

# Wastewater disposal at safari lodges in the Okavango Delta, Botswana

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## Abstract

Many safari lodges in the Okavango Delta obtain their water supply from boreholes in near-surface aquifers while disposing of their wastewater via soak-aways, creating a potential risk of contamination of their water supply. Most islands in the Delta contain sites where the groundwater has become salinised as a result of transpiration by island vegetation. This study of wastewater disposal at such a site on Chitabe Island, which involved surveying of the water table, measurement of groundwater salinity, field bacteriological screening and groundwater flow modelling has revealed that although water disposal has created a recharge mound, the depression in the water table induced by transpiration by island vegetation is such that pollutants will remain confined to the region of maximum groundwater depression. Although the soils are sandy, they exhibit significant filtration effects on bacteria. The field assay used in this study was unable to detect coliform and *E. coli* bacteria in groundwater within a distance of 20 m from the disposal point. Modelling of groundwater flows indicates that boreholes located on the outer fringes of the island are secure from contamination. The study suggests that disposal of wastewater into areas where the groundwater is salinised provides a sustainable solution to the problem of wastewater disposal in the Okavango Delta.

**Key words:** Okavango Delta; wastewater disposal; field bacteriological screening

## Introduction

The Okavango Delta of northern Botswana (Fig. 1) has become an important international tourist destination. The mixed terrain found in the seasonal swamps, which combines shallow wetland environments with densely forested islands, is a particularly popular region for siting safari lodges, and most of the lodges have been built in the dense, riverine forest on these islands. The majority of lodges obtain their water from boreholes on the island close to the lodge, and wastewater is treated and disposed of by means of septic tanks connected to french drains or soak-aways, also close to the lodge. Over most of the seasonal swamps, the water table is very shallow, and the wastewater soaks only a short distance, usually 2 to 3 m, before encountering the groundwater table. The soils of the Delta are dominated by aeolian sands of the Kalahari Group. Lodges typically accommodate between 16 and 24 guests, and the ratio of staff to guests is usually about 2, so that at full occupancy, a lodge may entail a community of up to 75 people. The quantity of wastewater generated can therefore be quite large, and for the bigger camps may exceed 15 m<sup>3</sup>·d<sup>-1</sup>. In addition, most lodges dispose of organic refuse in pits in the general camp area. These pits are typically about 2 m deep, and close to the water table.

The close proximity of water draw-points to wastewater and other refuse disposal sites in an environment of shallow groundwater and sandy soils creates a potential risk of contamination of the water supply by inorganic and organic contaminants (e.g. diesel fuel) and particularly by pathogens. Parker and Mee (1982), for example, found that *Salmonella* spp. and fecal coliforms could

survive for longer than 64 d, the duration of their experiments, in shallow aeolian sand aquifers similar to those of the Okavango Delta. Olanrewaju (1990) has reviewed the problems associated with disposal of outflow from septic tanks. Although septic tanks are claimed by manufacturers to remove most (some claim all) pathogens, this situation is rarely, if ever, attained in normal use, and especially in remote areas, where proper routine maintenance of the tanks cannot be carried out. Micro-organisms are released in large numbers in the outflow, and can enter the groundwater, especially if the water table is shallow. Survival and dispersal in the groundwater environment is also highly variable, and *E. coli* have been reported to have moved as much as 46 m vertically and 70 m horizontally in an aquifer under favourable conditions. At Fort Devens, Massachusetts, enteroviruses have been detected in groundwater 183 m from a wastewater point source. Viruses in particular are believed to be removed from wastewater by adsorption, especially by clays. Low-clay, sandy soils, such as those in the Okavango region would probably have a relatively low adsorption capacity. In addition to contamination, there is the added risk of eutrophication. Wastewater, especially sewage, is rich in nutrients, and its escape into the environment could lead to local eutrophication, particularly given the hyperoligotrophic status of the Okavango Delta ecosystem (Cronberg et al., 1995). Such eutrophication of surface water arising from septic tank soak-away effluent has been recorded elsewhere (e.g. Wall and Webber, 1970).

Although there are potential risks associated with the subsurface disposal of wastewater in the Okavango Delta, there are no other alternatives. Surface disposal, such as in specially created wetland areas, is out of the question, because of the very real danger that large animals such as elephants and hippopotami could spread pathogens from these created disposal sites into the wetland at large. Realising this, McCarthy et al. (1994) proposed a strategy to reduce the potential risk associated with subsurface wastewater

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Received 16 October 2002; accepted in revised form 28 August 2003.