ABSTRACT

The main aim of this research project was to investigate the feasibility of including alternative methods of nitrogen and phosphorus removal in the existing on-site Biocycle™ activated sludge treatment system.

Baseline studies were undertaken to determine the extent of nutrient removal, and the factors limiting high rate nutrient removal in the existing Biocycle™ treatment process. This experiment examined the quality of the raw sewage, and the partially treated liquor after each treatment phase, to determine whether the performance of each treatment was adequate and played the role in the treatment process for which they were designed. This experiment demonstrated that the primary treatment chamber was over designed for the intended purpose of removing 10% of the chemical oxygen demand (COD), biological oxygen demand (BOD) and suspended solids (SS). Extensive nitrification occurred but the denitrification process was limited by the removal of readily degradable forms of COD in the primary treatment chamber. Phosphorus removal was inhibited by the presence of nitrates in the primary chamber. Nitrification in the primary treatment chamber resulted from a design fault in the sewage pumping equipment.

An experiment was conducted to determine the maximum sewage loading rate at which the required 20 mg BOD/L and 30 mg SS/L standards were exceeded, and the critical loading rate beyond which the system no longer functioned effectively as a biological treatment process. This experiment involved increasing the sewage loading rate until the system was overload and no longer functioned normally. The effluent quality was analysed for suspended solids and biological oxygen demand after each increase in sewage loading rate. The results indicated that the critical loading rate was 2400 L/day, which coincided with the loading rate above which the 20:30 BOD, SS standards were consistently exceeded. These results indicated that the treatment system was flushed of the established populations of mature micro organisms required to purify the wastewater under conditions of excessive hydraulic loading.

The optimum alum dose rate for chemical precipitation of soluble phosphorus to a concentration of 1.0 mg/L in the treated effluent was experimentally determined as a molar ratio of approximately 4

aluminium ions per molecule of phosphate. A molar ratio of 5.5 was required for complete removal of soluble phosphate and 98% of the total phosphorus.

The feasibility of achieving high rate biological nitrogen removal was assessed by using intermittent aeration regime in the existing Biocycle™ system, both with and without the use of an external source of carbon. The intermittent aeration regime used (4hrs aeration, 1hr anoxic) inhibited the removal of both nitrogen and phosphorus. Nitrification was slightly inhibited by the short length of the aeration phase. Where an external carbon source (acetic acid) was added, the suppressed levels of dissolved oxygen further inhibited nitrification. Denitrification was inhibited by the presence of dissolved oxygen during the anoxic phases. The use of acetic acid during intermittent aeration did not benefit denitrification, despite the favourable effects of reducing the dissolved oxygen concentration.

Phosphorus removal was inhibited by the presence of nitrates during the anoxic phases. The introduction of an external supply of carbon increased the phosphorus removal rate to that achieved during continuous aeration.