A strategy for evaluating the environmental impact of on-site sanitation systems

M B van Ryneveld* and A B Fourie
Department of Civil Engineering, University of the Witwatersrand, Private BagX3, Wits 2050, South Africa

Abstract

In order to ensure that all South Africans are provided with access to adequate sanitation within the constraints of limited national resources, policies currently being considered by the South African government envisage a significant amount of on-site sanitation in use in the urban areas of the country for the foreseeable future. However, concerns exist that widespread use of these systems will cause subsurface migration of contaminants which may have adverse impacts on human health and on the natural environment.

This paper provides an overview of the problem, reviews existing guidelines and presents a more rigorous strategy for evaluating the impact of on-site sanitation on human health and the natural environment.

The suggested strategy, which permits account to be taken of a multitude of variables encountered, is as follows:

- define compliance requirements in terms of both physical location (point of compliance) and allowable contaminant concentration;
- estimate risk of pollution by viruses and bacteria using a 'residence time' approach;
- estimate pollution risk by nitrates using a mass balance approach;
- for both microbiological and chemical contaminants, use a probabilistic approach (as far as the available data allow), allowing appropriate margins of safety in design, such margins of safety still to be determined
- carry out field monitoring of on-site sanitation schemes (if water resources are to be protected) to provide early warning of contaminant build-up.

The establishment of a set of general principles for compliance requirements together with the application of these principles to the different water bodies (both surface water and groundwater) in South Africa is the most urgent requirement for the implementation of the above strategy.

It is also suggested that evaluation of environmental impact of sanitation systems should not be confined to on-site sanitation alone, but should be extended to *all* forms of sanitation system, including water-borne sanitation systems as well.

Introduction

The subsidy cost of providing access to adequate sanitation facilities for the approximately 21 m. South Africans (DWAF, 1994) who are currently without such facilities is very significant in comparison with the funds available to central government (Van Ryneveld, 1995). In order to meet this challenge, it will be necessary to consider carefully what levels of service can be afforded by the country as a whole while still meeting acceptable standards of quality.

In 1991 the Water and Sanitation 2000 workshop suggested that the provision of ventilated improved pit (VIP) latrines for about half of the urban population as at the year 2000 was the kind of policy that the country needed to be looking at (Jackson, 1991). More recently, the Municipal Infrastructure Investment Framework (MIIF) study (Ministry in the Office of the President and the Department of National Housing, 1995) has proposed a programme of infrastructure provision that would eliminate much (but not all) of the backlog within 5 to 7 years and would match service levels with predicted household income levels in 10 years (i.e. by the year 2005). This programme would result in a 55:25:20 distribution nationally between full, intermediate and basic levels of service. A basic level of service for sanitation would comprise on-site sanitation (e.g. a ventilated improved pit (VIP) latrine), while an intermediate level of service would comprise simple water-borne sanitation. Simple water-borne sanitation may include on-site systems such as the LOFLOS (low flush on-site sanitation system, also referred to by some as an aquaprivy).

Both studies therefore envisage a significant amount of on-site sanitation in use in the urban areas of South Africa for the foreseeable future, an option which is significantly cheaper than the use of full water-borne sanitation throughout. However, a problem that is often raised in relation to the use of on-site sanitation is the potential pollution of water resources that is associated with these systems (The term 'pollution' or 'pollutant' is used where the concentrations exceed acceptable levels. Otherwise the term 'contamination' or 'contaminant' is used).

A review of the literature on the subsurface movement of contaminants associated with on-site sanitation has been carried out (Fourie and Van Ryneveld, 1995); however, there is a need to translate this knowledge into guidelines for evaluating the environmental impact of these systems in practice. This paper provides an overview of the problem, reviews existing methodologies and presents a more rigorous methodology for evaluating the environmental impact of on-site sanitation systems.

Use of on-site sanitation on a large scale in an area of scarce water resources is a significant departure from existing approaches which appear to follow one of two routes:

- **In developing countries,** where water-borne sewerage is largely unaffordable, on-site sanitation has been used as the only viable alternative. Substantial improvements in health and environmental quality are obtained by the use of **on-site** sanitation as compared with **no** sanitation coverage (or, alternatively, as compared with high standards for a few and minimal or no sanitation coverage for the rest of the population). Therefore, while environmental quality is a

* To whom all correspondence should be addressed.
(011) 716-2597; fax (011) 339-1762;
e-mail mvanr@civen.civil.wits.ac.za
Received 7 May 1996; accepted in revised form 16 July 1997