# REVIEW OF GREYWATER REUSE PRACTICES IN VICTORIA

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## Abstract

Greywater reuse has become popular in rural and urban communities of Australia. In recent years, the Barwon region of Victoria has been affected by drought and as a result, water restrictions were imposed at different stages. While a water conservation by-law was introduced in February 2003 with overwhelming community support, greywater reuse is still debated among householders, Environment Protection Authority (EPA), local councils, and the water authorities. Higher levels of greywater reuse are needed due to low average rainfall in the region and high water consumption per capita. This paper looks at the position of the different parties that govern greywater reuse and presents the factors that restrain uniform reuse practices. Factors considered include quantity and quality of greywater generated in the Barwon region, current regulatory controls as reviewed through a series of surveys of local councils and water authorities. While the water restrictions resulted in an increased demand for alternative means of watering garden areas, the regulatory conditions were found to be unsettled about greywater reuse, with a wide range of concerns making these authorities unwilling to encourage it.

## Keywords

Barwon region, greywater reuse, on-site greywater systems, rural areas, sustainable resource, water restriction.

## 1 Introduction

Victorians generate some 1300ML of sewage daily, 80% of which is discharged to coastal waters. After treatment, 12% of this waste is discharged to inland streams and 8% recycled (EPA Victoria, 1995). As a result of this practice many streams and lakes may suffer from excessive levels of nutrients, accentuating dry weather or low-flow problems. EPA Victoria regards irrigation of land with wastewater as a more desirable alternative to discharging waste into water, particularly where soil and climate are favourable (Thomas, 1991).

In recent years, crucial water use restrictions were applied in the Barwon Region (Victoria) as a result of dry conditions. These led to a reduction in water consumption by 6% and 19% during Stages 1 and 2 restriction periods, respectively (Barwon Water, 2000). Having endured various degrees of restrictions from January 1998, abandoned in July 2001, and with permanent restrictions re-introduced in February 2003 (Barwon Water, 2003), officials seem to have changed their position about greywater reuse. At the time where Melbourne's water storages were 50.6% full in January 2003 (5.6% above cut-off for Stage 2), *Herald and Weekly Times* (2003) reported a politician's invitation to growers to reuse treated effluent from Werribee sewage treatment plant in crops. Although this is a good change of attitude, authorities surprisingly remained undetermined about reuse of a relatively small volume of greywater in our yards.

Following the 1998-2001 water restrictions, householders expressed interest to local authorities about reuse of greywater generated from clothes washing to water gardens and lawns. For the purpose of this paper, the definition of greywater is confined to the wastewater generated from a household's laundry and bathroom (not including toilet). Although recent dry conditions have brought the water reuse issue into the public spotlight, the possibility of disease transmission will remain the key factor making the approval of such practice quite a complex one. In fact, EPA Victoria recently considered regulating shelf products currently used in greywater diversions work (EPA Victoria, 2003). While users view reuse as being conservative, safe and may operate illegally to reduce their water consumption bill, water authorities may view any reduction in water consumption as a potential loss in revenue. This study examines greywater reuse as an integral part of the wastewater management system with the overall objectives to:

1. review the regulatory requirements in Australia and particularly in Victoria and the Barwon Region;
2. identify the pressure on existing water resources and characterise the greywater produced from residential properties in different regions;
3. identify existing greywater treatment technologies and their use in Victoria; and
4. make recommendations on future directions with greywater reuse.

## 2 Regulatory Requirements

Regulation and guidelines covering greywater reuse that are relevant to Geelong and the Barwon Region include:

- ***National:*** Australian Standard (AS/NZS 1547:2000) covers primary and secondary systems and associated land applications for waste generated from an equivalent population of up to 10 persons. Diversion systems are not covered.
- ***State:***. Environment Protection Act 1970 – Part IXB--Septic Tank Systems, EPA Guidelines. This extends septic definition to any modifications incorporated in greywater (ie, inclusion of a filter). Similar to above, diversion systems are not covered.
- ***Local:*** Guidelines for greywater (sullage) irrigation – City of Greater Geelong (2001a).

