

# Abundance of pathogenic bacteria and viral indicators in chlorinated effluents produced by four wastewater treatment plants in the Gauteng Province, South Africa

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## Abstract

The failure of South African wastewater treatment plants to produce effluents of a high microbiological quality is a matter of great concern in terms of the pollution of water resources. This study aimed at assessing the effectiveness of 4 wastewater treatment plants in the Gauteng Province, namely the Zeekoegat, Baviaanspoort, Rayton and Refilwe Water Care Works (WCW), in the removal of pathogenic bacteria and viral indicators. Also taken into consideration were free chlorine concentrations and turbidity levels, which were measured using standard methods. Conventional methods and/or polymerase chain reaction (PCR) techniques were used to detect and identify pathogenic bacteria and coliphages. The turbidity ranged from 2.39 to 62.40 NTU and the concentrations of free chlorine ranged from 0.03 to 1.60 mg·L<sup>-1</sup> for all plants. Despite high free chlorine residual concentrations in treated effluents, the survival and occurrence of *Escherichia coli*, *Salmonella typhimurium* and *Vibrio cholerae* were significantly higher at Baviaanspoort (100%, 88.2% and 35.3%), Refilwe (87.5%, 59.4% and 21.9%) and Rayton (75%, 38.2% and 9.4%) compared to Zeekoegat, which only showed the survival of *E. coli*, at a much lower occurrence rate of 8.8%. Somatic and F-RNA coliphages were removed at 15.57 % and 13.96% for Baviaanspoort, 11.62% and 22.42% for Refilwe, 25% and 32.10% for Rayton, and 40.41% and 52.57% for Zeekoegat WCW. Significant correlations were found between pathogenic bacteria and coliphages at all plants ( $r = 0.765$  for Baviaanspoort,  $r = 0.904$  for Zeekoegat,  $r = 0.680$  for Refilwe,  $r = 0.796$  for the Rayton WCW,  $p < 0.01$ ). A combination of sedimentation, rapid sand filtration and chlorination processes was found to be a major prerequisite for the reduction of turbidity levels and viral indicators and the successful removal of pathogenic bacteria in the Zeekoegat WCW. This study therefore suggests an upgrading of the wastewater treatment plants by including processes such as rapid sand filtration and UV disinfection, which have proved to be effective in the removal and inactivation of pathogenic bacteria and viruses.

**Keywords:** wastewater, chlorination, effluent, pathogenic bacteria