

# Greywater reuse for toilet flushing at a university academic and residential building

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## Abstract

Interest in water reuse is increasing all over the world and particularly in South Africa, because of its potential to supplement scarce freshwater resources in the face of increased demand and aridity. If water reuse is to be implemented, it must be done sustainably. This study: (i) describes the perceptions of beneficiaries before and after greywater reuse (GWR) implementation; (ii) determines the attributes of greywater that were important to beneficiaries when reusing greywater and their willingness to pay for these attributes; and (iii) undertakes an economic analysis of the implemented GWR systems. To this end, two GWR systems for toilet flushing were installed. The first was installed at a university academic building at the University of the Witwatersrand, Johannesburg, and the second at a university residence at the University of Johannesburg. Perceptions highlighted included respondents' preference to reuse greywater for toilet flushing rather than irrigation, and the greater preference for GWR for toilet flushing expressed for the university academic relative to the university residential building. In sequence, 'smell', 'colour' and 'greywater tariff' emerged as the attributes of greywater that were important to respondents. In terms of payback period, net present value and benefit-cost ratio, both systems generated a net loss and were economically unfeasible.

**Keywords:** greywater reuse for toilet flushing, perceptions, economics

## INTRODUCTION

Increased socio-economic development of South African communities has led to an overall increase in water demand for various purposes. Globally, water reuse is encouraged because of its potential to (i) supplement freshwater resources; (ii) provide reliable water services in remote or environmentally sensitive locations; (iii) mitigate the rising costs of meeting drinking water treatment and wastewater discharge standards; and (iv) reduce sewage discharges to water bodies. Water reuse seems inevitable in many South African communities especially those faced with declining freshwater availability (Ilemobade et al., 2012). If water reuse is to be implemented, it must be implemented sustainably. Sustainable development requires life-cycle consideration and assessment of different aspects (e.g. technical, social, economical, environmental, institutional, and health) impacting on or being impacted by the development.

Several water reuse schemes failed because benefactors/decision-makers underestimated or ignored the importance of and/or impact of varied social and economic factors (May-Le, 2004; Po et al., 2003). To this end, perceptions were recognised as a key element of the success of water reuse (May-Le, 2004; Po et al., 2003). In many water reuse schemes in the US and Australia, perceptions have determined the acceptability of water reuse, with water reuse applications requiring little to no human contact (e.g. toilet flushing and irrigation) being the preferred amongst several reuse applications (Radcliffe, 2003).

In addition to perceptions, the economics associated with water reuse has become vital in the assessment of the viability and sustainability of reuse. In favour of greywater reuse (GWR), for example, Faruqi and Al-jayyousi (2002) published a benefit-cost ratio ranging from 2.8 to 9.4 for a 4-member household irrigating with greywater in Jordan. Other reasons in favour of GWR included high potable water tariffs, the availability of subsidies/grants for GWR, and the lower costs of greywater treatment in comparison to potable water treatment. On the other hand, Surendran and Wheatley (1998), March et al. (2004), and Ghisi and Ferreira (2007) determined long payback periods of between 8 to 14 years for GWR for toilet flushing in hotels and high-rise buildings. Greywater, which excludes toilet wastewater, refers to wastewater from showers, baths, hand wash basins, laundry and kitchens. Greywater is categorised into light and dark greywater, with light greywater of better quality because it excludes kitchen effluent. Henceforth, all references to 'greywater' imply 'light greywater', unless otherwise stated.

Technically, GWR infrastructure (i.e., treatment, storage, distribution, operation and maintenance infrastructure) is similar to potable water infrastructure and may thus be designed and implemented in similar fashion (Ilemobade et al., 2009). Institutional arrangements (in respect of the availability and application of regulations and/or guidelines) for the planning, implementation and management of GWR are often location-specific, and most often present problems where GWR has developed in the absence of regulations, guidelines and management capacity. Some of these problems include the difficulty in achieving uniformity in GWR plumbing and installation, and the potential risks to health.

South African research published in the area of greywater and wastewater reuse has been few: Ilemobade et al. (2009) and Adewumi et al. (2010) provided tools to guide wastewater reuse for non-potable domestic and institutional applications from

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