.5.12. The manufacturer must warrant filters for use with wastewater (resistant to corrosion).

3.5.13. Filter backwash must be included in calculating the maximum discharge rate (where applicable) and the backwash must flow to the approved wastewater system.

3.6. Design Flow

3.6.1. Greywater volume will vary according to the daily habits of the people that use the building and the flow from the fixtures.

3.6.2. If accurate flows are not known for each fixture, use the volumes from Table 4 multiplied by the number of people using the fixtures.

Table 4 Estimate of Flows by Fixture

Fixture	Greywater Volume Gallons per person per day
Laundry - water conserving washing machine	8
Laundry - traditional washing machine	11
Laundry – sink	3
Bathroom - water conserving sink (lavatory basin)	5.4
Bathroom - water conserving shower	10
Bathroom - traditional sink (lavatory basin)	6
Bathroom - traditional shower	17
Bathroom – bathtub	24 – per bath
Kitchen – sink	6
Kitchen – dishwasher	1

Because a Tier two and three greywater system is designed so that excess greywater returns and/or drains to the wastewater system, it is better to design a smaller system that will receive the anticipated volume rather than a larger system that might not receive the amount anticipated.

3.7. Components / Sizing

3.7.1. The following equation is used to determine the size of the irrigation field:

$$\text{Irrigation area (square feet)} = \frac{\text{Greywater volume (gallons per week)}}{\text{Evapotranspiration} \times \text{Plant Factor} \times 0.62}$$

Where:

Evapotranspiration (ET) = The monthly average of May through September ET rates in inches divided by four – this gives a weekly average, Appendix A includes weekly ET rates for most areas in Washington State.

Plant Factor = 0 to 0.3 for low water use plants;
0.4 to 0.6 for average water use plants;
0.7 to 1.0 for high water use plants;

NOTE: Appendix A includes a table with plant factors by type of plant

Conversation Factor = 0.62 (from inches of ET to gallons per week)

3.7.2. To maximize the potential for water savings and ensure the available water stays within the acceptable range, use the most accurate input variables available for each site. Tables that list the average weekly ET rates and plant factors are provided in Appendix A. However, a designer may use more current and accurate site-specific information, if available. Evaporation is a large factor in the equation. To maximize water conservation, controlling factors that can increase

evaporation is important. Factors include wind, sun exposure, effectiveness of mulch, and planting density.

The size of the irrigation field may be limited by the amount of greywater generated on-site or the land area available. Keep in mind some greywater may be needed to back flush filters and that when excess greywater is generated, the flow returns unused to the acceptable sewerage system. To protect the potable water source, do not plumb potable water into the greywater irrigation system.

3.7.3. Irrigation rate must not exceed the maximum allowable soil loading rate in Table 5 based on the finest textured soil in the lower twenty-four inches of suitable soil. The soil loading rate in Table 5 may be increased up to a factor of 2 for soil types 1-4 and up to a factor of 1.5 for soil types 5 and 6 when a treatment component that meets the requirements of subsection 1.3 is used.

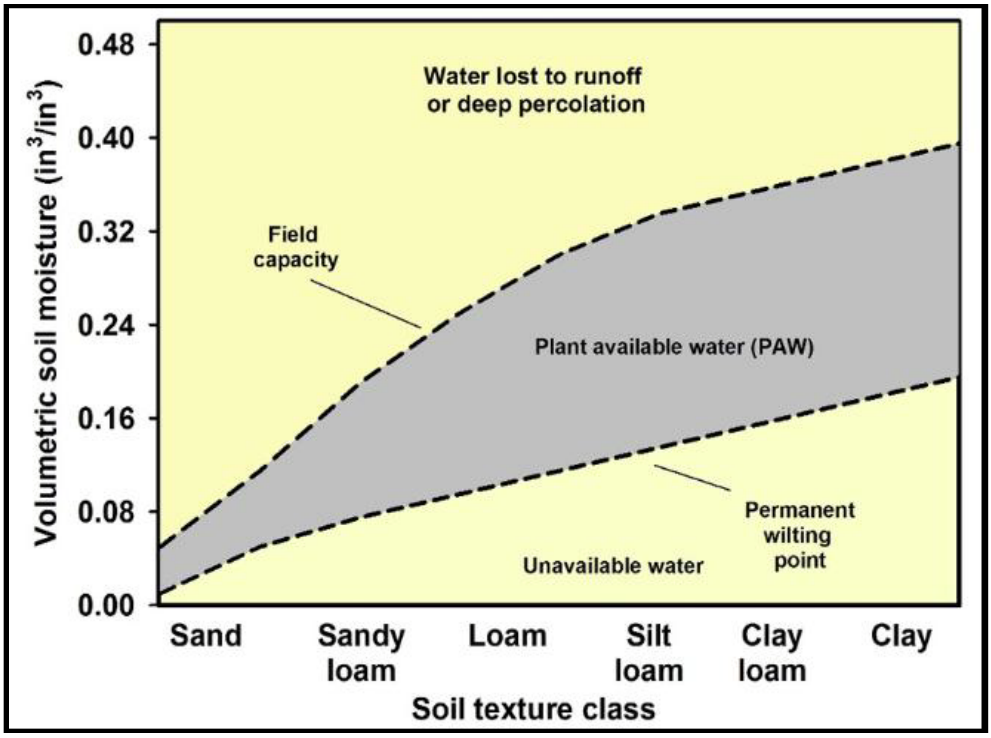
Table 5. Soil Type Description and Maximum Hydraulic Loading Rate

Soil Type	Soil Textural Classification Description	Loading Rate for Greywater gal./sq. ft./day
1	Gravelly and very gravelly coarse sands, all extremely gravelly soils excluding soil types 5 and 6, all soil types with greater than or equal to 90% rock fragments.	Not suitable without augmentation 1.0 with augmentation
2	Coarse sands.	Not suitable without augmentation 1.0 with augmentation
3	Medium sands, loamy coarse sands, loamy medium sands.	0.8
4	Fine sands, loamy fine sands, sandy loams, loams.	0.6
5	Very fine sands, loamy very fine sands; or silt loams, sandy clay loams, clay loams, and silty clay loams with a moderate structure or strong structure (excluding a platy structure).	0.4
6	Other silt loams, sandy clay loams, clay loams, silty clay loams.	0.2

3.7.4. One of the most important applications for ET rates is irrigation scheduling. While ET based irrigation scheduling has shown to save water, it is based on many assumptions to give an approximation of the actual water requirements of the plants. Micro climates and highly varying soil conditions introduce error in ET calculations which in turn will increase error in the scheduling. The ultimate goal for an irrigation schedule is to keep the soil moisture level that is best for plants. With almost any plant, the soil moisture needs to be maintained at the

available water, which is between its field capacity and permanent wilting point. Figure 2 shows the range of plant available water based on soil texture.

