WATER CONSERVATION OPPORTUNITIES FOR THE PALOUSE

A WATER CONSERVATION HANDBOOK

Prepared for the
Pullman-Moscow Water Resources Committee

by the
Palouse-Clearwater Environmental Institute

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About the Palouse-Clearwater Environmental Institute

The Palouse-Clearwater Environmental Institute (PCEI) is a non-profit, tax-exempt grassroots organization dedicated to increasing citizen involvement in the decisions that affect our region's environment. Through community organizing and education we strive to enable members of our community to find effective and sustainable solutions to local and regional environmental problems.

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INTRODUCTION

The purpose of this handbook is to describe water conservation measures appropriate for homes and businesses in the Pullman-Moscow area. The report has been prepared under contract with the Pullman-Moscow Water Resources Committee (PMWRC). The PMWRC is an intergovernmental organization charged with the planning for a stable, long term water supply. This Water Conservation Handbook is organized into four sections followed by a Glossary and Appendices. The four sections include:

I. Identifying Water Use
This section of the handbook describes water meters, water bills and tools on how to learn more about existing water use.

II. Indoor Water Conservation
This section provides the necessary guidelines and tools to make home or business as water efficient as possible. The reader is guided through the inside of a home, from room to room, to find potential money savings. This section also looks at the collective savings and offers tips on water efficient fixtures.

III. Outdoor Water Conservation
This section provides a tour of water conservation measures for outside the home, beginning with water use for cleaning and recreation. This section also focuses on lawns and other grassy areas, water efficient irrigation methods, drought tolerant landscaping, and/or trapping rainwater for later irrigation use.

IV. Recommendations
In this section, suggestions are made for community water conservation measures that might be considered on the Palouse. The list was compiled on the basis of a preliminary analysis of local water consumption patterns and focus on community-wide conservation measures to be considered by university personnel, city planners, elected officials, and municipal water managers.

A glossary follows the recommendations, defining key terms used in the handbook. Additional information is presented in the appendies. The appendices include a list of various locally pertinent resources such as: low water use demonstration gardens, low water use design manuals, local/regional native plant suppliers, low water using plants for the pacific northwest, low water use irrigation designs, youth education materials and references.

I. IDENTIFYING WATER USE

This chapter provides an introduction to your water meter, water bill, and how to learn more about your existing water use. This section is designed to help you determine how much water you are currently using. There are discussions on how to read your water meter, how to read your water bill, and how to conduct an audit of your household's water consumption.

How to read your city water meter

As a water consumer in the Pullman / Moscow area, you already get a record of your water consumption on every water bill. Sometimes, however, your water consumption is estimated (such as during the winter months when many water meters are covered with snow). This section is designed to help you keep track of your water usage yourself, and keep a running record of it every month to see how much water you are saving.

Follow these simple instructions:

1. First, find the water meter. It is usually located in a small concrete or metal vault near the street. The vault cover usually has a small access lid in the center of the cover. Take a large screwdriver with you.

2. Once you find the vault, use your screwdriver to lift off the access lid. Even if the meter has been read recently, it may be covered with dirt or debris. If dirt or snow cover is removed to locate a meter during a winter reading, be sure to replace this material to help reduce the chance of freezing. Your meter will probably display a number, perhaps centered in the middle of a dial.

The simplest meter to read is the one with the straight-reading register which is a direct reading of cubic feet from the movable dial.

Current reading

If a meter looks like this, the reading is 65867 cubic feet.

Previous reading

If the same meter had looked like this one month before, the reading was 64352 cubic feet. To determine the water use between the two readings, subtract the previous reading from the current reading.

Current reading = 65867 cubic feet
Previous reading = 64352 cubic feet
Consumption = 1515 cubic feet
(one cubic foot = 7.4805 gallons, for estimation purposes use 7.5)

If consumption during a one month billing period (30 days) is 1515 cubic feet, then 1515 x 7.5 = 11,362.5 gallons / 30 days = 378.75 gallons per day.

How to read your water bill

Moscow Bills:
Your city utility bill comes once a month, and includes charges for water, sewer, trash collection, street lights, and other associated charges. There are a list of codes and amounts charged for each code. A list of billing codes accompanies each bill. The charges associated with water usage include:

WB = Basic Water, a flat fee ($4.25/month) for water meter upkeep and repair
WA = Water, your water usage, either estimated or actual.
SE = Sewer, a flat fee ($17.50) for sewer

The water rate for winter months is $1.00 per 100 cubic feet or approximately 750 gallons. The summer rate is $1.25 per 100 cubic feet.

To determine your monthly usage, find the row on your bill that begins with the WA in the code column. The numbers in the amount column refer to your current water charge being billed. The number in the reading date column refers to the date that your meter was read (or estimated). The present reading and previous reading columns are in units of cubic feet. If the letter "A" precedes these figures, they are actual readings from your meter. The total water usage for the month is shown in the consumption column. Contact the Moscow finance department at 883-7000 if you have any questions.

Pullman Bills:
Your city utility bill comes every two months including water, sewer and other charges. The codes for water is 1 and sewer is 2. You are given the previous and present water meter readings and a total consumption in cubic feet under the "CU. FT." heading. The volume charge per 100 cubic feet is $0.71. That figure is multiplied by the number of hundreds of cubic feet of water consumed and added to a monthly fee assessed on users. This monthly fee is dependent on the size of your household's meter and whether or not you live in a single, double or multiple family dwelling. Sewer rates are also base charges dependent on the type of home in which you live. The Pullman bill does not itemize the volume charges and the base charges separately, so it is more difficult to determine the portion of the water bill that results from your direct water consumption. Contact the Pullman finance department at 334-4555 if you have any questions.

Exercise: Calculate total water consumption for your household from your utility bills or water meter using the following steps.

Total monthly water use_____cubic feet (cf) divided by 30 days = _____
Divide by persons in household = _____ cf / person / day.
Multiply this number by 7.5 to convert to gallons = _____ gallons per day.
Suggested goal: 35 gallons per person per day.

Note: Due to estimations that are sometimes used for billing purposes, we suggest that you conduct this exercise using actual readings from your water meter on known dates.

How to conduct a water audit of your home

A water audit is an effective starting point for planning how to increase indoor water use efficiency. An audit allows you to gather information on how water is used in your home. This audit will take you around your home to check water usage throughout your home. From this audit you will be able to determine if you are wasting water through leaks, and it will enable you to better learn how efficiently you are using water. Water conservation measures and recommendations will be discussed in later chapters.

Service Meter

❒ Read your meter once a week. Keep track of your water usage using this information and / or your water bill.

❒ Meter Leak Test. Turn off all water-using appliances in the home. After one hour (with no water use) check the meter dial. If it is still moving, there is a leak in the service line that should be repaired promptly. Most homes have a shut-off valve where the water line enters the house. It may be located in your meter box located near the street. If the building has a shut-off valve at the entry point to the house, shut it off first, then check the meter. If the meter is still turning, the leak is between the meter and the house. In that case, or if the meter is the only shut-off valve location, call the city for assistance. Generally the valve at the meter box is very hard to work. Some homes are equipped with a second shut-off valve inside the home. Find the valve and make sure it closes easily. Valves close in a clockwise direction. (You may also need to use this valve in case of an emergency or necessary plumbing repairs.)

Water system

❒ Check water pressure. This may be done using a pressure gauge at the washing machine hook-up. Inside water pressure should be between 50-60 PSI. Pressure that is too high will cause water to be used inefficiently by all your water fixtures. High water pressure is also rough on your pipes and the inside workings of your toilet. (The homeowner usually cannot control this pressure except by installing a pressure reducing valve on their service line.)

Kitchen

❒ Check for drips and leaks in all fixtures.

❒ Check the rate of flow from faucets fully open. Using a watch with a second hand or a stop watch, time how many seconds it takes to fill a 1-gallon jug. Divide 60 by the number of seconds it took to fill the jug. (e.g.. If it took 15 seconds to fill the jug, the rate of flow is 4 gallons per minute). Use this information to determine if you should replace your faucet with a lower flow faucet.

❒ Do your faucets have aerators? If you can feel or see a plastic stopper, your faucet has a flow reducing aerator. If there is not one consider getting one. Check with the City to see if any are available free to residents (Moscow: 883-7000 / Pullman: 334-4555).

Bath/Shower

❒ Check for drips and leaks in shower and faucets.

❒ Check shower flow rate. Use the method described above to determine flow rate.

Toilets

❒ Check for leaks.

❒ Place a dye tablet or a few drops of food coloring in the tank. Do not flush the toilet. After ten minutes, look in the bowl. If colored water is present, there is a leak.

Outside

❒ Check for leaks in the sprinkler, hose, or sprinkler system. Close off the end of your hose with a screw cap or closing nozzle. Fill your hose with water. Leaks and worn washers will be evident.

❒ Measure the flow rate of faucets and hoses by timing how long it takes to fill a pail of a known volume..

❒ Check the position of automatic sprinklers. Determine whether the sprinklers cover only the area to be watered or whether the sprinklers need adjustment to prevent water from falling on homes, sidewalks, and other areas.

❒ Run the sprinkler system for fifteen minutes and then turn it off. Check the water level in the cans. All the cans should have the same amount of water in them. If not, adjustments should be made.

❒ Check if swimming pools and spas are covered when not in use to minimize evaporation.

II. Water Conservation Measures to Try Inside Your Home

Introduction

Inefficient water usage in the home represents one of our communities most immediate opportunities for water conservation. In the previous chapter we learned about the tools available to us in determining our personal water consumption. This chapter provides the individual or family with the necessary guidelines and tools to make their home or business as water efficient as possible.

Water Conservation Demonstration House

The Casa Del Agua, located in the Sonoran Desert near Tucson, Arizona serves as a demonstration project for residential conservation of water. It is a single family residence with three bedrooms and two baths that have been retrofitted to incorporate low water use fixtures and water reuse systems. Because of this up-to-date technology, the total water used at Casa Del Agua, including municipal, rain, and greywater is about 33% less than the 105 per gallon per capita per day (gpcpd) used in the typical Tucson single family home (Foster et al., 1988). A single family home in Tucson, Arizona, implementing all possible conservation devices, uses 35 gallons per capita per day (gpcpd) (Karpiscak, 1990). The Palouse household can reduce its water use remarkably by following the simply steps outlined in this report.