**EPA role.** The EPA manages all discharges of wastes from point sources to surface water by a robust framework entailing licencing, monitoring and auditing (EPA Victoria, 2001b). EPA may be involved if the operation of an on-site system involves discharge into waterbodies. Their main concern is nutrients and pathogenic input into waterways that may lead to algal blooms and unsafe beaches. In Victoria, State Environment Protection Policies (SEPP) encourage recycling and reuse of wastewater and irrigation of effluent to land (EPA Victoria, 1994). For this purpose, guidelines were developed to provide specifications for the use of effluent in any scheme. These are applied to both public and private sectors and set the rules for treatment, control mechanisms and monitoring of wastewater use. Due to increased pressure about water restrictions, EPA published a greywater bulletin to address these interests. Options for greywater reuse as identified by EPA bulletin are detailed under two broad categories (EPA Victoria, 2002): i) the diversion of untreated greywater for immediate use, and ii) the installation of systems to collect and treat household wastewater, and reuse of the resulting effluent. Some of these observations are noted below.

**Flexible control (diversion systems).** Mainly allowed during warm and dry conditions, and although they seem to be flexible, the authority states that "*householders are advised to contact the water authorities and local councils before installing a diversion system".* A licensed plumber must carry out the installation. The lack of local or State government

controls on household diversion systems makes users vulnerable to future legal liabilities. Householders are advised about 19 necessary but unmeasurable procedures, to reduce the health and environmental risks. Under this flexible control, the guidelines include instructions on: dry period irrigation, backflow prevention, use of low phosphorus detergent, diversion of low risk greywater, restriction on irrigating edible crops, and containment of greywater within property boundaries (EPA Victoria, 2001a).

**Rigid control (treatment systems).** If the user's intention is to collect, treat and reuse the greywater, the authority states that *"an approved EPA system must be installed and a septic tank permit must be issued by the local council*". Overall, the above guidelines seemed to be less stringent than the Health Act (1958) which states that *"a person other than a sewerage authority shall not use wastewater for any purpose whatsoever unless a permit or licence is granted"* (McQuire, 1999). A limited number of greywater systems are approved by EPA, and these require an operational permit issued by the local council.

**Council's role**. At the local level, councils follow the guidelines set out by the EPA, and it is each council's responsibility to implement and regulate these guidelines which were only intended for use during Stage 2 water restrictions. In the City of Greater Geelong, the guidelines set the criteria for greywater irrigation, and these include: subsoil disposal, restriction on reuse when there is gastrointestinal illness in the household, diversion to sewer in periods of heavy rain, containment of waste within property boundaries, no accessibility to children, irrigation should not result in ponding, and irrigation of vegetables is not allowed (City of Greater Geelong, 2001a). Prior to approval of a new development, municipalities have a key role in assessing the capability of the land if the wastewater is to be managed on-site, including greywater approved systems. A recent draft of SEPP, Clause 29, EPA Victoria (2001b) proposes that "*municipalities regularly audit the performance of on-site wastewater systems against permits conditions issued by them. Once an on-site system is installed, no person shall create offensive conditions or conditions that may pose a threat to public health"*. Similarly, greywater treatment systems are regulated by various acts: *Environment Protection Act* 1970 (makes it an offence to pollute water, air and land, and so greywater has the potential to do all three) and *Health Act* 1958 (makes it an offence to cause nuisances, which are or liable to be, offensive or dangerous to health).

# 3 Pressure on Water Resources

Water restriction has been an issue in Geelong and the Barwon region for a number of years. Using Geelong's 1999 population of 190,000 (City of Greater Geelong, 2001b) and a domestic water percentage of 60% (Barwon Water, 2001), the water consumption per capita showed a slight decrease (Table 1).

**Table 1 Water consumption in the region (Barwon Water, 2001)**

| Date | Water consumption rate, ML | Water consumed per person, L/capita.d | Service area |
|---|---|---|---|
| 1999 | 37,313 (30,155) | (260) | Region (Geelong) |
| 2000 | 35,710 (28,240) | (243) | Region (Geelong) |

Notes: Region- Geelong, Barwon Coast, Colac, Barwon, and Bannockburn

Recent dry conditions experienced in Geelong and the Barwon Region have translated into low water storage over the past four years, with Barwon Water using the Barwon Downs wellfield to supplement demand. Throughout 1999/2000 a total of 11,400 ML of groundwater was extracted to meet the demand (Barwon Water, 2001). Reuse of greywater is one way to achieve future water demand, which is likely to result in less fresh water being required,

reduced influent loads into treatment facilities, and reduced effluent discharge rate into the waterways. Two questions have to be answered: would the quantity and quality of this source be appropriate for reuse?