Figure 2. Plant Available Water vs. Soil Texture Showing Estimates of Field Capacity, Permanent Wilting Point.

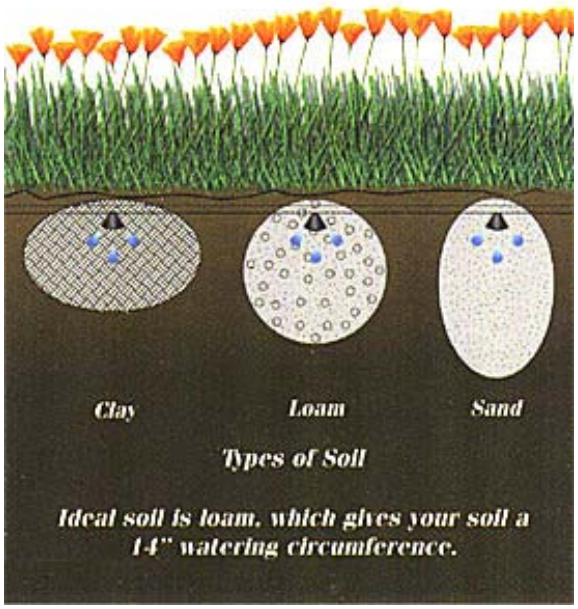


3.7.5. The use of automated systems used to adjust the irrigation rates to ensure the available water stays within the acceptable range is preferred. In precision irrigation, the most accurate irrigation schedule use regional ET forecasts in combination with soil moisture sensors to ensure that the soil moisture values stay at a level that is best for the plants.

3.7.6. Soil type also affects the capillary action within the soil, depicted in Figure 3. It is important to adjust the distance between driplines to ensure even distribution. Soils with a higher percentage of clay content will provide better capillary action to distribute the greywater further. Soils with a high sand content require driplines be placed closer together. Consult manufacturer specifications for specific distances.

3.7.7. To accommodate plants with different water needs, use more than one hydrozone to adjust for the variation.

Figure 3. Water Patterns by Soil Type



3.8. Layout / Configuration

3.8.1. Configuration of a Tier two greywater system should be designed to maximize irrigation efficiency, ensure access for maintenance, and minimize greywater storage time. Options include:

3.8.1.1. Tank to gravity distribution, with or without a pump, when the system uses less than 60 gpd - laundry to landscape systems for example. Note that while it is possible to spread 60 gpd "evenly" using gravity, the uneven water use throughout the day results in a less efficient method for distributing greywater throughout the irrigation field.

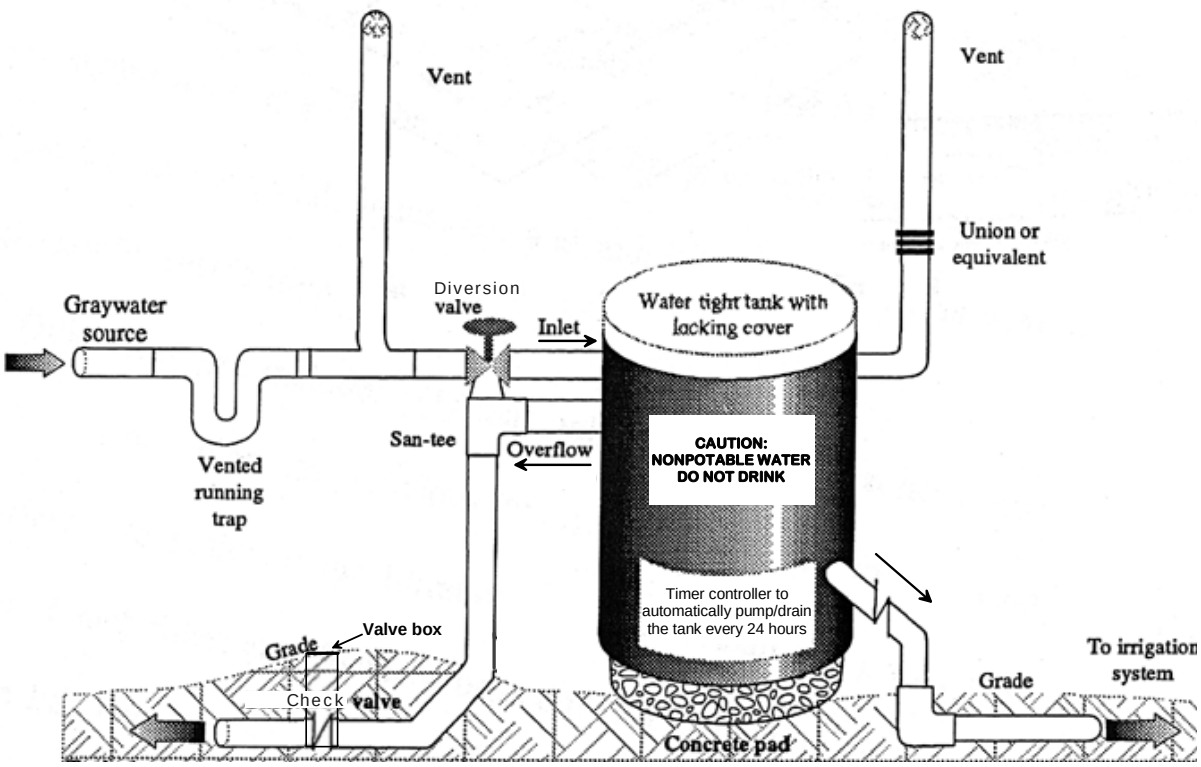
3.8.1.2. Simple system that include a small tank, pump, short storage time, pressurized distribution lines, and features that make it easy to maintain.

