

A flow balance approach to scenarios for water reclamation

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Abstract

Water reclamation, or the direct use of treated sewage effluent to replace a proportion of the fresh water demand, is a non-conventional approach to water demand management which is gathering momentum internationally. A recent WRC study showed that the proportion of water reclaimed as a percentage of total wastewater produced in a country ranges from less than 1% for Japan as a whole, to 84% for Israel. However, the same study showed that in South Africa, total direct reclamation of water is estimated to be less than 3% of the total flow of treated sewage effluent discharged to surface and marine waters, estimated to be 1.086×10^6 m³/a in 1996.

This paper argues that increasing demand for water caused by urbanisation and industrialisation should be matched by water reclamation, which provides an increasing intensity of land-based treatment and recycle depending on the proportion of total water demand which is satisfied by reclaimed water. The flow balance approach allows for the calculation of the total water availability to the urban reticulation network, following the implementation of water reclamation. Water losses from the system through leakage, evaporation, or use of water for irrigation, must be known. Scenarios for zero effluent discharge to surface waters are explored. In addition to flow balances, salt balances for certain scenarios are given.

Introduction

South Africa is a semi-arid country with limited water resources and a rapidly growing population. With increasing industrial and urban development, the demand on the country's water resources is nearing the point where conventional supplies will soon be exceeded. Planning for the water needs of the country in the future is a complex task, and non-conventional areas must now be addressed to supplement the two major areas of water resource management and water demand management. Water reclamation, or the direct use of treated sewage effluent to replace a proportion of the fresh-water demand, is such a non-conventional approach. Internationally, especially in countries which have water shortages similar to that in South Africa, water reclamation is becoming increasingly common, as shown in a recent Water Research Commission study (Grobicki and Cohen, 1998). However, the study showed that less than 3% of available treated sewage effluent is directly reclaimed in South Africa.

In this paper, "water reclamation" is used as the generic term for the various practices and applications of reusing or recycling treated sewage effluent, industrial effluent, or wastewaters, although the words are used interchangeably. The term water reclamation is preferred for a number of reasons: it is increasingly the accepted term used in the international literature (Crook and Surampalli, 1996; Maeda et al., 1996; Mills and Asano, 1996); it carries a positive environmental connotation; and it avoids the negative social connotations that the terms "wastewater reuse" or "reuse of treated sewage effluent" carry for many people.

Potential applications for the direct reuse of reclaimed water include:

- Construction applications (dust control, soil settling and compaction, aggregate washing, concrete making)
- Domestic - non-potable applications (fire fighting, car washing, toilet flushing, garden watering)

- Industrial applications (cooling towers, boiler feed, quenching, washdown)
- Groundwater recharge (recharge of aquifers)
- Agricultural irrigation
- Provision of potable water (drinking water, either supplied directly or blended with raw water).

The recent study carried out for the Water Research Commission focused primarily upon water reclamation for industrial and other urban applications, rather than on agricultural applications or upon full reclamation to potable water standards. The potential for agricultural applications of water reclamation in South Africa deserves a separate study in its own right. Treatment to potable standard is unnecessarily costly, compared to treatment for direct reuse in non-potable applications. In conventional water treatment and reticulation networks, all water is treated to potable standard, although only a small fraction of water is actually used for drinking. Rather than bringing treated sewage effluent to supplement South Africa's raw water supplies through treatment to potable water standard, this paper argues that substantial treatment cost savings, as well as raw water savings, can be made by short-circuiting this treatment loop and reclaiming water directly for certain uses.

National and international usage of reclaimed water

No overall figures have been found to exist for volumes of water currently reclaimed over the whole of South Africa, nor indeed within individual local authorities (Grobicki and Cohen, 1998). Table 1 shows the major applications in South Africa, which are (in order of importance): direct reuse in the paper industry, cooling in municipal power stations, and aquifer storage and recharge. Return to rivers (also termed planned indirect reuse in South Africa) is excluded from these calculations of direct reuse and is dealt with in more detail below. Although reclamation for potable purposes is well known and has been practised in Windhoek, Namibia, for over 30 years (Haarhoff and Van der Merwe (1996)), a pilot project at Faure in Cape Town found this application to be financially

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