AN OVERVIEW OF ON-SITE **GREYWATER RECYCLING** FOR COMMERCIAL BUILDINGS AND SCHOOLS

THE EMERGING WATER CRISIS

Water conservation is now a topic of broad and current interest in California, but the conversation transcends the immediate response to the current severe drought cycle. There is a growing consensus that drier climate and related climate instability will be the State's "new normal" into the foreseeable future. Another long-term planning concern is State population growth. California's population increased by 10 million between 1980–2000 and will increase by another 14 million by 2030, reaching 48 million. Most Californians no longer take the supply of clean potable water for granted, but instead perceive it as an increasingly finite and valuable natural resource. On-site greywater (GW) re-use is one strategy under discussion that can conserve or extend the supply of clean potable water for urban use.

WHAT IS GREYWATER?

Light GW is waste water that comes from showers, bathroom sinks, laundry rooms, while dark GW, which comes from dishwashers and kitchen sinks, might be included. Blackwater (BW) comes from toilets and urinals. While rainwater is often called GW when used in place of potable water, it does not meet the technical definition. There is a significant difference between GW and BW from a water quality perspective.

WATER CONSERVATION POTENTIAL OF GREYWATER RECYCLING

On-site GW recycling offers significant potential to reduce urban water demand by up to 25%. Many schools and colleges in California have long since incorporated the "low hanging fruit" of water saving strategies. For example, conventional water-saving technologies such as low-flush toilets, water saving bathroom fixtures and sophisticated water-efficient landscape irrigation systems are either standard design or accepted best practices in many schools. About 50% of waste water discharge from schools is GW, but this may approach 80% for school gymnasiums with shower facilities.

COMMUNITY-WIDE BENEFITS OF GREYWATER RECYCLING

Water conservation is not the only important reason for incorporating on-site GW reuse. Perhaps the most compelling long-term justification is water pollution abatement. Many municipal sewer systems in the U.S. today are operating at near capacity. Untreated sewage overflows into coastal waters and local water courses are common pollution mishaps which can occur when storm water surges overwhelm sewage treatment capacity. This pollution can threaten vital potable water resources for local communities. The reality is that as little as one-tenth-inch of rainfall has resulted in releases of untreated sewage into rivers in some communities.

Municipal sewage treatment is an expensive and energy-intensive industrial operation. If GW were not sent for sewage treatment, municipal sewage capacity would be increased substantially. This would not only reduce the risk of water pollution, but would offset the high cost of building new or expanded sewage treatment plants. GW is relatively easy and inexpensive to treat, but once it becomes intermixed with BW (and storm water in some cases) the entire volume becomes highly contaminated which require much more intensive industrial-level treatments involving physical, chemical and biological processes.

HOW IS GREYWATER REUSED ON-SITE?

1. Shower Water
2. Washing Clothes
3. Flushing toilets and urinals
4. Washing dishes
5. Subsurface Irrigation
6. Dust Control
7. Artificial ponds

ON-SITE TREATMENT OF GREYWATER

Although GW may be perceived to be "clean," it can actually be highly polluted with Biological Oxygen Demand (BOD) concentrations up to several hundred milligrams per liter (mg/l) and can contain harmful microorganisms. The quality of greywater is highly variable and can cause health risks and negative aesthetic effects, especially in warmer climates. The kitchen sink, laundry and dish washer are the main contributors to contaminants in GW.

A few off-the-shelf commercial size GW treatment systems are available to process GW on-site. Most treatment systems are based on physical and chemical processes (filtering and disinfection) but some advanced systems now incorporate a biological treatment step. These systems rely on surge tanks, pumps, and filtration systems to process GW. GW must be treated if it is to be stored for 24 hours or more to prevent microorganism growth and odor. GW should also be treated if the intended on-site use has a high risk of human contact.

TREATMENT METHODS

No Treatment. Often the best on-site solution is to maintain a system in which water does not require storage. The most common no treatment option is sub-surface irrigation for landscaping, parks and athletic fields. Subsurface irrigation allows contaminants to be treated within the layer of soil with little risk of human contact. Most contaminants in GW are non-harmful to plants or act a fertilizer. Some studies show that untreated GW can have a hydrophobic impact on soils when GW has high surfactant concentration; however a low tech solution is available. GW can be effectively treated with a vertical flow constructed wetland to eliminate these soil absorption problems.

Treatment by filtration. First-stage filtration prevents course contaminants such as hair, lint and food particles from entering the grey water system. Depending on the end use, higher quality water requires finer filtration charcoal, cellulose or ceramic cartridges.

Treatment by Settlement and Floatation. This method can remove solids, grease and oils from greywater and allow for cooling hot water before release.

Biological Treatment. A rotating biological contactor may be incorporated to reduce chemical oxygen demand and organic matters. This "secondary treatment" provides aeration and promotes degradation of pollutants by introducing beneficial microorganisms.

Treatment by Disinfection. This step should only be carried out following biological treatment. Adding chlorine is the most common method, followed by ultraviolet disinfection and ozonation.

OBSTACLES TO GREYWATER HARVESTING

- High cost to retrofit separate greywater plumbing systems in existing buildings. New Construction is more cost-effective
- Some Health Department Regulations prohibit or regulate GW reuse
- GW must be treated prior to storage
- Commercial on-site GW treatment systems are complex, require regular maintenance and must be designed by qualified professionals
- Resistance to change
- Public perception about whether treated GW is unsanitary for some uses, such as showering and washing dishes
- Unproven payback economics

COST AVOIDANCE BENEFIT TO GREYWATER HARVESTING

Some vendors of commercial off-the-shelf GW treatment systems claim typical payback for on-site GW recycling in 3–5 years. However there is relatively little documentation to support these claims and the payback economics appears to be unproven. At any rate there are many project-specific variables that would profoundly influence the payback economics of on-site GW recycling. For example, variables include economies of scale, the cost of potable water, state and local health department regulations, the quality of GW, GW treatment required, GW treatment equipment life, the intended on-site end-use(s) for GW, and whether the GW recycling project involves an existing building or new construction.

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REFERENCES & RESOURCES

Aquaco Water Recycling www.aquaco.co.uk/Grey-Water

Purewater LLC www.purewater2000.com

Wahaso Water Harvesting Solutions http://wahaso.com/greywater_system.php

Green Building Alliance
www.go-gba.org/resources/green-building-methods/greywater-system/

Al-Hamaiiedeh, H., and Bino, M., "Effect of treated grey water reuse in irrigation on soil plants" Desalination 256.1 (2010) 115-119

Al-Jayyousi, O. "Greywater reuse: towards sustainable water management." Desalination 156.1 (2003), 181-182

Allen, L.J., Christian-Smith, and M. Palaniappan, "Overview of greywater reuse, the potential of greywater systems to aid sustainable water management " Pacific Institute, November 2010

Cohen, Y. (2009). Graywater-A potential Source of Water, Southern California Environmental

Friedler, E., Kovalio, R., Galil, N.I., (2005) "On-site greywater treatment and reuse in multi-story buildings" Water Science & Technology Vol 51 No 10 pp 187-194

Memon, F.A., et al. "Economic assessment tool for greywater recycling systems" Proceedings of the ICE-Engineering Sustainability 158.3 (2005), 155-161