Conserving water inside your home

In this section we will travel around the inside of your home, from room to room helping you to find places where you can save water and money. We will start in the kitchen and finish in the bathroom. After this tour, we will look at your collective savings and offer a few tips on water efficient fixtures that you might consider.

Kitchen

Faucets:

Average conventional kitchen and lavatory faucets have a maximum flow capacity of 3.0-7.0 gallons per minute (gpm) and use 8.0-13.2 gallon per capita per day (gpcpd), or about 15 percent of total indoor water use. By replacing conventional kitchen and lavatory faucets with water-conserving fixtures (discussed below) with maximum flow rates of 2.5 and 2.0 gpm, respectively, a typical household can reduce water demand by 1.2-6.4 gpcpd. For a typical 2.7 person household, these savings amount to 3.2-17.2 gallons per day (gpd). Water savings in this category would range from 15 to 48 percent.

Here are a few easy things you can do to save water in your kitchen :

❒ **Install flow restrictors.** Flow restrictors limit the rate of flow from showerheads and faucets. Flow is usually limited to 2.5 gallons per minute. Water savings of 50 to 70 percent are claimed for flow-limiting showerheads and up to 50% for faucets.

❒ **Install spray taps**. Water is sprayed from the tap rather than issuing a single stream as in conventional faucets. The spray allows for faster washing and rinsing with less water used as a result.

❒ **Install faucet aerators**. This device mixes water with air, reducing the amount of water flowing from a faucet so that less water is used for washing and rinsing.

❒ **Consider installing thermostatic mixing valves**. These valves mix hot and cold water to preset temperatures. Water issues from the tap at this temperature, thus water is not wasted while its temperature is being adjusted by manipulating the hot and cold water faucets.

❒ Wash dishes by hand in a half-filled sink or turn dishwasher to energy saver wash and use only for full loads.

❒ Pre-wash dishes for automatic washer only if necessary, and if you do, stopper the sink and merely soak dishes in soapy solution, then load directly into dishwasher.

❒ Stopper the sink when washing pots, pans, dishes, etc.

❒ Add vinegar to dishwash water to cut grease readily from dishes, pots and pans.

❒ Limit the use of the food disposal or start a compost system for outdoor plants.

❒ Use a small tub or a partially filled sink for washing fruits and vegetables rather than letting the faucet run.

❒ Keep a capped bottle of drinking water in the refrigerator to avoid letting water run to obtain a cold drink.

❒ Draw coffee or tea water for what you expect to consume rather than always making a full pot.

❒ Consider setting aside water used to steam vegetables to use in soups.

❒ Use a lid on pots when boiling foods.

❒ Thaw frozen foods ahead of time rather than thawing with running water.

❒ Remove ice trays from freezer ahead of time rather than loosening the ice cubes with hot water.

Laundry

❒ Wash only full loads. If you must do a small load, use the machine's level control to reduce water required.

❒ If buying a new clothes washer, seek machines with water and/or energy savings features. Choose a water efficient, front-loading washing machine.

Bathrooms

Faucets:

❒ Install flow restrictors.

❒ Turn water off when brushing teeth, shaving, and washing face and hands. Use a stopper to fill bowl, thus avoiding wasted water while you wash.

❒ Brush teeth first, before washing, using cold water while waiting for the hot water to warm up.

❒ Use a glass of water to rinse your mouth and brush rather than cleaning brush under water flow.

❒ Consider shaving with an electric razor; it's cheaper than heating the hot water for a fixed-razor shave.

Showerheads:

The maximum flow rate of the common showerhead in US homes averages 3.0 to 8.0 gallons per minute (gpm) and uses about 12.5 gallons per capita per day (gpcpd); showers account for about 22 percent of total indoor water use. In contrast, a 2.5 gpm shower uses only 8.2 gpcpd. Replacing a conventional showerhead with a 2.5 gpm fixture would result in an annual household water savings of 4.3 gpcpd in the case of post-1980 fixtures (3.0-5.0 gpm) and 8.1 gpcpd in the case of pre-1980 fixtures (5.0-8.0 gpm). For a typical 2.7 person household, water savings from switching to a 2.5 gpm fixture would range from 11.7 to 22.0 gpd, a savings of 34-50 percent in this category. Water saving showerheads will pay for themselves quickly from the energy savings in hot water bills. Prices range from 10-40 dollars. Check with the City to see if any are available free to residents (Moscow: 883-7000/Pullman: 334-4555).

❒ Install low flow shower heads.

❒ Shorten showers or don't turn shower on at full pressure.

❒ When preparing to take a shower, run only the hot water first; then add cold water to avoid wasted water running down the drain.

❒ Turn shower off while lathering up (a cut-off valve installed on or behind the shower head or a thermostatic mixing valve makes this operation simple). Use the rinse water from rinsing out your shampoo to rinse the rest of your body, therefore rinsing only once.

❒ Scrub with wash brush, wash cloth, or hand, to clean dirt than relying on force of water to do the job.

❒ Don't stand in the shower for long periods. Five minutes is a recognized average and quite adequate.

❒ Showers use less water than a bath if you confine your shower to four minutes. If you do use a bath tub, restrict the quantity of water used.

❒ Consider allowing small children to bathe or shower together.

❒ Know the capacity of your hot water heater. Much water can be wasted trying to get hot water out of a cold tank.

❒ Place buckets in shower to catch excess water to irrigate household plants or to flush the toilet.

Toilets:
A typical US household's conventional toilet using 3.5-7.0 gallons per flush uses 14 to 28 gpcpd, or approximately 24-38 percent of total indoor water use. In contrast, estimated per-capita water use based on a 1.6 gal/flush toilet is 6 gpd. Replacing a conventional toilet with a 1.6 gal/flush toilet unit would reduce a typical household's per capita water use by an estimated 8-22 gpcpd, which translates into a total savings of 21.6-59.4 gpd per household, a savings of 57-78 percent in the category of plumbing fixtures. These estimated savings assume an average of only four flushes per person per day.

❒ **Replace conventional toilet with a low flush toilet.** These toilets are available from all plumbing dealers, are now required by most building codes and are competitively priced.

❒ **Install toilet dams or plastic bottles**: Toilets dams or plastic bottles (with rocks in the bottom to weight them down) placed in the tank of a conventional toilet will save 1-2 gallons per flush by forming a reservoir in the tank while maintaining the necessary head pressure. The cost ranges $0-8. Check with the City to see if any are available free to residents (Moscow: 883-7000/Pullman: 334-4555).

❒ **Consider pressure toilets**: Pressure toilets store water under pressure so that when the toilet is flushed, the air pressure provides the velocity required to clean the bowl. Such systems use only 2.5 gallons/flush. Other systems use compressed air from an air compressor to flush the toilet. The advantage is that only two quarts of water are needed per flush. This toilet requires no modification to existing plumbing. Cost less than $600.

❒ **Consider a dual flush device:** This device has two flush volumes. By pushing up on the handle a smaller amount of water is flushed for liquids; by pushing down, a normal flush for solids. It fits most toilets.

❒ Do not flush toilet to simply carry away a soiled tissue; place a waste basket next to the toilet.

❒ Consider cutting down on the number of times you flush the toilet.

How Much Water Can You Save Inside Your Home?

Turn off Running Faucet when...	Potential water saved (In gallons per person per day)
Brushing teeth	3
Washing and shaving	5
Scrape off dishes before washing	5
Washing and rinsing dishes (half fill basin)	5
Scrubbing vegetables (use sink or pan)	5
Drawing cold water (refrigerate bottle)	5
Install low flow aerators on faucets	5
Tub and shower:	
Limit shower to three minutes	10
Install shower flow control	10
Install low flow shower head w/ turn off	15
Half-fill bathing tub	15
Wash Full Loads:	
Dishes in automatic dishwasher	10
Clothes in automatic washing machine	10
Toilet:	
Limit flushes to 3 times a day	10
Install 1/2 gallon bag or bottle	3
Install dam or displacement devices	5
Install low flush toilet	12
Total gallons saved per person	**88**
Total gallons saved per person per year	**32,120**
Savings in Dollars per year	**Moscow $ 42.94***
	Pullman $ 30.49**

*Moscow City water rates: $10.00 per 1000cubic feet or 7480gallons (winter rates)
**Pullman City water rates: $7.10 per 1000cubic feet or 7480gallons

Table 1: How Much Water Can You Save Inside Your Home?

House-wide

Total household savings:

For a typical 2.7 person household potential estimated savings range from 36.4 to 90.4 gallons per day (gpd). Using water-efficient fixtures would result in a new estimated household water budget of 21.0 gallons per capita per day (gpcpd), or 56.7 gpd per household (20,700 gal/year)-saving of 39-61 percent over the current estimated household water budget of 34,000-53,700 gal/year (Vickers 1990). Table 1 shows how much water can be saved by an individual implementing a full water conservation strategy.

- ❒ **Leak Detection and Repairs:** Prevent leaks by checking all faucet washers, pipes, and joints at least once a year. Replace washers on dripping faucets. A 1/16 inch opening at 40 psi will leak 970 gallons in 24 hours. Some faucets are equipped with hard to get at "O" rings. If your faucet leaks and new washers fail to correct the problem, remove the delivery arm and take to the hardware store. They will normally have a special device to replace the "O" ring right on the spot.

- ❒ **Install water efficient plumbing fixtures and appliances.** Replace old appliances with water saving models.

- ❒ **Install "on-demand" hot water heaters for each hot water faucet in new home.** While the initial investment for multiple "on-demand" water heaters is greater, the long term savings of both water and energy can repay the cost of this device. On-demand water heaters are used extensively in Europe and Central America.

- ❒ **Reduce pressure in household water systems.** Regulator valves reduce home water pressure to 50 lbs. This conserves water and reduces wear on washing machines. Cost is less than $50 plus installation. This device may conserve more than 30,000 gallons of water per year.

Washington State standards for water efficient plumbing

Washington State Legislature approved a bill creating water use standards for toilets, urinals, showerheads, faucets, and aerators in 1989. These standards were implemented in two phases; the first phase went into effect July 1, 1990 and the second phase became effective on July 1, 1993.