# 4 Quantity & Quality of Greywater

Greywater quantity and quality can vary considerably depending on what each household chooses to dispose of down the drain. Some of the factors influencing the characteristics of greywater are reported by Jeppesen (1994) and these include: source (bathroom or laundry), socio-economic factors, personal hygiene, habits and activities, types of cleansers and detergents used, family composition; and climate.

**Quantity.** The quantity of greywater generated by any household will be directly related to the number of occupants in the house, water use practices, and the greywater sources. A breakdown of in-house water use, as in Table 2, may vary from house/region to another. Barwon Water (2001) data shows that about 54% of the total wastewater generated inside an average Barwon Region home could be available for reuse. Estimates made by urban water authorities around Australia on domestic water use in Geelong (Barwon Region figures) and the capital cities are produced in Table 3.

**Table 2 Typical breakdown of household water use in the Barwon region (Barwon Water, 2001)**

| Wastewater Type | Total wastewater generated | | Total greywater generated, | |
|---|---|---|---|---|
| | % Total | L/day | % Total | L/day |
| **Toilet** | 31 | 148 | - | - |
| Bathroom | 31 | 148 | 57 | 148 |
| Laundry | 23 | 111 | 43 | 111 |
| Kitchen | 15 | 74 | - | - |
| Total | 100 | 481 | 100 | 259 |

**Table 3 Major urban water authorities domestic usage (Jeppesen, 1994 & Barwon Water, 2001)**

| City | In-house consumption, L/day/house (%) | Ex-house consumption, L/day/house (%) | Total water consumed, L/day/house |
|---|---|---|---|
| Geelong | 481 (65) | 259 (35) | 740 |
| Melbourne | 450 (62) | 275 (38) | 725 |
| Adelaide | 466 (50) | 466 (50) | 932 |
| Brisbane | 586 (48) | 646 (52) | 1232 |
| Darwin | 959 (50) | 959 (50) | 1918 |
| Perth | 473 (53) | 423 (47) | 896 |
| Sydney | 680 (75) | 226 (25) | 906 |

As such, most cities are split roughly 50-50 on water usage inside and outside the home, with the major differences attributed to differing climatic conditions. Christova-Boal *et al* (1995) reported similar variations in greywater quantities in urban houses. In their study, quantities of greywater generated from four Melbourne houses varied significantly (Table 4), mostly due to occupants' water use patterns.

**Quality of greywater.** Faecal coliforms such as *Eschericia coli* (*E.coli*) are used as a pollution indicator to suggest whether greywater has faecal contamination. Rose *et al* (1991) and Jeppesen (1994) reported that faecal coliforms may be used to assess the relative safety of greywater. Although toilet wastes are not included in a greywater stream, the bacterial load in greywater may still be high enough to indicate a health risk.

**Table 4 Greywater quantities produced in four Melbourne houses (Christova-Boal *et al*, 1995)**

| Site | Bathroom water generated, L/week/house | Laundry water generated, L/week/house | Greywater generated per week, L/week/house |
|---|---|---|---|
| 1 | 2450 | 1200 | 3650 |
| 2 | 1420 | 400 | 1820 |
| 3 | 460 | 210 | 670 |
| 4 | 840 | 520 | 1360 |

Many studies report faecal coliforms in greywater (Khalifé, 2000, Christova-Boal *et al*., 1995, Rose *et al*, 1991). Rose *et al*. (1991) report that families with young children exhibit higher levels of total and faecal coliforms, averaging 1.5 x $10^3$ and 3.2 x $10^5$ cfu/100ml, respectively. For families without children, the bacterial load varies between 6 and 80 cfu per 100ml. Total and faecal coliforms were reported as higher in shower water, $6x10^3$-$10^5$ cfu/100ml than in laundry wash and rinse water, 25-126 cfu/100ml. These values compare well with faecal coliforms levels in combined untreated domestic wastewater of $10^6$-$10^7$ cfu/100mL (Tchobanoglous *et al*, 1991), and indicate that greywater may have the same bacterial levels found in combined domestic wastewater. Khalifé (2000) reported faecal coliform levels of $6x10^7$ cful/100mL in greywater generated from six households in central Australia. In addition to the bacterial levels, greywater may contain other pollutants of concern, as in Table 5, such as solids, organic matter and nutrients (ie, nitrogen and phosphorus).