3.8.1.3. Larger system typically used by a commercial facility that incorporate controls and sensors used to apply greywater at a variety of rates so that greywater reuse is optimized during months with the highest ET rates and ensure greywater is not used during wet soil conditions. These systems require on-going maintenance and do best when a maintenance manager is frequently on-site. For these systems, follow the manufacturer's recommendations for design specifications. The RS&G for Subsurface Drip Systems provides design standards for these types of systems.

3.8.2. Configuration of a Tier three system must be designed to meet the requirements of the manufacturer or applicable RS&G and include features that maximize irrigation efficiency and ease of maintaining the system.

3.8.3. In all cases the system must be designed with a drain and an overflow pipe that flows to the approved wastewater system. The overflow pipe must be the same size as the inflow pipe. In most cases this is done by gravity. However, if a system is designed so that gravity over-flow is not an option, a pumped system may be permitted at the discretion of the local health officer. If the design uses a pump to empty the tank, an alarm and redundant pump mechanism should be used to ensure the tank can be emptied and excess greywater flows to the approved wastewater system.

Figure 4. Example of Tier Two and Three Greywater Pump Tank (above-ground)



3.8.4. A Tier two system must be designed with a timer controller to empty the tank once every twenty four hours.

3.8.5. A check valve to prevent backflow from the sewer or septic tank must be used.

3.8.6. The system must be properly vented through a minimum of one vent pipe.

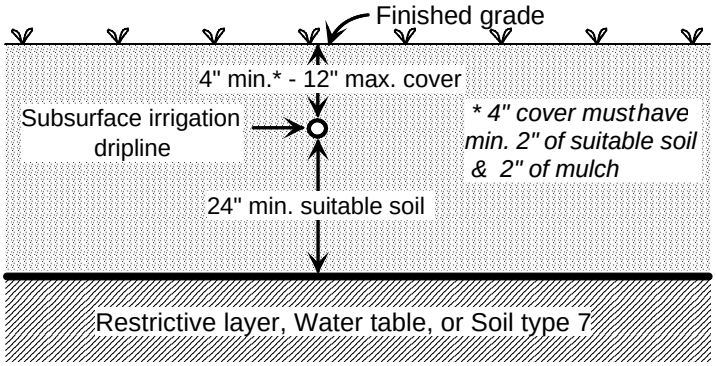
3.8.7. Irrigation field:

3.8.7.1. Must have a minimum of twenty-four inches of suitable soil between the subsurface irrigation components of the greywater irrigation system and any restrictive layer or the highest water table during the growing season.

3.8.7.2. Must be installed as level as possible and parallel to contours on sloped sites.

3.8.7.3. The subsurface irrigation components of the greywater irrigation system must be installed a minimum of four inches deep and no deeper than twelve inches below the finished grade. The four-inch cover layer must consist of two inches of suitable soil and two inches of mulch.

Figure 5. Cross Sectional View of Irrigation Field



3.8.7.4. Refer to subsurface irrigation dripline manufacturer's recommendations to determine emitter and line spacing based on soil type.

3.8.7.5. If the original soil is augmented, the mixture used for augmentation must meet the following criteria to ensure that suitable soil is used:

3.8.7.5.1. The mixture must have an organic content that is at least five percent to support plant life and increase soil structure, and no greater than ten percent to prevent excessive decomposition.

3.8.7.5.2. The mixture must be a well blended mix of mineral aggregate (soil) and compost where the soil ratio depends on the requirements for the plant species. However, a volumetric ratio of compost and aggregate of 40/60 is recommended to provide an optimum growth media to support long-term plant and soil health and water quality treatment capability.

3.8.7.5.3. The mineral aggregate must have the following gradation:

Sieve Size	Percent Passing
3/8	100
No. 4	95 - 100
No. 10	75 - 90
No. 40	25 - 40
No. 100	4 - 10
No. 200	2 - 5

NOTE: For systems larger than 300 gpd, a lab analysis or soil specification sheet should be included in the design application.

3.8.7.6. If native soil is augmented, the additional soil must be mixed with the native soil a minimum of four inches.

3.8.7.7. The mulch provides protection from soil erosion, reduces evaporation, discourages weeds, and provides organic matter. Bark mulch is not recommended because it is low in nutrients, repels water, and could have dye added to it.

3.8.7.8. To keep plants healthy and alive, consideration of the water needs and salt tolerance of plants to be irrigated is important. To learn more about healthy soil read http://www.soilsforsalmon.org/pdf/Soil_BMP_Manual.pdf. To learn more about salt loading from greywater and salt tolerant plants read http://www.waterforlife.nsw.gov.au/__data/assets/pdf_file/0003/14619/Greywater_Factsheet_4_Keeping_Plants.pdf.

The intent of the soil requirements is to provide an environment that is fertile for plants, has good soil structure and pore space, and encourages microbial growth. Soils used for stormwater facilities and rain gardens are blended to meet these requirements. A receipt showing a rain garden mix or stormwater blend would meet the requirements. To learn more about how a healthy soil can help the environment, increase the health of plants, and help to treat pollutants, read http://www.ieca.org/chapter/pacificnorthwest/soilshandout.pdf.

3.9. Operation and Maintenance

Design of the greywater subsurface irrigation system must facilitate access and be commensurate with the building type. For example, a homeowner will not want to conduct O&M weekly, but a commercial facility staff person may.

3.9.1. The system must be designed to allow easy access for operation and maintenance.

3.9.2. A user's manual that describes the system components, design including irrigation requirements, and includes instructions for operation and maintenance procedures must be provided to the building owner.

3.9.3. The system must be designed to be drained by gravity or pump for winterization. Instructions for how to winterize must be included in the operation and maintenance manual.