The legislature adopted a phased approach which supersedes all local government codes and precludes cities and towns from enacting the new standards prior to the effective date. RCW 19.27170(9) adds:

> *The water conservation performance standards shall supersede all local government codes. After July 1, 1990, cities, towns, and counties shall not amend the code revisions and standards established. . . .*

The following standards apply to all new construction and remodeling involving replacement of plumbing fixtures in all residential, hotel, motel, school, industrial, commercial use buildings or other buildings as determined by the Washington State Building Code Council:

Fixture	**Standard**
Toilets	1.6 gallons per flush
Urinals	1.0 gallons per flush
Showerheads	2.5 gallons per minute
Lavatory faucets	2.5 gallons per minute
Kitchen faucets	2.5 gallons per minute
Public lavatory faucets (other than self-closing)	0.5 gallons per minute
Replacement aerators	2.5 gallons per minute

The legislation adds that no individual, public or private corporation, firm, political subdivision, government agency, or other legal entity may, for purposes of use in this state, distribute, sell, offer for sale, import, install, or approve for installation any plumbing fixtures unless the fixtures meet the above water use standards.

Older style toilets use from 6 to 8 gallons per flush. These standards will translate into a water savings from toilet flushing of 75 - 80%, and their other household uses by about 50%.

Thus, with new fixtures and additional conservation habits the average personal water usage will be reduced from its present 75-80 gallons per day towards 45-50 gallons per day (Municipal Research News, 1992).

Water efficient plumbing fixtures and appliances

Indoor water conservation products that meet and exceed code requirements are readily available locally and by mail order. Some studies have indicated that there is *not* a direct relationship between the price of a water conserving fixture and its ability to provide good service. Therefore, price may not be an indicator of quality or performance.

It is important to choose quality products that have standard replaceable components designed for best long-term performance. New products are frequently introduced; it is advisable to review Consumer Reports for updates on the performance of the new products.

Indoor water use can be impacted significantly through water appliance selection. Different models of laundry washing machines and dishwashers vary greatly in the quantity of water need.

Placement of the water heater as close as possible to the point(s) of use for hot water will conserve water that is lost while waiting for hot water to come from the tap.

Approximately 8,000 gallons are lost in this manner in the average household. Strategic placement of the water heater leads to cost-effect water and energy savings.

Consumer Reportss (February, 1995), rates both low-flow showerheads and low-flow toilets, noting cost and overall performance. The article rates 29 different shower heads and 32 low flow toilet model. Prices for showerheads range from $7 to $65, and prices for toilets range $65 to $700. These costs do not include installation costs. The following tables, Table 2 Water Savers Low-flow Showerheads Ratings and Table 3 Low-flow toilets Ratings are compiled from the Consumer Reports article *Water Savers.* The top seven choices for both water efficient toilets and showerheads have been noted.

Brand and Model	**Price**	**Flow 20psi/80psi**	**Overall Score**	**Comments**
Teledyne Water Pik Original Shower Massage SM-62-P	$30	1.6/2.5 gpm	*Excellent*	Strong, wide massage pattern. Reduced flow setting.
Teledyne Water Pik Original Shower Massage SM-82-W	$37	1.8/2.6 gpm	*Excellent*	Wide massage pattern. Reduced flow setting.
Pollenex Power Shower PS320	$25	1.2/2.5 gpm	*Excellent*	Rotating spray head. Larger than most.
Interbath Intouch II Massage B26595WW	$25	1.2/2.1 gpm	*Excellent*	Shut-off setting. Larger than most. 5-yr. warranty.
Kohler Mastershower 3-way K-9505-CP	$46	1.8/2.6 gpm	*Very Good*	
Whedon Saver Shower DS1C	$12	1.3/2.6 gpm	*Very Good*	Aerated mist; needle-sharp stream. smaller than most. 5-yr warranty.

Table 2.: Low-flow Showerheads Ratings

Brand and Model	Price	Overall Score	Comments
Gerber UltraFlush 21-302	$210	*Excellent*	Seat close to water; possible splashing problem. Dirt, hard water could clog rim outlet. Flush button on top of tank. Round bowl.
Kohler Trocadero Power Lite K-3437	$815	*Excellent*	Miniflush. Dirt, hard water could clog rim outlets. Electric water pump; installation may require electrician. Seat included. Round bowl. One-piece. White only.
Kohler San Raphael Lite K-3394	$570	*Very Good*	Poor rim wash-down. Dirt, hard water could clog rim outlets. Seat included. One piece. White only.
American Standard Cadet El pa 2168.128 (2168.100)	$390	*Very Good*	Seat close to water; possible splashing problem. Higher than most (useful for elderly and disabled people). Poor rim wash-down. Flush button on top of tank.
Eljer Berkeley 081-1595	$485	*Very Good*	Seat included. One-piece.
Kohler Wellworth Lite PC K3458	$265	*Very Good*	Dirt, hard water could clog rims.
Universal Rundle Atlas 4079 (4078) (4072)	$195	*Very Good*	Higher than most (useful for elderly and disabled people). Instructions for adjusting flush volume.

Table 3.: Low-flow Toilets Ratings

III. Outdoor Water Conservation

Introduction

Water consumption increases significantly during summer months. We can attribute most of the increase in water use to outdoor landscaping, lawn and garden maintenance during the hot, dry growing season. There are many potential outdoor water conservation measures ranging from easy daily habit changes to water efficient irrigation systems, rainwater collection and use, and drought tolerant landscaping that can limit the seasonal increase in water use during the summer months. Your personal water audit will help to instruct you on where you can save water outdoors.

Outdoor water use can be reduced by adopting watering schedules that limit lawn watering to the early morning or late afternoon hours when temperatures are lower and less evaporation occurs. Watering lawns for longer periods of time and less frequently encourages grass to grow longer roots and to make the lawn more drought resistant. Careful selection of the most appropriate drought tolerant plant species for the region is an important water saver. Water wastes can be reduced by choosing the appropriate irrigation system and keeping it in good working order. The individual or family can reduce their water use remarkably by thoroughly reviewing the sections outlined below and implementing a few simple practices.

Conserving water outside your home:

The tour of water conservation measures you can employ outside your home will start with how water is used for cleaning and recreation. We will also look at lawns and other grassy areas, water efficient irrigation methods, drought tolerant landscaping, and trapping rainwater for later irrigation use.

Cleaning outside the house

❒ Clean gutters and down spouts manually instead of hosing them down.

❒ Keep child's play in sprinklers to normal lawn watering intervals or invest in a plastic swimming pool.

❒ Wash cars with a bucket and then rinse. Wash your car over pervious materials or lawn to multiply the benefits from the water used. This will also prevent contamination of local streams and will conserve water resources.

❒ Sweep the sidewalk, don't rinse.

Lawns and other grassy areas

Keep turf areas practical and suited for intended use. Huge lawns require more maintenance and water than any other type of landscape plants. Lawns may be needed as children's play area, for pets, sports, or simply for the aesthetic appeal of turf. The maintenance needs of turf can be minimized by the shape of the turf area, the irrigation equipment used, and the turf type . One rule of thumb is to not have more lawn than you can cut with a reel push mower.

Design turf areas in rounded, compact shapes to water and mow more efficiently. Curving borders of plant beds around turf areas and the use of mowing strips, can make mowing and edging easier. Avoid long, narrow areas of turf, which are difficult to water efficiently. Locate turf areas close to the house, and lower-maintenance areas near the edges or rear of the lot.

Design turf areas so they can be watered separately from other landscape plants. If using an automatic irrigation system, the grass areas can be zoned to be watered according to the needs of the grass type. For non-automatic systems, use efficient hose-end sprinklers for grass areas and soaker hoses for beds. Watering times will vary by plant type.

Choose turf appropriate for the location.
The grass best suited to the palouse are the native bunch grasses such as Idaho Fescue and Bluebunch Wheatgrass. These are not turf grasses, but are quite attractive in home landscapes. Currently a cultivar of a Prairie Junegrass is being tested by Grasslands West of Clarkston, Washington for drought tolerance. Contact the local sources listed in Appendix A for their recommendations for your situation.

Avoid planting grass on steep slopes.
Sloping areas are difficult to mow and difficult to water without runoff. Terracing of slopes can help slow down water. Plant ground cover, shrubs, and perennials to minimize the difficult maintenance problems of slopes. Many slopes can be left in their natural state.

Minimize grass areas by using alternatives.
There are many alternatives to grass plantings which are aesthetically pleasing and low-maintenance. Planting beds are logical alternatives to grass if the green appearance of plants is desired. Wildflowers can be incorporated into native ground covers and grasses. Mulch beds of bark, stone or gravel can be used as pathways, or around driveways and utility areas.

Children's play areas can be covered with sand or bark mulch to create inexpensive "safety" zones with a ground surface that minimizes injuries and uses no water. Patios and decks add value to homes and increase the square footage of living space. (Use pervious paving materials if possible. Decks allow rain infiltration, and can be built around existing trees and over slopes.

Mow lawns correctly.
Mow the grass when it is about 1/3 higher than the desired height. Clippings can be left where they fall, recycling nutrients into the soil. If clippings are collected, compost them with raked leaves and organic kitchen waste. Never mow lawns too short. (Proper mowing heights can help lawns use less water. Grass cut too short is stressed and dries out quickly.) Set mowing heights at 2 to 3 inches.

Irrigate properly.
Water for longer periods less frequently. Let water sink deep into the grass. This encourages root system to extend and helps grass to be more drought resistant. Apply water only as fast as the soil can absorb it. Don't over water.

Never water lawns daily; once or twice a week during the warm season is adequate. Daily water will cause loss of nitrates and a yellowish-green appearance, invasions of weeds and diseases, soil compaction, loss of deeper roots, as well as waste of water. Irrigate lawns at the first sign of wilting.

Remove thatch and weeds to allow water to reach the roots of the grass. Poke holes in the soil (aeration) to allow the roots to get more water.

Water efficient irrigation

The type of watering equipment best suited to the job depends on the landscape, design, layout, and budget. The irrigation design should be integrated with the design of the landscape. A simple garden hose and sprinkler with a few soaker hoses may be the way to water some landscapes. Drip or underground systems may be more appropriate for other landscapes. Timing of watering is also very important.