**Table 5 - Greywater pollutant concentrations**

| Parameter | Melbourne Study (Christova-Boal *et al*, 1995) | Jeppesen (1994) | Combined Wastewater (Tchobanoglous, 1991) | Khalifé (2000) |
|---|---|---|---|---|
| BOD, mg/L | 48 – 290 | 33 - 620 | 110 – 400 | 530-1070 |
| SS, mg/L | 48 – 250 | 20 - 1500 | 100 – 300 | 290-774 |
| Total Kjeldahl Nitrogen, mg/L | 1.0 – 40 | 0.6 - 50 | 20 – 85 | - |
| Total phosphorus, mg/L | 0.062 – 42 | 0.3 - 35 | 4 – 15 | 3.2-3.7 |

# 5 Potential Reuse of Greywater & Health Concerns

Fifty four percent of water consumed inside the home is potentially available as greywater (Table 2). . Any presence of pathogens makes the reuse option prone to potential health risks with the main mode of transmission being through the faecal-oral route. There are two possible transmission paths (Jeppesen 1994): i) direct – through ingestion, inhalation or contacting infectious water droplets; or ii) indirect – coming into contact with media contaminated by greywater, such as soil or edible fruit and vegetables. Transmission by insect vectors such as flies and cockroaches is also possible. Numerous guidelines outline measures to combat possible causes of infections, including precautions that need to be taken. There are two options for greywater reuse proposed by Victorian EPA: i) greywater diversion and ii) greywater treatment. Details of the methods used for diversion and treatment can be found elsewhere (Ludwig, 1994). The information below highlights some of these systems.

Greywater diversion systems do not treat greywater and, therefore, are not covered by the Environmental Protection Act 1970 or AS/NZS Standard 1547:2000. Greywater diversion systems can be either gravity diversion or pumped diversion devices. These include: water dump (dishwashing water reuse, garden hose & bathroom fittings, siphon out bath and shower water), drain out back (irrigation of vegetated areas), hard plumbing to mini-leachfields (drained water into a mini-leachfield), enhanced drain out back (drain water into a mulch

basin where required), gravity drum (hose from washing machine is directed to a suitably sized surge tank), drumless laundry system (uses of tubing without surge tank, washing machine pump is also used to disperse the water). Greywater treatment systems (including biological and physical treatment such as filtration) are classified as "septic tank systems" under the Environmental Protection Act 1970. The Act requires that septic tank systems be approved for use in Victoria by the EPA and that the local government issue a septic tank permit prior to installation. Only two greywater treatment systems have been approved for use by the EPA – the Rotaloo and Robert Harry Greywater treatment systems. Some methods used for greywater treatment, not necessarily EPA approved systems, include (Ludwig, 1994): drum with pump and filter, infiltration beds, leaching chambers, leachlines under raised bed, constructed wetlands, and automated systems.

# 6 Reuse Survey in Victoria

At state level, greywater reuse regulations are set by the EPA and regulated by 78 local councils throughout Victoria. Water authorities and the Department of Human Services also have an advisory role to play. To investigate the current state of greywater reuse in Victoria, a survey was carried out of regional water authorities and local councils. The guidelines for reuse options for household wastewater and that of domestic wastewater management in sewered and unsewered areas, were both in draft form at the time the surveys were carried out (June 2001). Three questions were asked: Is greywater reuse practice permitted or encouraged? Are there any plans in the future to investigate greywater reuse? Is domestic greywater reuse seen as a sustainable option for reducing water consumption and disposing of wastewater? Councils have the delegated authority under the *Environment Protection Act* 1970 for septic tank installations up to 5000 L discharge per day, covering greywater reuse, as any form of treatment is considered as a "septic tank system" under the Act.