3.10. Installation

Design of the greywater subsurface irrigation system must include specific installation instructions including the following:

3.10.1. Material Specifications.

3.10.2. Pre-Construction issues such as responsibilities for permits, locating site utilities, protection of drip field area during construction, authorization for changes, etc.

3.10.3. Construction Methods: include detailed instructions for site/soil preparation and installation.

3.10.4. Component Testing: Identify components to be tested and methods to be used, etc.

3.10.5. Final Grading/Landscaping Requirements.

3.10.6. Documentation such as providing manufacturer cut sheets for electrical and mechanical components, as-built or record drawing, etc.

4. Installation

4.1. Installation Requirements

4.1.1. The installer shall:

4.1.2. Follow the approved design.

4.1.3. Have the approved design in possession during installation.

4.1.4. Make no changes to the approved design without the prior authorization of the person who designed the system and, if a permit is required, the local health officer.

4.1.5. Be on the site at all times during the excavation and construction of the system.

5. Operation and Maintenance Standards

The systems must be monitored and maintained as specified by the owner's manual.

5.1. Designers and Manufacturers

Designers and manufacturers must:

5.1.1. Provide a limited warranty for greywater irrigation system products and components.

5.1.2. Assure ongoing availability for repair parts.

5.1.3. Provide an owner's manual that includes contact information for the designer and installer, a description and as-built record of the system's design, a list of the components, a trouble shooting guide, the recommended maintenance tasks and frequencies for the following components:

5.1.3.1. Vacuum breakers, valves, pressure verification, alarms, and controls including start-up steps for first time use and annually thereafter;

5.1.3.2. Flushing and blowout including winter preparation steps;

5.1.3.3. Filters; and

5.1.3.4. Other information as needed.

5.2. Owners

Owners must be responsible for the proper operation and maintenance of the greywater irrigation system by:

5.2.1. Ensuring that the greywater flows to the approved wastewater system except when needed for irrigation.

5.2.2. Switch the diversion valve to the approved wastewater system when raining. Additional water increases the chance of runoff from the property.

5.2.3. Selecting detergents (to learn more go to http://www.lanfaxlabs.com.au/), soaps, and shampoos that are garden friendly.

5.2.4. Routinely check the irrigation system to ensure it is working correctly.

5.2.5. Monitoring the irrigation area for ponding, the plants for response to salt and water quantity, and mulch layer for appropriate cover. Conducting an annual soil analysis will provide important information to help keep the plants healthy.

5.2.6. Retaining the owner's manual and maintaining adequate records of repair and maintenance activities.

5.2.7. Providing on-going maintenance as specified in the owner's manual.

5.2.8. Complying with local maintenance and inspection reporting requirements if applicable.

5.2.9. Include the greywater irrigation system on the seller's disclosure form found in Chapter 64.06.020 RCW.

Appendix A – Tables of Evapotranspiration (ET) Rates and Plant Factors

Table 6. Western Washington Monthly Average Reference Evapotranspiration

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Aberdeen	0.11	0.56	1.37	2.19	3.22	3.51	3.91	3.10	2.47	1.46	0.36	0.04	22.30
Anacortes	0.25	0.69	1.56	2.84	4.10	4.64	5.46	4.33	3.06	1.44	0.41	0.12	28.90
Battle Ground	0.11	0.72	1.60	2.99	4.47	5.04	6.16	5.15	3.56	1.64	0.47	0.07	31.98
Bellingham	0.10	0.60	1.41	2.66	3.97	4.60	5.49	4.36	2.97	1.33	0.32	0.00	27.82
Blaine	0.06	0.57	1.41	2.68	4.00	4.63	5.47	4.31	2.93	1.29	0.29	0.00	27.64
Bremerton	0.12	0.69	1.58	3.05	4.63	5.16	6.29	5.26	3.56	1.63	0.42	0.04	32.43
Buckley	0.05	0.55	1.25	2.75	4.02	4.74	5.91	4.57	3.60	1.48	0.27	0.00	29.19
Centralia	0.11	0.61	1.34	2.90	4.19	4.91	6.11	4.73	3.79	1.61	0.35	0.00	30.65
Clearbrook	0.03	0.53	1.44	2.74	4.06	4.65	5.54	4.36	2.99	1.32	0.28	0.00	27.94
Concrete	0.00	0.34	1.14	2.31	4.10	4.75	6.63	5.32	4.38	1.58	0.22	0.00	30.78
Coupeville	0.20	0.65	1.48	2.67	3.90	4.45	5.27	4.23	2.94	1.32	0.36	0.07	27.55
Elma	0.07	0.55	1.38	2.24	3.40	3.73	4.20	3.34	2.54	1.44	0.33	0.01	23.24
Everett	0.20	0.66	1.50	2.74	4.03	4.66	5.54	4.41	3.04	1.39	0.38	0.08	28.63
Grapeview	0.13	0.72	1.61	3.07	4.67	5.19	6.31	5.27	3.54	1.61	0.46	0.08	32.67
Grayland	0.18	0.62	1.40	2.13	3.09	3.34	3.65	2.88	2.33	1.43	0.40	0.08	21.54
Grays River	0.11	0.55	1.36	2.09	3.15	3.48	3.94	3.12	2.41	1.38	0.34	0.02	21.96
Hoquiam	0.16	0.60	1.41	2.17	3.21	3.48	3.87	3.09	2.48	1.48	0.39	0.06	22.42
Long Beach	0.19	0.62	1.45	2.11	3.07	3.33	2.67	2.90	2.31	1.38	0.41	0.10	21.55
Longview	0.13	0.71	1.64	3.07	4.56	5.07	6.24	5.23	3.63	1.70	0.48	0.09	32.56
Monroe	0.20	0.68	1.53	2.82	4.15	4.78	5.67	4.54	3.16	1.45	0.39	0.07	29.44
Mount Vernon	0.20	0.67	1.53	2.72	4.01	4.58	5.42	4.33	2.97	1.36	0.36	0.06	28.21
Oakville	0.05	0.52	1.35	2.18	3.30	3.68	4.18	3.31	2.47	1.37	0.31	0.00	22.72
Olga	0.20	0.64	1.50	2.74	3.93	4.42	5.20	4.12	2.91	1.37	0.38	0.09	27.49
Olympia	0.20	0.53	1.19	2.64	3.92	4.71	5.89	4.55	3.56	1.44	0.26	0.00	28.71
Packwood	0.00	0.30	1.02	2.08	3.78	4.58	6.49	5.20	4.19	1.47	0.16	0.00	29.28
Port Angles	0.21	0.64	1.43	2.58	3.79	4.32	5.12	4.08	2.93	1.33	0.37	0.08	26.89
Puyallup	0.09	0.59	1.30	2.84	4.14	4.88	6.04	4.64	3.66	1.54	0.30	0.00	30.02
Quilcene	0.00	0.61	1.51	3.00	4.56	5.12	6.28	5.16	3.45	1.50	0.34	0.00	31.52
Raymond	0.11	0.50	1.41	2.16	3.16	3.47	3.86	3.11	2.32	1.34	0.30	0.00	21.74
Seattle-Tacoma	0.13	0.73	1.60	3.03	4.61	5.20	6.39	5.28	3.56	1.63	0.45	0.07	32.67
Sedro Wolley	0.18	0.64	1.54	2.83	4.11	4.66	5.51	4.39	3.06	1.41	0.36	0.06	28.75
Sequim	0.19	0.61	1.43	2.63	3.88	4.44	5.27	4.23	2.97	1.34	0.34	0.06	27.41
Shelton	0.1	0.69	1.57	3.03	4.63	5.21	6.36	5.28	3.54	1.58	0.42	0.05	32.46
Snoqualmie Falls	0.09	0.66	1.54	2.99	4.50	5.01	6.17	5.09	3.37	1.53	0.39	0.03	31.36
Tacoma	0.18	0.78	1.67	3.15	4.72	5.26	6.43	5.34	3.63	1.69	0.50	0.11	33.45
Toledo	0.08	0.61	1.31	2.74	4.01	4.74	5.93	4.63	3.69	1.57	0.32	0.00	29.62
Vancouver	0.09	0.61	1.40	2.96	4.21	4.97	6.22	4.84	3.88	1.69	0.39	0.00	31.26