It is important to note that a newly installed landscape will require more water during an establishment period of one to two years. Drought tolerant landscaping should require no irrigation after establishment. Unless there are large expanses of non-native turf and other thirsty plants, drip irrigation may be sufficient. However, many homeowners prefer the convenience that an automatic irrigation system provides.

Water deeply only when plants need it .

❒ Deeper, more drought tolerant root systems will develop from a weekly deep soaking.

❒ Irrigate in the coolest parts of the day (early mornings and evenings) to avoid increased evaporation loss and wind drift.

❒ Irrigation equipment should be tested to determine how long it takes to apply one inch of water. See the test used in the audit section of this handbook.

❒ Wet the soil to a depth of five or six inches, and allow it to dry out between waterings. (You can learn to recognize the signals of a thirsty landscape: shrubs will begin to droop and grass will lie flat and leave footprints when walked on.)

❒ As a general rule, during the growing season most grass needs about one inch of water per week. This will vary depending on soil type and depth, sun, plant conditions, and rainfall occurrence.

❒ Watering can taper off gradually as fall arrives and gradually increase in the late spring.

❒ Water shrubs and plants separately from lawns.

❒ For clayey, tight soils use sprinklers that emit water at as slow a rate as possible. Apply water over short periods separated by a soaking-in period of at least twice the length of application, i.e., 10 minutes on, 20 minutes off, 10 minutes on, etc. Treat steep slopes like you would a clayey soil area. When irrigating sandy loam or open soils, apply water rapidly and in one continuous period. Occasionally, about 12 to 24 hours after irrigating, check soils with a soil tube, auger, probe, or spade and note depth of water penetration by change in color or feel of soil. If any soil in the root zone is dry, apply water longer in future irrigation.

Low-flow irrigation equipment.

❒ Do not turn on the spigot all the way open. This reduces the rate of flow through the hose which saves water and is kinder to delicate plants. Do not rely on nozzles as faucets. Always shut off faucet when through using a hose. Use 1/2 inch garden hose, it is normally more than adequate for low flow garden irrigating.

❒ Evaporation losses can be minimized by drip irrigation, soaker hoses, or bubblers. Drip irrigation systems are ideal for watering plants in beds and gardens. Drip lines require no expensive underground trenching, and are easy to utilize in a retrofit of an existing landscape.

❒ Drip irrigation uses a flexible hose system which can be easily modified, to apply water at the ground surface to individual plants. Emitters are punched into the supply line where they are needed. A variety of types and flow rates for emitters are available.

❒ If water pressure at the source exceeds 30 psi, a pressure regulator may be necessary. Filters to remove sediment should be installed at the water source. Flush caps should be installed at the ends of the drip supply lines so that the entire system can occasionally be flushed of contaminants. Drip lines should be secured to the soil surface and covered with organic mulch to improve appearance and protect them from sunlight.

❒ Irrigation systems need regular maintenance to ensure proper working order and to adjust irrigation scheduling. A complete system *audit* should be conducted annually, and irrigation schedules adjusted quarterly at a minimum. Irrigation lines should be flushed and all stations, heads, nozzles, and/or emitters checked for proper functioning.

Water efficient automatic irrigation system may include:

❒ A *timer* that allows for scheduling every 5 - 7 days (14 or 15-day programming) and independent zone programming.

❒ Features such as *multi-cycling* (or multiple start times) will help in watering areas which may need several short irrigation cycles to avoid runoff.

❒ An inexpensive *rain shut-off* device, which will prevent unnecessary irrigation during rain.

❒ A *soil moisture sensor,* unlike the rain shut-off device, the soil moisture sensor actually measures soil moisture, and overrides programmed irrigation when the soil moisture level is adequate.

❒ Non-mist type *low trajectory* nozzles and *pressure-compensating* devices for spray systems in turf areas, or *micro-spray* heads should be used for spray systems in turf areas.

❒ A *zoned approach* whereby plants of similar water requirements are grouped together in the same zone capable of independent station programming (i.e. turf areas separate from shrub areas, sunny areas separate from shady areas).

Xeriscape: Drought tolerant landscaping

Drought tolerant landscaping, or Xeriscapes, are defined as "quality landscaping that conserves water and protects the environment." Xeriscape is a term referring to "dry-landscaping", but is much more than cactus and gravel. Xeriscape landscapes can initially cost more than conventional landscapes due to the comprehensive nature of Xeriscape design and replacement of inexpensive turf with other plants. Xeriscape will decrease the life cycle maintenance costs of landscaping.

Planning and design is the first and most important step in Xeriscape landscaping. The Xeriscape landscape takes into account the regional and microclimatic conditions of the site, existing vegetation and topographical conditions, the intended use and desires of your property, and the zoning of plant materials according to their water needs.

The maintenance requirements of a Xeriscape landscape are generally less than those of a conventional landscape. This is due to both a reduction in turf area and unadapted plants that might have more disease, require more insect control, and demand more water and fertilizer. However, there is no such thing as a maintenance-free constructed landscape. In general, a properly maintained yard is hardier and better able to withstand drought, freezing and pest problems. There are things you can do to make maintenance easier and more water efficient.

Proper site planning

❒ Design of house and various plantings should reflect the site topography.

❒ Split level housing, terracing, and decks can help integrate building features into site conditions and minimize the cost and effects of grading.

❒ Shade producing plants should be combined with building design to decrease energy demands for cooling.

Preserve and protect as much existing vegetation as possible.

❒ Incorporate existing trees into plans for locating structures and power lines. Allow room for the trees to grow.

❒ If areas around trees must be paved, use pervious materials (see section on Pervious Paving) or, at a minimum leave large holes spaced at regular intervals in the tree's root zone (openings will help give trees needed air and water).

Preserve and protect topsoil on construction sites.

❒ Topsoil is a valuable resource which can only be replaced with expensive topsoil hauled from other sites, or with many years of the natural process of soil formation. In areas where topsoil must be stripped, it should be collected and stockpiled for future use on the site.

❒ Consider temporary erosion control devices such as hay bales, erosion control fabrics, or erosion control fencing in all areas where construction disturbances may lead to the soil erosion (see list of suppliers in appendix).

❒ In landscaped areas, a thick layer of organic mulch should be applied to planting beds to prevent erosion and control weeds and evarporation.

Landscaping for energy and water conservation should be an integral part of any landscape design.

❒ Plant deciduous trees on the west and southwest sides of structures. Such trees can create enough shade to lower roof and wall temperatures by up to 20 degrees.

❒ Deciduous trees that create summer shade and then lose their leaves in the fall will allow sunlight through open branches to warm and light the home during winter.

❒ Shade can also be created by using a combination of landscape features, such as shrubs and vines on arbors or trellises.

❒ Natural cooling with air conditioning can be enhanced by locating trees to channel summer breezes. Cooling breezes will result from passing through the shade of trees placed near the house.

Add organic matter to planting soil to enhance plant health and conserve water.

❒ Organic matter improves soil texture and moisture retention. (Soil rich in organic matter also provides nutrients and micro-organisms which help to produce healthier plants.)

❒ For planting beds, spread 2 inches of organic matter and mix it in 6 inches deep.

❒ For soil to fill a hole for planting shrubs or trees, mix 1/3 organic matter into the soil. (Some native plants may not require this, as they are well adapted to poor soils. Check with your supplier.)

❒ Compost can be an excellent sources of nutrients for ornamental landscapes. The organic matter release nutrients slowly to the plants, making frequent fertilizing unnecessary and minimizing the risk of fertilizer washing out of sites and becoming non-point source of pollution.

Select plants that require a minimal amount of supplemental watering.

❒ When landscaping, consider the many attractive Idaho/Washington native plants that are drought-tolerant. They require less water (see a list of these and other drought tolerant plants in the appendix).

❒ Most Xeriscape plants will need no supplemental watering after an establishment period, unless there is an extreme drought. The establishment period after installation may require from 18 to 24 months.

❒ Almost any plant can be used in a Xeriscape if grouped accordingly to its water needs. Annuals and exotic plantings can be located in small, easily accessible area to make maintenance easier. Irrigation can then be zoned according to plant water needs to make irrigation possible.

❒ Many native plants are well adapted to the natural soil and rainfall conditions of our area. They have protection mechanisms that cause them to go dormant during periods of stress. They may appear brown, but will turn green again when temperatures improve and/or it rains.

Choose a diversity of plant species.

❒ Avoid planting large numbers of only one plant species, which can create a monoculture susceptible to pest or insect problems. (A variety of plant species occurs in nature, making more stable and diverse plant populations.) This will facilitate the aesthetic success of your landscaping.

❒ The abundance of Xeriscape plants - trees, shrubs, perennials, ground covers, vines and grasses - available in the nursery industry make it possible to choose plantings which give color and interest (flowers, fruits, berries, and foliage) year-round.

Lawson Gardens Xeriscape Garden

A Xeriscape or drought-tolerant garden has been established in the Lawson Gardens in Pullman, Washington. The goal of the Xeriscape garden is to demonstrate water conservation and landscaping using drought tolerant and native plants. After the young plants have been secured and their roots system have matured, the garden should flourish, requiring no irrigation from city water. The garden presents a variety of attractive, native shrubs, trees, perennials, annuals and bulbs that can be planted in the home garden.

All of the plant species in the xeriscape garden are available from local nurseries. A list of drought tolerant shrubs, trees, perennials, annuals and bulbs is found in the appendix. While not all of these species are native to the area, some are and all of them do well in local rainfall conditions.

Use a deep layer of mulch in planting beds to help retain moisture, slow weed growth, and prevent erosion.

❒ The use of mulches on sloped areas along with terracing and plantings can also help prevent runoff and erosions problems.

❒ Examples of organic mulch material include:

shredded bark	wood chips
pine needles	straw
leaves	old hay
grass clippings	compost

❒ The depth of mulch needed will depend on the ok use. As a general rule, the coarser the material, the deeper it should be applied. A 3 to 4 inch layer of bark mulch should be sufficient. Mulch needs to be reapplied as it decomposes.

❒ Use mulches from locally or regionally derived materials to decrease transportation costs, and utilizes local resources. Organic mulches can be the byproduct of local Christmas tree recycling, tree trimming, land clearing, or sawmills. Check with the supplier to determine the source of mulches.

❒ Dig basins around trees and shrubs to hold the water.

Develop a composting area.