**Table 6 Regional water authority responses to survey (Dyall, 2001)**

| Water Authority | Greywater Policy | Encourage Reuse | Further Investigation | Concerns/Comments |
|---|---|---|---|---|
| Barwon | X | ✔ | | Long term application, health/environmental impacts, volume of application |
| Central Highlands | | X | | Winter rainfall patterns, public health / GW seen as a valuable resource with potential |
| Coliban | | Neither ✔ nor x | | Need for a change in human habit before GW wont be a substantial public health concern |
| East Gippsland | | Neither ✔ nor X | X | Concern about costs, owner motivation and interest to operate systems. Currently no incentive to reduce demand – water supply greater than demand. |
| Gippsland | | X | | Share EPA concerns |
| Glenelg | | | | No response |
| Goulburn Valley | | | | No response |
| Grampians | | Water conservation practices | X | Must be sustainable & not compromise public health / Further investigation is required |
| Lower Murray | | X | | Environmental & health issues /All GW should be treated – even then it is not looked on favourably in built up areas |
| North East | X | X | | No direct involvement with reuse of GW at this time |
| Portland Coast | | | | No response |
| South Gippsland | | Not fully | | Health & environmental issues, legislative aspects not settled/Acknowledge GW reuse has potential to reduce water consumption |
| South West | ✔ | X Not currently | | Customer Charter states customers can reuse wastewater other than kitchen or toilet subject to council approval |
| Western | ✔ | ✔ | | Customer Charter includes provision for customers to install reuse systems |
| Westernport | | | | No response |

**Key to Table 6**: **Policy** – Does the water authority have a policy on domestic greywater reuse, **Encourage Reuse** - Does the water authority encourage domestic greywater reuse, **Further Investigation** – Does the water authority plan investigate greywater reuse in the future, **GW** – Greywater, * Where a square has been left blank no direct comment was made in regard to the question, **x**- No, ✔ - yes.

Eleven of 15 regional water authorities (Table 6) and thirty-eight local councils (Table 7) in Victoria responded to the survey, and show differences in awareness of existing policies, permissions for reuse, and initiatives to encourage reuse or further investigation into reuse.