(From Washington State University State of Washington Irrigation Guide, Appendix B)

Table 7. Eastern Washington Monthly Average Reference Evapotranspiration

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Chamokane	0.26	0.68	1.73	3.22	5.35	6.41	8.36	6.85	4.15	1.62	0.44	0.20	39.26
George	0.43	1.08	2.68	4.39	6.68	8.15	9.59	7.79	5.03	2.60	0.93	0.38	49.71
Goldendale	0.44	1.04	2.49	4.06	6.41	8.25	10.26	8.76	5.55	2.65	0.80	0.41	51.1
Harrah	0.56	1.22	3.00	4.73	6.99	8.56	9.81	8.10	5.52	2.91	1.08	0.45	52.93
Legrow	0.73	1.30	3.07	4.91	7.16	8.71	9.98	8.52	5.47	2.87	1.14	0.59	54.44
Lind	0.47	1.10	2.74	4.42	6.57	8.04	9.81	8.36	5.50	2.96	0.94	0.38	51.28
Manson	0.23	0.75	2.14	4.01	6.13	7.63	9.18	7.33	4.21	1.83	0.43	0.17	44.05
Odessa	0.42	1.06	2.72	4.47	6.66	8.30	10.45	9.20	6.01	3.15	0.93	0.39	53.76
Omak	0.30	0.81	2.29	4.07	6.06	7.38	9.07	7.34	4.65	2.14	0.59	0.26	44.96

(From AgriMet, The Pacific Northwest Cooperative Agricultural Weather Network)

Table 8. Plant Factors for Various Plant Types (unitless)

Plant	Plant Factor
Ground covers, flower beds, evergreen, some perennials, small shrubs (under 4 feet tall), vines	1.0
Apples, cherries	0.85
Mature shade trees (broadleaved trees), lawns	0.80
Plums, pears, peaches, apricots	0.75
Native plants in semi-arid areas, some ornamental plants, large shrubs (over 4 feet tall)	0.70
Established low-water use native or other low water use plants	0.40

Appendix B - Definitions

"**Backflow preventer**" means a device or means to prevent backflow into the potable water system.

"**Building sewer**" means that part of the horizontal piping of a drainage system extending from the building drain, which collects sewage from all the drainage pipes inside a building, to an on-site sewage system. It begins two feet outside the building wall and conveys sewage from the building drain to the remaining portions of the on-site sewage system.

"**Diversion valve**" means a valve that diverts greywater from a building's drainage system before it enters the sewer or the subsurface irrigation system.

"**Licensed On-site Sewage System Designer**" means a person who matches site and soil characteristics with appropriate on-site sewage technology. Throughout this chapter this term applies to both on-site sewage treatment system designers licensed under RCW 18.210 and professional engineers licensed under RCW 18.43.

"**Evapotranspiration rate**" means the sum total of plant transpiration, evaporation off of the soil surface, and water used for plant growth.

"**Failure**" means a condition of a greywater system or component that threatens the public health by creating a potential for contact between greywater and the public. Examples of failure include:

(a) Greywater on the surface of the ground;

(b) Greywater leaking from a storage tank;

(c) Inadequately treated greywater reaching ground water or surface water;

(d) Noncompliance with the installation permit; or

(e) Other noncompliance with the requirements of this chapter, as determined by the local health officer.

"**Field capacity**" means the amount of water that can be held in soil before gravity will begin to drain the soil.

"**Fecal coliform**" means bacteria common to the digestive systems of warm-blooded animals that are cultured in standard tests. Counts of these organisms are typically used to indicate potential contamination from sewage or to describe a level of needed disinfection. Generally expressed as colonies per 100 ml.

"**Green roof**" means a roof of a building that is partially or completely covered with soil and vegetation.