❒ Yard and garden waste and vegetable trimming from the kitchen can be recycled into high-quality compost. This minimizes the load on landfills and encourages wise resource use. Soils augmented by compost have an increased ability to hold water and generally encourage healthy plant growth.

❒ To locate a compost area, choose a well-drained corner of the yard that is convenient to the kitchen and out of sight.

❒ Compost bins are easy to build. Extensive information on construction of recycling bins can be obtained from the Moscow Recycling Center (882-2925).
Remember:

1) Use inexpensive materials.
2) Allow for air circulation and
3) Make the bin wide enough to turn and lift compost.

❒ You can use chicken wire, woven wire, or inexpensive fencing to build a bin. Try using wood stakes, wire, or chain snaps to support and fasten the bin. Discarded wood pallets can be put together with wire to make an inexpensive rectangular bin.

A portable bin can be built of wood slats and wire mesh. Cinder blocks or brick can used if gaps are left to allow air circulation.

❒ Commercially prefabricated composters are available.

Fertilize wisely.

❒ Many native plants do not need fertilizer since they are adapted to natural soil conditions.

❒ Other plants, such as non-native grasses, need additional nutrients for healthy growth especially if trimmings are regularly removed.

Use inorganic mulches such a pea gravel, crushed granite or pebbles in unplanted areas.

❒ Such areas can become inexpensive pathways, utility area, or decorative border strips. Don't use stone mulches in areas immediately adjacent to buildings, as they can heat up and cause glare. Use medium colored stone, such as beige or light gray, over white, which causes glare, or black, which absorbs heat. Stone mulches can be produced from regional quarries.

❒ Pervious paving areas can be used to facilitate ground water recharge. Pervious paving can accept runoff from roofs and adjacent parking areas and allow it to infiltrate the ground. It can also reduce the need for curbs and gutters as drainage features. Cultivation of grass in interlocking pavers will be most successful in medium to low traffic areas. Paving systems that have distinct ridges above the soil level can prevent the crown of the plants from being crushed.

Harvested rainwater of irrigation

Harvested rainwater is that which is captured from roofs of buildings on residential property. There are many potential uses for this water resource from irrigation to animal watering. In some areas, drinking water is collected in this manner; however, our discussion will be limited to irrigation.

Since the largest need for irrigation water in our area occurs during the time of lowest rainfall and highest temperature, a rainwater collection system designed to meet this need will have to capture some water prior to the summer irrigation system. The Moscow-Pullman area receives an average of 22 inches of rain per year but little comes in the summer time (see table IIIa below).

Rainwater harvesting systems designed to fill all the water needs of a home can be similar in cost to the expense of putting in a well. Operating costs for a rainwater system can be less. Rainwater collection systems designed to supplement the water needs of a home already on the city system for irrigation purposes can be a significant added expense. The primary expense is the storage tank (cistern).

The size of the storage system may be prohibitive for using rainfall for the sole source of irrigation water in large or water-intensive landscapes. A low water demanding landscape is required.

Table 4 1993 Rainfall per Month (Moscow, ID Pullman, WA)

	1993 Rainfall	
Month	Moscow	Pullman
January	3.21	2.89
February	2.12	2.09
March	2.04	1.96
April	1.98	1.58
May	1.99	1.52
June	1.65	1.49
July	0.17	0.53
August	1.07	0.95
September	1.1	0.99
October	1.83	1.61
November	2.95	2.64
December	3.31	3.07
Totals	**23.42**	**21.32**

Capacity

The capacity of a rainwater harvesting system depends on the amount of rainfall, size of collection area, storage capacity, and the household's level of demand for water.

To determine the square footage of catchment available from the house, use only the house's footprint. (The actual area of roof material will be greater due to the roof slope. However, the amount of rainfall on the roof is not affected by the slope.)

Exercise: To calculate the amount of rainwater that falls of the roof of your house in a year use the following calculation:

Length x width of house = _____roof footprint (square feet).

Multiply by .92 feet (22 inches, or average rainfall, this figure varies from year to year) = _____cubic feet.

Multiply by 7.48 gallons / cu ft = _____ gallons.

Note: About 1/4 of this will be lost to just wetting the roof and evaporation each time there is a precipitation event. You may wish to calculate the rainwater that falls on your roof on a monthly or seasonal basis to meet your irrigation needs.

For outdoor uses of rainwater, the types of plants, amount of exposure to direct summer sun, soil conditions, presence or lack of mulch, and size of the area will determine how much irrigation water is needed. Large landscapes with large water demands are not readily accommodated by rainwater catchment systems.

Simple harvesting systems may channel water out of the gutters and down spouts and onto the base of a single tree or cluster of shrubs. More complex rainwater harvesting systems consist of the following subsystems: catchment area (roof), conveyance system (guttering, down spouts, and piping), filtration, storage (cistern), and distribution.

Catchment Subsystem

Rainwater harvesting can be done with any roofing material if it is for non-drinking use only. Asbestos roof material used in older homes should not be part of a system to provide drinking water. Asphalt shingles can contribute grit to the system and need a pre-filter for the water before it enters the cistern. Lead materials in any form should not be used in the system.

Conveyance subsystem
The conveyance piping from the gutter system to the cistern or filter should be Schedule 40 PVC or comparable in a 4 inch diameter. Do not exceed 45 degree angle bends in horizontal pipe runs and provide 1/4 inch slope per foot minimum. Use one or two-way cleanouts in any horizontal pipe run exceeding 100 feet.

Storage subsystem
The storage tank (cistern) must be sized properly to ensure that the rainwater potential is optimized. Cisterns can be located above or below ground The best materials for cisterns include concrete, steel, ferro-cement, and fiberglass.

When ordering a cistern, specify whether the cistern will be placed above or below ground. (Fiberglass cisterns are constructed differently to meet the various criteria.)

A cistern should be durable and watertight. A smooth clean interior surface is needed. Joints must be sealed with non-toxic waterproof material. Manholes or risers should have a minimum opening of 24 inches and should extend at least 8 inches above grade with buried cisterns. Fittings and couplings that extend through the cistern wall should be cast-in-place.

Dissipate the pressure from the incoming water to minimize the stirring of any settled solids in the bottom of the cistern. This can be accomplished in a concrete cistern by placing concrete blocks (cavities facing upward) surrounding the base of the inlet pipe. The blocks can be 8" x 8" x 16" blocks with the pipe exiting one inch above the bottom of the cistern. Baffles to accomplish the same result can be made as part of fiberglass cisterns. This is not a concern for cisterns that always have a large reserve.

The use of two or more cisterns permits servicing one of the units without losing the operation of the system. Have a fill pipe on the cistern for adding purchased water as a backup if this is the only feed to your irrigation system. Have a cover to prevent mosquito breeding and algae growth from contact with sunlight.

Filtering subsystem
The rainwater may become contaminated by dirt, debris, and other materials from the roof surface. The best strategy is to filter and screen out the contaminants before they enter the cistern. A leaf screen over the gutter and at the top of the down spout is helpful. Prefiltering to keep out debris will reduce sediment buildup.

Distribution
Removing water from the cistern can be achieved through gravity, if the cistern is high enough above the use area, or by pumping. Most cases will require pumping the water into a pressure vessel similar to the method used to withdraw and pressurize water from a well (except a smaller pump can be used to pump from a cistern).

A screened 1.25 inch foot valve inside the tank connected to an 1.25 inch outlet from the cistern approximately one foot above the bottom (to avoid any settled particles) will help maintain the prime on the pump. A float switch should be used to turn off the pump if the water level is too low.

Another alternative is the use of a floating filter inside the cistern connected to flexible water line. This approach withdraws the water from approximately one foot below the surface which is considered to be the most clear water in the cistern.

Public Health Issues

While cisterns offer interesting opportunities for more efficient and diverse use of water there are some drawbacks relative to public health concerns. Many public health officials discourage the use of cisterns for water needs on developed property. The concern is the potential for contamination of this water from the surfaces of roofs and other parts of the collection system. Because a potential exists that this water could be introduced into the city potable water supply extreme caution is warranted.

Many cities will require the property owner that desires a cistern to install a positive backflow prevention device on their service line to prevent possible contamination to the city system. This may be required even if there is no intention of hooking the system into the property water supply. Even so, the risk of contaminated water being used for other than landscaping needs is present and a concern. It is advised that prior to undertaking a cistern project the interested party contact the city to discuss the plans for the cistern.

IV. COMPREHENSIVE WATER CONSERVATION RECOMMENDATIONS

The Palouse-Clearwater Environmental Institute (PCEI) offers the following recommendations for community water conservation measures. The list was compiled on the basis of a preliminary analysis of local water consumption patterns. These recommendations are intended as departure points for discussion within the Pullman-Moscow Water Resources Committee for the purpose of enhancing the effectiveness of local water conservation efforts.

Water conservation education

Water conservation education measures and services could correspond with City and University efforts to strengthen building and landscaping codes and to adjust water rates. Possible contents for the conservation education programs include landscape maintenance personnel training, a city sponsored home audit and retrofit program, a community oriented drought tolerant plant publicity program, and a continued primary school education program.

Landscape maintenance personnel training program. A training program for landscape personal, in both the public and private sectors, could yield knowledgeable water conservation practitioners. A similar program has been enacted by the City of Bellevue, Washington in which the water utility is working with the city parks department to improve city efficiency of irrigation systems. A locally sponsored program in our area could serve private citizens as well as city, university, and school district personnel and could include:

- ❒ Training in irrigation scheduling.
- ❒ How to spot problems in irrigation equipment and make needed repairs.
- ❒ Landscape maintenance practices that reduce the need for irrigation water.
- ❒ Principles of drought tolerant landscaping, and workshops on area native plants.

The City of Phoenix, Arizona holds free water management workshops at its public libraries with special programs designed for park and school districts. (It also conducts basic information sessions for homeowners.) Some of the topics discussed include inspection of irrigation systems and methods of correcting problems, irrigation audits and scheduling, and how to build conservation programs.

Retrofit program. It is recommended that the committee explore a retrofit program directed at single family homes, group housing, multi-residential housing, and large commercial water consumers. The program, in which retrofitting water conserving

showerheads and faucets are delivered and installed, with auxiliary water conservation education material such as a conservation brochure and conservation handbook could be a highly effective conservation measure.