| Council | Greywater Policy | Permit Reuse | Encourage Reuse | Further Investigation | Concerns/Comments |
|---|---|---|---|---|---|
| Alpine | | ✓ - FT | ✗ | ✗ | Homeowner commitment to reuse |
| Ararat | | ✗ | ✗ | | Costs – installation, operation & maintenance |
| Ballarat | ✓ | ✗ | ✗ | May consider | Location of municipality – at headwaters of a number of catchments |
| Bass Coast | ✗ | ✓ - not in built up areas | ✗ | | Noisy neighbors not agreeing with system and fabricating complaints. |
| Campaspe | | | Not discouraged | | Public health in urban areas |
| Casey | | ✓ EPA | | | Cost of treating both greywater and blackwater (two systems) |
| Central Goldfields | ✗ | | | ✓ | |
| Colac-Otway | | | ✓ minimal | | Legal liability, health risks, structural damage, nuisance factor, high rainfall |
| Delatite | | | ✗ | Still to be decided | Have experienced problems with septic reuse systems |
| East Gippsland | | ✓ unsewered areas | ✓ | | Property changing hands – no commitment from the next owners, cost, health issues |
| Gannawarra | | ✗ | Packaged TP | | will not be considered |
| Golden Plains | | | Sandfilters / packaged TP | ✓ | |
| Hobson Bay | | | ✓ | ✓ | Cost/Greywater reuse has been recommended by the council for a 68-townhouse development, this will also be the case for other similar developments in future. |
| Hume | ✗ | | ✓ EPA | | Received a few applications and are generally approved. |
| Indigo | | | | | Have nothing to do with water in their area |
| Kingston | | | | ✗ | See GW reuse as a sustainable option to reduce water consumption and to dispose of WW |
| Latrobe | | | | | Uncontrolled reuse not permitted, all WW must be treated according to EPA 20/30 standard and chlorinated. |
| Loddon – Env Health Services contracted to Bendigo | | ✓ must be treated (EPA) | | | GW seen as a vital resource and a sustainable option/ Would like more education from EPA regarding what systems are available. |
| Maribyrnong | | | | | Offer no information and referred to Australian Institute of Environmental Health |
| Maroondah | ✗ | | ✗ | | Possibility of allowing GW to be used for toilet flushing. |
| Monash | | | ✗ | ✗ will focus on stormwater | Have experienced problems with GW reuse – retarding plant growth/killing plants. |
| Moorabool | | | | | Env Health Officer from Ararat has just taken over, position will be very similar to Ararat. |
| Moreland | | | | | Policy encourages green options where feasible |
| Mount Alexander | | | | | Follow EPA – no further opinion |
| Murrindindi | | | | ✗ | No plans for any GW reuse in the shire |
| Nillumbik | | ✓ Treated | | | Movement in the shire towards packaged TP that incorporate reuse. |
| North Grampians | ✗ | | ✓ packaged GW systems | | There is a Wattworks GW system operating in Halls Gap at Youth Hostel Australia. |
| Queenscliffe Borough | | ✗ | ✗ | ✗ | No GW reuse, and no plans to introduce GW reuse |
| Greater Shepparton | | | ✗ | | Impact on stormwater system. Goulburn Valley Water subdivisions have been reluctant to encourage GW reuse in new subdivisions. |
| South Gippsland | | | ✓ | | Callum Morrison – Wastewater Planner is well informed and can offer good GW information. |
| Swanhill | | | ✗ | | Follow EPA but oppose GW reuse, except in remote areas because of health risks. |
| Surf Coast | ✗ | ✓ | | | Have systems operating in shire and allow untreated reuse as long as owners are aware of the health & environmental risks. |
| Wangaratta | | ✓ | Not actively | ✗ | Correct operation / is seen as a sustainable option for the future. |
| Warrnambool City | | ✗ | ✗ | | Declared an "all-waste" municipality |
| Whittlesea | | | Sustainable development | | Currently considering a site where sewerage capacity is below the 40,000 pop. GW treatment and reuse is an option. |
| Whitehorse | | ✓ - EPA approved system | | | |
| Wyndham | | | ✓ | | Need for community education - Council expects this will be subdivision design over next decade. |
| Yarra City | | | ✓ | ✓ | Block sizes |

## Table 7 Council responses to survey (Dyall, 2001)

**Key to Table 7: Policy –** Does the council have a policy on domestic greywater reuse, **Permit Reuse –** Does the council permit domestic greywater reuse, **Encourage Reuse** - Does the council encourage domestic greywater reuse, **Further Investigation** – Does the council plan investigate greywater reuse in the future, **GW** – Greywater, **WW** – Wastewater, **FT** – Full Treatment, **TP** – Treatment Plant, * Where a square has been left blank no direct comment was made in regard to the question, **x**- No, ✓ - yes.

# 7 Conclusions

EPA, local councils and water authorities regulate greywater reuse in Victoria. The 2001 survey indicates uncertainties with reuse. Reuse is acceptable and partially regulated and untreated reuse is acceptable with limited control when water restrictions are applied. Under current guidelines, users are prone to liability, local authorities lack reuse policies and encouragement, some allow reuse if it does not create a nuisance and owners are made aware of potential health risks. Water authorities share many concerns expressed by local councils and may be affected by reuse on a large scale through the beneficial reduction in potable demand and reduced loads to sewage treatment plants. An attractive option is for customers to discharge all household wastewater into the sewer and for the authority to sell treated water back to the customer through a separate pipeline for non-potable use. Only eight of the eleven regional water authorities saw potential savings from reuse or as an option for future water demands. The low price of potable water and the available treatment systems mean treating greywater on a household scale is economically infeasible. Untreated reuse is the most likely reuse option in the short term.

This study highlighted the unsettled nature of practices and regulations covering greywater reuse in Victoria and the lack of guidelines for reuse at local level. Interest in reuse attracts media and politicians attention in times of drought. While authorities remain undetermined about policies and guidelines, practices will deviate from best management approaches. By over-regulating reuse, authorities impair sustainable wastewater management. Proactive measures through community consultation and education, incentives creation, and active involvement in research and trials are required, not more regulations.

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