"**Greenhouse**" means structures used to grow plants that utilize greywater for subsurface irrigation when the greywater is distributed evenly below the ground and the requirements in WAC 246-274-415 are met. This may include a temporary structure that has the sides and roof covered with polyethylene, polyvinyl, or similar flexible synthetic material and is used to provide plants with either frost protection or increased heat retention.

"**Greywater**" means domestic type flows from bathtubs, showers, bathroom sinks, washing machines, dishwashers, and kitchen or utility sinks. Greywater does not include flow from a toilet or urinal.

(a) "Light greywater" means flows from bathtubs, showers, bathroom sinks, washing machines, and laundry-utility sinks.

(b) "Dark greywater" means flows from dishwashers, kitchen and nonlaundry utility sinks alone or in combination with light greywater.

"**Greywater irrigation system**" or "**system**" means an integrated system of components located on the property it serves, or on nearby property where it is legally allowed to be used, that conveys greywater from the residence or other building where it originates and provides subsurface irrigation of plants during the growing season.

"**Growing season**" means the period of time between the last frost of spring and the first frost of autumn, when annual plants die and biennials and perennials cease active growth and become dormant. The growing season may be extended with the use of a greenhouse so long as the plants irrigated within the greenhouse continue active growth.

"**Hydrozone**" means the practice of grouping plants that have similar water requirements.

"**Installer**" means a person approved by the local health officer to install on-site sewage systems or components.

"Irrigation Efficiency" means amount of water that needs to be applied in addition to the plant requirements for a particular type of irrigation system to meet the component system losses. It is expressed as the ratio of water used beneficially by the plants to the volume delivered for use.

"**Large on-site sewage system**" means an on-site sewage system with design flows of between three thousand five hundred gallons per day and one hundred thousand gallons per day.

"**Local board of health**" means a board created under RCW 70.05, 70.08, or 70.46.

"**Local health officer**" means the person appointed under RCW 70.05 as the health officer for the local health department, or appointed under RCW 70.08 as the director of public health of a combined city-county health department, or a representative authorized by and under the direct supervision of the local health officer.

"**Maintenance**" means the actions necessary to keep the on-site sewage system components functioning as designed.

"**Mulch**" means a protective covering for establishing a vegetative landscape that is spread or left on the ground to reduce evaporation, maintain even soil temperature, reduce erosion, control weeds, or enrich the soil.

"**Monitoring**" means periodic or continuous checking of an on-site sewage system, which is performed by observations and measurements, to determine if the system is functioning as intended and if system maintenance is needed. Monitoring also includes maintaining accurate records that document monitoring activities.

"**Nonresidential building**" means a building that is used for commercial or other nonresidential purposes.

"**On-site sewage system**" (OSS) means an integrated system of components, located on or nearby the property it serves, that conveys, stores, treats, and/or provides subsurface soil treatment and dispersal of sewage. It consists of a collection system, a treatment component or treatment sequence, and a soil dispersal component. An on-site sewage system also refers to a holding tank sewage system or other system that does not have a soil dispersal component.

"**Plant factor**" means a number which represents the approximate portion of evapotranspiration used by a plant species.

"**Permanent wilting point**" means a condition where the soil moisture is at low level where a plant cannot uptake any water.

"**Plant available water (PAW)**" means the amount of water that a soil can store that is available for use by plants in their root zone. This is varies based on the soil type and plant root depth.

"**Pressure distribution**" means a system of small diameter pipes equally distributing greywater.

"**Professional engineer**" means a person who is currently licensed as an engineer under the provisions of RCW 18.43.

"**Proprietary treatment product**" means a greywater treatment technology, method, or material, subject to a patent or trademark that functions to treat greywater generated by residential or nonresidential buildings.

"**Public domain technology**" means a sewage treatment and distribution technology, method, or material not subject to a patent or trademark.

"**Public sewer system**" means all facilities used in the collection, transmission, storage, treatment, or discharge of any waterborne waste, whether domestic in origin or a combination of domestic, commercial, or industrial wastewater. A public sewer system may also be known as a sanitary sewer system.

"**Qualified professional**" means an on-site sewage treatment system designer licensed under RCW 18.210 or a professional engineer licensed under RCW 18.43 who is knowledgeable in irrigation system design.

"**Residential building**" means a building used as a residence including single-family residences and multi-family residences.

"**Residential sewage**" means sewage having the constituency and strength typical of wastewater from domestic households.

"**Restrictive layer**" means a stratum impeding the vertical movement of water, air, and growth of plant roots, such as hardpan, claypan, fragipan, caliche, some compacted soils, bedrock and unstructured clay soils.

"**Sewage**" means any urine, feces, and the water carrying human wastes, including kitchen, bath, and laundry wastes from residences, buildings, industrial establishments or other places.

"**Single-family residence**" means one single-family house that is not used for commercial or other nonresidential purposes.

"**Soil type**" means one of seven numerical classifications of fine earth particles and rock fragments as described in WAC 246-272A-0220 (2)(e).

"Subsurface drip system" (SDI) means a pressurized wastewater distribution system that can deliver small, precise doses of effluent to soil surrounding the dripline.

"**Subsurface irrigation**" means applying greywater below the surface of the ground directly into the plant root zone.

"**Suitable soil**" means unsaturated soil above the seasonally high water table and any restrictive layer in which the movement of water, air, and growth of roots is sustained to support healthy plant life and conserve moisture.

"**Tier one greywater irrigation system**" means a light greywater subsurface irrigation system with maximum design flows of sixty gallons per day serving a single-family residence. A Tier one system serves a single-family residence connected to an approved public sewer system or on-site sewage system.

"**Tier two greywater irrigation system**" means a light greywater subsurface irrigation system serving a residential or nonresidential building. A Tier two system only serves a building connected to an approved public sewer system or large on-site sewage system, except as provided in WAC 246-274-200 (1)(e).

"**Tier three greywater irrigation system**" means a light or dark greywater subsurface irrigation system serving a residential or nonresidential building and using a treatment component. A Tier three system only serves a building connected to an approved public sewer system or large on-site sewage system, except as provided in WAC 246-274-300 (3)(e).