Washington Water Power (WWP) in Moscow conducted a *Showerheads and Aerators Program (S&AP)* encouraging their customers to replace their current showerheads and bathroom and kitchen aerators with more energy and water efficient ones. Both residential electric and gas water heating customers were able to request a free showerhead and aerator kit through a variety of methods.

Image Craft of Spokane, Washington provided WWP and the City of Moscow with their retrofit packages and the city distributed 2,229 showerheads over a year period. Between 10 and 30% of Moscow residents were reached with this particular program. The total cost to purchase and fulfill house mail out orders of two showerheads and three aerators to requesting customers was $16 per kit. Shower heads were rated at 2.5 gallons per minute.

According the *S&AP* Summary, installation rates are high for showerheads, with 81 percent of participants installing at least one showerhead. The overall installation rate for kitchen aerators was 65 percent and for bathroom faucet aerators, 36 percent. By far, the most frequent reason to participate was to save water (48 percent), followed by 26 percent who want to get free equipment or save money, and 22 percent who wanted to save energy.

According to the *S&AP* Summary 30 percent of eligible customers overall say they did not hear about the *S&AP* program. About 15 percent of all eligible customers say they are unlikely to participate in the program in the next six months. These non-participants are more likely to be lower income (under $40,000) and apartment renters.

One of the major program challenges was providing kits to apartments. The *S&AP* program summary suggests that there is still an opportunity for another retrofit program in Moscow and Pullman.

Ashland, Oregon invests in efficiency

According to a study of water use patterns in Ashland, Oregon, the City of Ashland saved significant amounts of water through a relatively painless community-wide efficiency program. The program was developed as an alternative to building an $11 million dollar dam project when a key water right was due to expire. The program cost $825,000 for a city of fewer than 20,000 people, about one-twelfth that of the dam. The city council approved the program in the spring of 1992 and by July, the City Conservation Department was conducting home water audits and issuing rebates for efficient toilets and showerheads. Now, two and a half years into the program, Ashland residents are saving 134,000 gallons a day - about a third of the town's goal, and right on schedule for meeting their goal by the year 2000. Ashland's program saves residents more than 500,000 kilowatt-hours a year on water heating, mainly due to low flow showerheads, and reduces waste water treatment volume.

Drought tolerant plant publicity. In Clark County, Washington residents are getting help identifying drought tolerant plants at local garden supply stores. In over 20 different nurseries, gardeners are finding posters and brochures listing planting tips to improve water efficiency and discovering that many of the plants are identified with special "Climate-Friendly" tags. The City of Vancouver Water Conservation Office and Clark County Public Utilities teamed up with local garden supply stores with the hope of spreading the word about outdoor water conservation.

A locally sponsored drought tolerant plant publicity program similar to Clark County's program could be tailored to meet some of Moscow and Pullman's water conservation needs. A local program could include workshops at area nurseries, some of which have already offered their facilities and resources, and professional presentations for landscapers, developers, and planning and development personnel concerning drought tolerant landscaping planning and design.

A series of home garden and demonstration garden tours and native plant workshops could serve both to inform the public about drought tolerant landscaping and act as meeting points for the various groups involved.

Dr. Richard Naskali, University of Idaho Arboretum, has offered to conduct native plant tours at the UI Arboretum. The Pullman Garden Center on the highway between Moscow and Pullman has offered their facilities as a meeting point and a resource for drought tolerant landscaping workshops. The Pullman Garden Center has a wide array of native, drought tolerant plants, a resource / reference library and a rainwater collection site for irrigation.

Such a program would run in the spring in conjunction with spring plantings and the workshops would be held in middle to late summer and in the fall in conjunction with fall plantings.

School-based water conservation education. An effective water conservation education program should reach both into the homes and the schools. The schools can provide the science and philosophy behind water conservation and the home can act as

its testing ground. A large scale water conservation education program could be implemented in the Moscow and Pullman public schools with a well-developed year long curriculum designed for the appropriate ages. An effective education program could be developed to cover a period of years. See the *Water Conservation Curriculum and Classes* offered by PCEI under separate cover.

To implement education in the schools, the teachers could be prepared through professional workshops, i.e. in service workshops, instructing them about water use patterns, general local geology and teaching tactics for water conservation education so they can incorporate water conservation education into their classes independently.

Several goals could be realized by in service training. Primarily, educational training will educate the teachers to prepare conservation oriented material in their science, social studies, and mathematics units. Secondarily, once water conservation is incorporated within basic curriculum, parents will be informed by their children about conservation efforts in the schools.

Moscow and Pullman teachers could attend workshops on water conservation as an in service training and teachers could be provided with curriculum and resource presentations. A continued water conservation education unit might include such activities as planting a drought tolerant garden in part of the schools playground area, filming or recording a water conservation message to be aired on local television and radio stations, and visiting City Sewage and Water Treatment facilities as active learning experiences.

PCEI could provide in-school support in designing a drought tolerant garden for the playground, producing audio and video public messages, and arranging field trips.

Conservation pricing.

The Pullman-Moscow Water Resources Committee should continue to explore a water pricing structure that encourages water conservation efforts. Such a pricing structures would be best received and have the greatest impact if it became effective in both Pullman and Moscow simultaneously. The pricing structure should be easy to understand and fair to all residents. It should be developed to generate sufficient revenue to pay for the cost of the above water conservation education measures, while providing an incentive for residents and businesses to conserve water.

Analyze current institutional uses

The Universities should consider a plan that would have each university department pay for their own water. All buildings on campuses would have to be metered. Each department would be provided with a budget for sewer and water. The effect of such a measure would be to make each department aware of their water, sewer and energy expenditures. The two cities should consider metering water supplies to all parks to better analyze water use. Like conservation pricing, this recommendation uses economic incentive to persuade the consumer to conserve.

All four entities should conduct internal audits of how water is being used both indoors and out. This could help to detect and modify wasteful water consumption practices such as hosing down sidewalks rather than sweeping.

Examples of water practices that could be reviewed by intitutional audits:
The use of of aspirator vacuum pumps on water faucets can waste many gallons of water each day in student and faculty laboratories. They could be replaced with mechanical vacuum pumps.

The use of flowing water as a cooling device in experiments could be replaced with closed cycle cooling systems.

Codes, standards and guidelines

Collaborative efforts between the cities and universities are necessary in the developing community water conservation projects and implementing guidelines. The Pullman-Moscow Water Resources Committee should consider reviewing all building, plumbing and landscaping codes for both residential and commercial buildings to ensure that such codes promote water conservation and are consistent in both communities. All four entities should consider the Washington State Standards for water efficient plumbing fixtures when developing our local standards or guidelines.

The cities and universities could adopt guidelines that requires new and remodeled developments to incorporate water-conserving landscaping practices, such as drought tolerant landscaping techniques or plants, turf limitations, water efficient irrigation systems, landscape watering schedules, rainwater collection projects and water reuse systems for irrigating large developments. Developers could be advised to retain some areas of natural vegetation depending on the nature of the vegetation and to avoid removing the natural soil in order to reduce erosion and compaction of the soil.

Some communities have designated review boards, usually consisting of landscape architects or planners, to evaluate and approve landscape designs for certain types of new developments.

Two examples of actions adopted by other entities promoting water conservation include:

- ❒ The City of Aurora, Colorado enacted a land use code that limits the amount of turf permitted for new construction.

- ❒ The North Marin County Water District offers cash credits to customers based on district guidelines for outdoor landscaping. Guidelines include a reduction in turf area, compared to traditional landscapes, use of drought tolerant shrubs and ground cover, efficient design of underground sprinkler systems and guidelines for soil care and preparation. These guidelines evolved from research in 1985 showing that planned unit developments (such as town houses, and condominiums) with efficient landscaping resulted in a 54 percent water savings and significant labor and fertilizer cost reductions compared to traditional, turf grass oriented landscaping.

Landscaping and irrigation water efficiency standards could be encouraged by implementing water cost incentives, in which greater water usage is priced at higher rates. Drip irrigation rebate incentives offered by the city, such as North Marin County cash credits, could encourage developers and homeowners to install water efficient systems and investigate the possibilities and benefits of drought tolerant landscaping.

Consider greywater systems

Presently, installation, development, or use of a greywater system in the cities of Moscow, Idaho and Pullman, Washington is illegal. Both Moscow and Pullman operate on the 1991 Uniform Plumbing Code. The coding for GREYWATER SYSTEMS FOR SINGLE FAMILY DWELLINGS, is added in the 1994 Uniform Plumbing Code, but has not been adopted by the States, the Cities or the Health Departments.

In light of the significant water savings that are possible with greywater recycling efforts, the Pullman-Moscow Water Resources Committee should research and consider the promotion of greywater use for irrigation and/or blackwater flushing.

What is "Greywater"

The best greywater sources are bathroom, tubs, showers, and sinks. However, any water that has been used in the home, except water from toilets, is called greywater. Dish, shower, sink, and laundry water comprise approximately 80% of inside residential "waste water." This may be reused for other purposes, especially landscape irrigation. Toilet-flush water is called black water. Contaminated greywater or waste water that is difficult to handle, such as solids-laden kitchen sink water or water used to launder diapers, is sometimes called "dark grey" or "blackwater". Waste water without added solids, such as warm-up water from the hot water faucet, reverse-osmosis reject water or refrigerator compressor drip water, is called "clearwater".

Greywater systems have been used informally for a long time. Greywater systems are modifications of septic system technology and thereby use components standards to septic systems. The primary modification is the location of the drainfield in the root zone of plants making the greywater most useful for irrigation. An important feature of a greywater system is the isolation of blackwater to a separate system, leaving the greywater available for reuse, most often as irrigation water.

Greywater as a source of water for flushing toilets can be used in conjunction with or independent from a greywater irrigation system. Rather than using fresh, potable

water to flush toilets, waste water from sinks or showers is stored and later pumped or dumped by gravity into the flushing tanks of toilets. Such a system requires "double plumbing" part of homes to possibly include: water storage, pumping, and surplus water overflow.

The treatment of the greywater topic in this recommendation is introductory in nature. Developing a complete greywater system would require more significant research in the concept, design and implementation of such a system. For a list of Greywater Resources see Appendix A: Resources.

The benefits of greywater recycling include:

Lower demand for deep aquifer pumping. Greywater can replace ground water in many instances, saving money and increasing the effective water supply in regions where irrigation is needed. All water except toilet water could be recycled outdoors, achieving the same result with significantly less ground water pumping.

Less strain on septic tank or treatment plant. Greywater use greatly extends the useful life and capacity of septic systems and municipal treatment systems. The decreased water flow generally means higher treatment effectiveness and lower costs and it increases the life of the waste water treatment plant before an addition is needed.

Highly effective purification. Greywater is purified to a high degree in the upper, most biologically active region of the soil. This protects the quality of natural surface and ground waters. Since most of the greywater is used to irrigate plants, most of it is transpired by the plants to the atmosphere.

Less energy and chemical use. Less energy and chemicals are used due to the reduced amount of both fresh water and waste water that need pumping and treatment. For those providing their own water or electricity, the advantage of a reduced burden on the infrastructure is felt directly. Also, treating your waste water in the soil under your own fruit trees definitely encourages you to not dump toxic chemicals down the drain.

Reclamation of otherwise wasted nutrients. Loss of nutrients through waste water disposal in streams or rivers is a subtle but highly significant form of erosion. Reclaiming nutrients in greywater helps to maintain the fertility of the land.

The drawbacks of greywater recycling include:

Legal concerns. In most parts of the country, the legality of greywater systems is a "grey" area. However, there seems to be a general movement toward regarding greywater recycling with renewed merit concurrent with increased experience and improved systems. Santa Barbara County (Calif.) was one of the first localities in the U.S. to legalize greywater use in 1989. Greywater was legalized at the state level in California in 1994. Other municipalities in the nation have legalized and regulated the use of greywater for irrigation or flushing toilets.

Health concerns. The main reason greywater remains illegal in many areas is concern for public health. However, in practice, the health threat from greywater has proven to be insignificant. There is no known documented record of an instance in which a person in the U.S. became ill from greywater. The first actual field test by the

Department of Water Reclamation in Los Angeles found that greywatered soil teemed with pathogens. However, the control soil did as well.

Drain pipes impossible to reach. It may be difficult to gain access to drain pipes within your home.

Unsuitable soil. Soil that is extremely permeable or impermeable may preclude the use of a greywater system or at least require special adaptations.

Insufficient combined waste flow. If all greywater is reused all the time, the flow through municipal sewers may occasionally be insufficient to move toilet solids.

Additional initial costs to the consumer. The use of greywater for irrigation requires separate blackwater and greywater waste lines in the house. This is not a difficult task in new construction but can be problematic in existing buildings. The best applications for greywater will be in conjunction with low water demanding landscapes.

An example of greywater approval: Austin, Texas

Greywater systems are a popular alternative water system in Austin, Texas. Public presentations regarding greywater systems have been well attended over the past several years. A greywater system must be approved by the Health Department. Current regulations deal with sub-surface greywater systems similar to septic tanks. The Austin-Travis County Health Department approves "Innovative Systems," in that there is a case by case review of innovative approaches. The possibility of system failure causing a public health threat, liability, and maintenance issues, and potential negative environmental effects are central concerns in considering approval of innovative systems. Currently, the Health Department will not approve above-surface irrigation systems. The Health Department has a "cookbook' of acceptable septic system and greywater designs. Standard designs may be allowed in accordance with lot size and conditions such as slope. Any system outside of the "cookbook" typically requires submission by a registered Professional Engineer.

GLOSSARY

Cubic Foot (cu ft):	A measurement of water. One cubic foot = 7.4805 gallons (sometimes rounded to 7.5)
GPD:	Gallons per day
GPM:	Gallons per minute
GPCPD:	Gallons per capita per day
Greywater:	Waste water from showers, sinks, and laundry not containing human waste
Xeriscape:	Drought tolerant landscaping, the use of low water demand plants and materials in a strategy to reduce water demand in landscaping.

APPENDIX A: RESOURCES

Low water use demonstration gardens

Lawson Gardens in Pullman, Washington planted a Xeriscape or drought tolerant garden plot. When the plants have established healthy root systems, they will be largely drought tolerant, requiring little or no watering.

Carol Ryrie Brink Nature Park in Moscow, Idaho planted in the Fall of 1995 with native trees, shrubs, grasses and flowers will provide the community with examples of riparian (streamside) and drought tolerant native species. Contact PCEI at 882-1444 for a complete planting list and other information.

The University of Idaho Arboretum has several species of native drought tolerant plants and grasses. Dr. Richard Naskali, Arboretum Director, offers free native plant tours in the Arboretum and surrounding areas. Contact Dr. Naskali at 885-6250.

Contact Master Gardeners in Moscow and Pullman for residents with drought tolerant gardens and landscaping in their homes. The Master Gardener program, offered by the cooperative Extension Service, can be contacted by phone to answer questions directly or callers can ask to hear one of several tapes on landscaping topics. For further information on these services, contact your local extension agent.

Latah County Extension Office (208)
Whitman County Extension Office: (509)
Harriet Hussman, Nez Perce Extension Office, (208) 799-3096

The Seattle Water Department has sponsored low water use demonstration gardens at the Northwest Flower and Garden Show. The Show is usually in February. For information - Seattle's previous involvement in the Flower and Garden Show, contact the Seattle Water Department's Conservation Office (206) 684-5879,

The grounds at Children's Hospital and Medical Center, especially the buffer strips in parking lot 4, are planted using low water use plants. The Hospital is located at 48000 Sand Point Road Way Northeast, in Seattle. For further information on the grounds, contact David Johnson (206) 527-3889.

The Center for Urban Horticulture at the University of Washington has a marvelous library for low water use landscaping materials. The Elisabeth C. Miller Library has made researching low water use landscaping easy by collecting relevant articles in easy-to-use subject files and preparing booklists on the subject. The Center also has a speakers bureau which can be accessed for lectures on aspects of low water use landscaping and offers classes related to water efficient gardening and landscaping. Contact the Center at (206) 543-8616 for more information.

Local/regional native plant suppliers

Native Habitat for Gardens
225 E. Henley
Moscow, Idaho 83843
Phone (208) 882-7063

Native Habitat for Gardens is a local retailer of native plants.

NORTHPLAN/Mountain Seed
P.O. Box 9107
Moscow, Idaho 83843-1607
Phone: (208)

NORTHPLAN / Mountain Seed stocks a wide array of wildflower / herbaceous species, deciduous shrubs, vines and trees, coniferous trees, and some native grasses for wildland landscaping.

Plants of the Wild and Seeds, Inc.
P.O. Box 866
Tekoa, Washington 99033-0866
Phone (509) 284-2848
FAX (509) 284-6464

Seeds, Inc. stocks a variety of turfgrasses, fieldgrasses, wheatgrasses, clovers, legumes, and forbes. Retail and wholesale.

Grassland West
P.O. Box 489
1392 Port Drive
Clarkston, WA 99403
Phone: (509)

Grassland West, designed for reclamation specialist, ranchers, wildlife managers, and anyone else who uses seed products for landscaping projects, stocks a variety of grasses, legumes, trees, shrubs, wildflowers, and wetland and riparian plants.

Wind River Seed
Rt. 1 Box 97
Manderson, WY 82432
Phone (307) 568-3325
FAX (307) 568-3326

Wind River Seed, established in 1975, stocks a variety of grasses, legumes, shrubs and trees, and wildflowers and forbes.

Bitterroot Native Growers, Inc.
445 Quast Lane
Corvallis, Montana 59828-9406
Phone (406) 961-4991
FAX (406) 961-4626

Bitterroot Native Growers, Inc. (BNG) combines a native plant nursery with a full-service, highly trained, professional services staff to provide creative solutions to revegetation needs. BNG's nursery produces the finest quality container-grown trees, shrubs, wildflowers and wetland seedlings.

Landscape design and gardening

Xeriscape: Landscaping to conserve water, (PAS Memo, February 1991). Chicago: American Planning Association, 1991. 3 p.

Daniel, Alice, "Xeriscaping: Return of the Wild Ones", *Buzzworm: The Environmental Journal,* vol. 1, number 3, Spring 1989

Kourik, Robert, "Xeri-what?", *National Gardening,* August 1989

Nelson, John Olaf, "Water Conserving Landscapes Show Impressive Savings", *Journal AWWA,* March 1987. This article illustrates the water, fuel, labor, fertilizer and herbicide savings achievable through low water landscaping.

Nelson, John Olaf, "Why Turf Requires So Much Water", May 1990. Copies of this paper cost $1.00 and are available by contacting the North Marin Water District, 999 Rush Creek Place, Novato CA 94945, (415) 8977-4133.

Sonoma County Water Agency, "Xeriscape", 2150 W. College Ave., Santa Rosa CA 95401, (707) 526-5370. This booklet contains illustrated xeriscape designs and a plant list.

Ferguson, Nicola, *Right Plant, Right Place,* Summit Books, 1984.

Hakala, Sue, *Drought Gardening,* Storye communications, Pinwale VT, 1981.

Robinette, Gary O., *Water Conservation in Landscape Design and Maintenance,* Van Nostrand Reinhold, New York, 1984, 258 p.

Gottehrer, Dean M., *Natural Landscaping,* Dutton, New York, 1978, 182 p.

Sunset Books, *Water Wise Gardening,* Lane Publishing Co., Menlo Park CA 1989

Welsh, Douglas F., *Landscape Water Conservation Xeriscape,* Texas Agricultural Extension Service, College Station TX, 1988, 9 p.

Taylor's Guide to Water Saving Gardening, Houghton Mifflin, Boston, 1990, 447 p. Part of the *Taylor's guides to Gardening* series.

Kruckeberg, Arthur, *Gardening with Native Plants of the Pacific Northwest; an Illustrated Guide,*. University of Washington Press, Seattle, 1982, 252 p.

PlantMaster, Gerry Kiffe of Acacia Software, P.O. Box 90525, Santa Barbara CA 93190, (805) 964-7497. This software can help both landscape architects and water utility managers choose California native plants and other drought resistant plants for use in low water landscapes. The plants are cross referenced for soil type, height, etc.

Cooperative Extension, "Saving Water--Lawns and Other Turf", Washington State University, 1977. Available for a small fee from your local Cooperative Extension Agent or contact: Bulletin Dept., Cooperative Extension, Cooper Publications Bldg., Washington State University, Pullman WA 99164-5912.