"**Treatment component**" means a technology that treats greywater according to WAC 246-274-400 in preparation for subsurface irrigation of plants.

"**Vector**" means an animal including, but not limited to, an insect, a rodent, or a bird, which is capable of transmitting an infectious disease from one organism to another.

Appendix C – Useful Links

- **Rules and Regulations Referred to in this Document**
  - Chapter 246-274 WAC - Greywater Reuse for Subsurface Irrigation
    http://apps.leg.wa.gov/wac/default.aspx?cite=246-274
  - Chapter 246-272A WAC – On-site Sewage Systems
    http://apps.leg.wa.gov/wac/default.aspx?cite=246-272A
  - Chapter 246-272B WAC – Large On-site Sewage Systems
    http://apps.leg.wa.gov/wac/default.aspx?cite=246-272B
  - Chapter 246-272C WAC – On-site Sewage System Tanks
    http://apps.leg.wa.gov/wac/default.aspx?cite=246-272C
  - Chapter 51-56-1600 WAC – State Building Code Adoption and Amendment of the 2009 Edition of the Uniform Plumbing Code – Greywater Systems
    http://apps.leg.wa.gov/wac/default.aspx?cite=51-56-1600
  - Chapter 70.118B RCW – Large On-site Sewage Disposal Systems
    http://apps.leg.wa.gov/RCW/default.aspx?cite=70.118B
  - Chapter 64.06.020 RCW – Improved Residential Real Property – Seller's Duty – Format of Disclosure Statement – Minimum Information
    http://apps.leg.wa.gov/RCW/default.aspx?cite=64.06.020
  - Chapter 43.20.050 RCW – Powers and Duties of State Board of Health – State Public Health Report – Delegation of Authority – Enforcement of Rules
    http://apps.leg.wa.gov/RCW/default.aspx?cite=43.20.050
  - Chapter 70.05 RCW – Local Health Departments, Boards, Officers - Regulations
    http://apps.leg.wa.gov/RCW/default.aspx?cite=70.05
  - Chapter 70.08 RCW – Combined City-County Health Departments
    http://apps.leg.wa.gov/RCW/default.aspx?cite=70.08
  - Chapter 70.46 RCW – Health Districts
    http://apps.leg.wa.gov/RCW/default.aspx?cite=70.46
  - Chapter 18.210 RCW – On-site Wastewater Treatment Systems – Designer Licensing
    http://apps.leg.wa.gov/RCW/default.aspx?cite=18.210
  - Chapter 18.43 RCW – Engineers and Land Surveyors
    http://apps.leg.wa.gov/RCW/default.aspx?cite=18.43

- **Standards and Guidance Documents**
  - Tier One Greywater System Checklist and Irrigation Area Estimation Tool - DOH
    http://www.doh.wa.gov/ehp/ts/WW/greywater/ww-gw-CLDOH.pdf
  - Subsurface Drip Systems RS&G
    http://www.doh.wa.gov/ehp/ts/WW/Drip_8-29-07.pdf
  - Water Conserving On-site Wastewater Treatment Systems RS&G
    http://www.doh.wa.gov/ehp/ts/WW/Water_Conservation_8-29-07.pdf
  - Complete Listing of Wastewater Section RS&Gs
    http://www.doh.wa.gov/ehp/ts/WW/pubs-ww-topic.htm#RS&Gs
  - List of Registered On-site Treatment and Distribution Products
    http://www.doh.wa.gov/ehp/ts/WW/ww-register.pdf
  - List of Registered Sewage Tanks
    http://www.doh.wa.gov/ehp/ts/WW/wwtankslist.pdf
  - Washington State Building Code
    https://fortress.wa.gov/ga/apps/sbcc/page.aspx?nid=3
  - Criteria for Sewage Works Design (Orange Book**)**
    http://www.ecy.wa.gov/biblio/9837.html
  - NSF International Product & Service Listing
    http://www.nsf.org/Certified/Wastewater/
  - ATSM International Standards
    http://www.astm.org/Standard/index.shtml
- **Characteristics of Greywater**
  - Summary of Literature
    http://www.doh.wa.gov/ehp/ts/WW/greywater/WWGWTechIsu.pdf
  - Technical Memorandum
    http://www.doh.wa.gov/ehp/ts/ww/greywater/WW-GW-Crook.pdf
- **Designing Greywater Systems**
  - See also the Standards & Guidance Documents section above.
  - Oasis Design - http://oasisdesign.net/
  - Graywater Gardening - http://www.graywatergardening.com/
  - Greywater Gardening Presentation
    http://www.iapmo.org/Documents/ETS_PowerPoint_Presentations/Clipboard%202%20-%20Graywater%20Re-use%20-%20A%20Residential%20Perspective%20-%20James.pdf

- A Green Affordable Housing Coalition Fact Sheet
  http://frontierassoc.net/greenaffordablehousing/FactSheets/GAHCfactsheets/28%20Graywater%20final.pdf

- **Information about Soils**
  - Bioretention Soil Mix Review and Recommendations for Western Washington
    http://www.psparchives.com/publications/our_work/stormwater/BSMResults-Guidelines%20Final.pdf
  - Low Impact Development, Technical Guide Manual for Puget Sound
    http://www.psparchives.com/publications/our_work/stormwater/lid/LID_manual2005.pdf
  - Soils for Salmon: Integrating Stormwater, Water Supply, and Solid Waste Issues in New Development and Existing Landscapes
    http://www.soilsforsalmon.org/pdf/SoilsforSalmonLIDrev9-16-04.pdf

- **Information about Irrigation**
  - AgriMet - The Pacific Northwest Cooperative Agricultural Weather Network
    http://www.usbr.gov/pn/agrimet/h2ouse.html
  - Irrigation in the Pacific Northwest
    http://irrigation.wsu.edu/
  - Washington Irrigation Guide
    http://www.wa.nrcs.usda.gov/technical/eng/irrigation_guide/index.html