Ball, Ken. *Xeriscape ™ Programs for Water Utilities,* American Water Works Association, 1190, 91 p.

California Department of Water Resources, *Landscape Water Conservation,* Guidebook No. 8, March 1988. This guidebook covers the basics of a low water landscaping program, for lawn watering to plant tagging. Available from: Department of Water Resources, central Records, P.O. Box 942836, Sacramento Ca 94236-0001, (916) 445-9371.

Rethinking the Lawn. Turf Warfare in the American Suburbs. Outside Magazine. July 1994. pgs 27-34.

Low water using plants for the Pacific Northwest

Pinyuh, George, "Low Water Use Plants", King County Cooperative Extension, 612 Smith Tower, 506 Second Avenue, Seattle WA 98104, bulletin #125. This plan list can be obtained by calling King County cooperative Extension at (206) 296-3900.

Johnson, David, "Appropriate Plants for Northwest Landscapes", Washington Toxics Coalition, 4516 University WA NE, Seattle, WA 98105, (206) 632-1545. This publication is available through the coalition. David Johnson is Director of Grounds Maintenance at Children's Hospital and Medical Center in Seattle and is a past president of the Western Washington Tilth Assoc. and Seattle Tilth.

Shank, Dale, editor. *Hortus Northwest: A Pacific Northwest Native Plant Directory and Journal,* issue 2, 1990. Hortus Northwest, P.O. Box 955, Canby OR 97013, (503) 266-7968. List of plants native to the northwest and a list of nurseries that carry these plants. Cross-referenced.

Kruckeberg, Arthur. *Gardening with Native Plants of the Pacific Northwest: an Illustrated Guide,* University of Washing Press, Seattle, 1982, 252 p. Lists and pictures.

Greywater resources

Harold Ball
Orenco Systems
2826 Colonial Road
Roseberg, OR 97470

(503) 673-0165

Well established information and hardware source for septic and alternative small treatment systems, including sand filters.

Bahman Sheikh
West Basin Water District
17140 South Avalon Blvd.
Suite 210
Carson, CA 90746
(310) 371-9172

Sponsor of City of Los Angeles Greywater Pilot Project; first scientific field testing of the public health and soil effects of greywater. Report available from Terri Taylor, Wateruse Association,
(916) 442-2746

Glenn France
Casa Del Agua
4366 N. Stanley place
Tucson, AZ 85705

Water conservation demonstration house sponsored by the University of Arizona. Glenn is working on an engineering manual for greywater systems.

Naresh Khofla
Enviromanagement Research
5415 B Backlick Road
Springfield, VA 22151
(703) 642-5310

Performed EPA study of greywater. Report available from National Association of Plumbing, Heating and Cooling Contractors.

Larry Farwell,
Program manager of water conservation planning,
Department of Water Resources,
State of California
(916) 322-1067

Very knowledgeable greywater advocate largely responsible for the current wave of greywater legalization

How to Use Greywater.
Guidelines to the approved Use of Greywater in Santa Barbara County
Version 1.1 May 1991
Prepared by the County of Santa Barbara Greywater Technical Advisory Committee

Irrigation design

Kramer, Jack. *Drip System Watering, For Bigger and Better Plants.* Norton, 1988.

"Drip". *Sunset Magazine,* June 1988, pp. 68-76

"Drip...It's Time Has Come". *Sunset Magazine,* May 1981, pp. 117-165

"How Much Water Does Your Lawn Really Need?" *Sunset Magazine,* June 1987, pp. 213-219

General water conservation materials

A Consumer Handbook on Water Saving and Wastewater Reduction (19 pp., 1976) is available from the Washington Suburban Sanitary Commission, 4017 Hamilton Street, Hyattsville, MD 20781.
This is the first customer handbook of its kind produced and distributed by a water and sewer utility. If offers practical suggestions for changing family and individual behavior to prevent water waste. changing water-use behavior alone can halve the amount of water households use.

Conservation Tips from PG & E
Energy Conservation and Services Department, 77 Beale Street, San Francisco, CA 94106. This public utility publishes pamphlets to help its customers reduce energy utility bills. A few of these are helpful for water conservation as well. They are:

- "Cooling your Home More Efficiently",
- "Saving Energy with Your Swimming Pool",
- "Shoppers Guide: Refrigerators, Freezers, Air Conditioners"

Dick church
Plumbing Manufactures Institute (PMI)
PO Box 484
Glen Ellwyn, IL 60137

PMI has information and conducts workshops on plumbing codes and residential water conserving devices.

The Unthirsty 100. Sunset Magazine. October 1988. Sunset Publishing Corporation. pgs 74-83.

Youth education materials:

Available at or through the PCEI office

EPA Youth Publications: Science Demonstrations Projects in Drinking Water, Grades (k-12) EPA 570-9-90-007, April 1990, YT-0490017

Water: The Source of Life, America's Clean Water Foundation YT-0092030

Don't Splash Your Trash (Coloring Sheet), WA Department of Ecology Y-0000039

Don't Teach Your Trash to Swim! (Coloring Book) Y-0000038

How Rivers are Formed, Water Lesson Plans, YT-0000018

Santa Barbara County Water Education Resource Guide, Grades K-12 Classroom Units: The Guzzler Gang and Activity Booklet, Grades K-3

Water Fun, Grades 1-3

Water is Your Best Friend, Grades K-3

Flannel Board Stories: Water is Peter's Best Friend, Grades K-2 and Peter's Magical Water Journey, Grades 2-4

The Story of Drinking Water, Grades 1-3, 4-6, 7-9

Water Fun for You Coloring Book, Grades K-3

The Official Captain Hydro Conservation Workbook, Grades 5-6

The Further Adventures of Captain Hydro, Grades 7-8

Think Earth, Grades K-6

Santa Barbara County Water Education Resource Guide, Grades K-12, Hands-On Activities Guide: Water Activities Manual for Santa Barbara County, Grades 6-8

Water Science, Grades 3-6

Project Water Works-Project Science Software, Grades 6-12.

Computer Software: *Hydroexplorer,* Grades 4-6.

Project Water Science, Grades 7-12.

Santa Barbara County Water Education Resource Guide, Grades K-12, Films and Videos: "H2O-2010" Video, Grades 7-12.

To Quench A Thirst Video, Grades 7-12.

Think Earth, Grades K-3.

Water Activities Manual, Grades 6-8, Santa Barbara County Water Purveyors

Parents and their Children in Environmental Education by Karen J. Peterson, RRT 487, May 10, 1994

Project Wet. 1192. Idaho Water Resources Research Institute. University of Idaho; Morrill Hall Room 106; Moscow, Idaho 838343. (208)885-6429

Project Wild/Project Wild-Aquatic. Western Regional Environmental Council. P.O. Box 180060; Boulder, CO 80308-8060. (303)444-2390

Teenage Mutant Ninja Turtles, Storm Drain Savers Coloring Booklets

Living Lightly in the City: an environmental education guidebook for grades 4-6, volume II. Second edition. Written by Maura O'Connor and Kathy McGlauflin. Illustrated by Nancy Chenery. 1982. Available through Schlitz Audubon Center, Robert Nichols, Director, 1111 East Brown Deer Road, Milwaukee, WI 53217

APPENDIX B: DROUGHT TOLERANT PLANT LIST

A partial list of drought tolerant plants available to Palouse landscapers include the following species. Additional species are identified by sources in the prvious appendix.

Shrubs:

Aronia melanocarpa	Black Chokeberry
Cornus sericea	Red Osier Dogwood
Elaeagnus umbellata	Autumn Olive
Elaeagnus angustifolia	Russian Olive
Cotoneaster divaricata	Spreading Cotoneaster
Cotoneaster multiflora	Flowing Cotoneaster
Caragana microphyla	Littleleaf Siberian Pea
Symphoricarpus orbiculatus	Coralberry
Rhus typhina	Staghorn Sumac
Rhus aromatica	Fragrant Sumac
Rosa nymbrifolia	Redleaf Rose
Rosa woodsii	Woods Rose
Berberis thumborcii	Japanese Barbery
Sorbaria sorbifolia	Ural Falsespiraea
Mahonia aquafolium	Oregon Grape

Trees:

Pinus nigra	Austrian Pine
Pinus ponderosa	Ponderosa Pine
Abies concolor	Concolor Fir / White Fir
Tilia tomentosa	Silver Linden
Corylus colurna	Turkish Filbert / Hazel
Robinia psuedoacacia	Black Locust
Quercus shumardii	Shumard Oak
Pinus Flexilis	Limber Pine

Perennials:

Achillea	Yarrow
Salvia	Salvia
Cerastium tomentosum	Snow in Summer
Sedum spectabile	Autumn Joy Sedum
Helenium autumnale	Helens Flower
Achillea millefolium cerise queen	Red Yarrow
Echinops ritro	Globe Thistle
Gypsophila paniculata	Baby's Breath
Echinacea purpurea	Purple Coneflower
Saponaria ocymoides	Soapwart

Stachys lanata	Lamb's Ear
Centaurea montana	Cornflower
Veronica	Veronica
Lavandula stoechas	Lavender
Santolina	Lavender Cotton
Ruta graveolens	Rue
Euphorbia polychroma	Flowering Spurge
Festuca glauca	Blue Fescue
Yucca	Yucca
Perovskia atriplicifolia	Russian Sage
Coreopsis verticillatia	Moonbeam' cereopsis
Culvers Root	Culvers Root
Chrysanthemum maximum	Shasta Daisy
Nepeta	Catmint
Carex glauca	Blue sedge
Elymus arenarius	Blue Wild Rye
Paeonia	Peony

Bulbs:

Muscari	Grape Hyacinth
Crocus	Crocus
Daffodil	Daffodil
Eranthis	Winter Aconite

APPENDIX C: REFERENCES

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City of Austin, Texas. *Sustainable Building Sourcebook:* supplement to the Green Builder Program.

Consumer Reports. Water Savers. February 1995.

Environmental Protection Agency. *The Alternative is Conservation.* August 1980.

Foster, Kennith E., Martin M. Karpiscak, and Richard G. Brittian. 1988. Casa Del Agua: A Residential Water Conservation and Reuse Demonstration Project in Tucson, Arizona. *Water Resources Bulletin* 24: 1201-1206.

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