- **Water Conservation**
  - City of Seattle Rainwater Harvesting and Connection to Plumbing Fixtures
    http://www.seattle.gov/DPD/Publications/CAM/CAM701.pdf
  - Drought Information
    http://www.doh.wa.gov/ehp/dw/drought/droughthome.htm
  - Saving Water - Washington State's Drinking Water for Kids!
    https://fortress.wa.gov/doh/eh/dw/kids/save-water.htm
  - Water Use Efficiency
    http://www.doh.wa.gov/ehp/dw/Programs/WUE-links.htm
  - Water Sense - an EPA Partnership Program
    http://www.epa.gov/watersense/index.html
  - Rainwater Collection (Harvesting)
    http://www.ecy.wa.gov/programs/wr/hq/rwh.html
  - Indoor Reuse
    http://apps.leg.wa.gov/WAC/default.aspx?cite=51-56-1600

- Reclaimed Water
  http://www.ecy.wa.gov/programs/wq/reclaim/index.html

- **Examples of programs that require multiple permitting agencies**

  - City of Seattle Rainwater Harvesting and Connection to Plumbing Fixtures
    http://www.seattle.gov/DPD/Publications/CAM/CAM701.pdf

  - City of Seattle Rainwater Harvesting and Connection to Plumbing Fixtures Policy
    http://www.kingcounty.gov/healthservices/health/ehs/plumbing/~/media/health/publichealth/documents/plumbing/RainwaterHarvesting.ashx

Appendix D – References

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APPENDIX E – Horizontal Setback Table

Table 9. Minimum Horizontal Setbacks

	From edge of subsurface irrigation components	From tank and other system components
Building foundations		
Down-gradient[1]:	10 ft.	N/A
Up-gradient:	2 ft.	N/A
Property or easement line	2 ft.	2 ft.
Pressurized water supply line/public water main	10 ft.	10 ft.
Interceptor/curtain drains/drainage ditches		
Down-gradient:	30 ft.	N/A
Up-gradient:	10 ft.	N/A
In-ground swimming pool	10 ft.	5 ft.
Spring or surface water measured from the ordinary high-water mark[2]	100 ft.	50 ft.
Well or suction line	100 ft.	50 ft.
Public drinking water well	100 ft.	100 ft.
Public drinking water spring measured from the ordinary high-water mark	200 ft.	200 ft.
Decommissioned well (decommissioned in accordance with Chapter 173-160 WAC)	10 ft.	N/A
Down-gradient cuts or banks with at least 5 ft. of original, undisturbed soil above a restrictive layer due to a structural or textural change	25 ft.	N/A
Down-gradient cuts or banks with less than 5 ft. of original, undisturbed soil above a restrictive layer due to a structural or textural change	50 ft.	N/A
On-site sewage system primary and reserve areas	10 ft.	N/A

[1]The item is down-gradient when liquid will flow toward it upon encountering a water table or a restrictive layer. The item is up-gradient when liquid will flow away from it upon encountering a water table or restrictive layer.

[2]If surface water is used as a public drinking water supply, the greywater system must be located outside of the required source water protection area.

Appendix F - Site Designs Examples

Design Example #1

The Jones family of four lives in a sewered residential development in King County and wants to use greywater to irrigate their lawn in a sandy loam. What is the irrigation area needed for diverting greywater from their a water conserving showerheads and traditional washing machine?

Where: GW means Greywater, $ET_{o\ means}$ Evapotranspiration, and PF means Plant Factor

Inputs: **GW** = 2.5 gpm x 7 minute shower x 4 = 70 gpd

(assumed average shower length is 7 minutes and each person has one shower per day)

GW = 11 gpd/person (washing machine) x 4 people = 44 gpd

Total daily potential = 114 gpd

Total weekly potential = 798 gal/week, rounded to **800** gal/week

ET_o = **1.25** inches/week *(average dry season irrigation demand, May-Sept)*

PF = 0.8 for lawn

Irrigation Area (ft^2) = $\frac{\mathbf{800}}{\mathbf{1.25} \times \mathbf{0.8} \times 0.62}$ = 1290 ft^2

The irrigation rate is 114 gpd/1290 ft^2 = 0.09 gpd/ft^2, which is less than the maximum soil loading rate 0.6 gpd/ft^2

Design Example #2

The Smith family of six live in a farm house in Goldendale and want to use greywater to irrigate their cherry trees which are planted in a silty clay loam. What is the irrigation area needed if they divert greywater from their traditional washing machine?

Inputs: **GW** = 11 gpd/person x 6 people

Total daily potential = 66 gpd

Total weekly potential = **462** gal/week

ET_o = **1.96** inches/week *(average dry season irrigation demand, May-Sept)*

PF = **0.85** for cherry trees

Irrigation Area (ft^2) = $\frac{\mathbf{462}}{\mathbf{1.96} \times \mathbf{0.85} \times 0.62}$ = 447 ft^2

The irrigation rate is 66 gpd/447 ft^2 = 0.15 gpd/ft^2, which is less than the maximum 0.2 gpd/ft^2 soil loading rate.

Design Example #3

Calculate the daily water needed for a mature, broadleaved shade tree with a 10 foot diameter canopy that's not very drought tolerant that is growing in a silt loam in Skagit Valley.

Equation for calculating water use by mature plants:

RG = (0.62 x CA x PF x ET_o)/IE

RG = Irrigation requirement in gallons per day per plant

Inputs: **0.62 =** conversion factor **CA =** plant canopy area in ft^2 = d^2 x 0.785 (area of a circle)

PF = Plant factor *(***0.8** for mature shade trees)

ET_o = reference crop (**0.15** inches per day in Mount Vernon during *May-August*)

IE = Irrigation efficiency (assume 90% for SDI)

CA = 10^2 x 0.785 = **78.5** ft^2

RG = (0.62 x **78.5** x **0.8** x **0.15** in. per day)/ 0.90 (drip system efficiency)

= 6.5 gpd

The irrigation rate is 6.5 gpd/78.5 ft^2 = 0.08 gpd/ft^2, which is less than the maximum 0.4 gpd/ft^2 soil loading rate.