Abstract

The Fate of Nutrients and Pollutants Resident Within the Sediment Reservoir of Hunts Bay as a Function of Improved Overlying Water Quality

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As a component of the proposed Kingston Water and Sanitation project, rehabilitation and expansion of the coverage of potable water and sewerage systems throughout the KMA* is planned. As new treatment facilities are developed, the massive volume of untreated wastewater currently flowing into the Kingston Harbour should decrease. This improvement in the quality of inflows should form the basis of proposed rehabilitation to the Kingston Harbour.

As the harbour waters cleanse, the sediment may become a significant source of nutrients to them. The plans to improve the quality of water may only be effective if the contaminated sediment already there does not serve as a significant nutrient source to the cleaner water. This thesis will therefore examine the potential of the sediment to act as a source of nutrients to the overlying water under conditions of improved overlying water quality.

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* KMA: Kingston Metropolitan Area of the Island of Jamaica. Covers the parishes of Kingston and St. Andrew

The Three-Mile (3M) Corner of Hunts Bay located within Jamaica's Kingston Harbour was selected as the site for a detailed study of sediment-water nutrient exchange. Hunts Bay may be best described as an enclosed, flow restricted estuary under strong anthropogenic pollutant influence. The information gained from the site would highlight the potential for the sediment to act as a source of pollutants to the overlying water once the quality of the water reaching the Bay has been improved.

Colour changes, defined by Munsell charts, were determined as a function of depth in sediment and used as a redox probe. Sediment cores, 5cm in diameter to depths of one meter were taken from the Three-Mile (3M) area and visually characterised. The linkage between colour and dissolved sulphide was also tested as a function of depth in the interstitial waters.

The Munsell Chart descriptions showed that the sediment in the northeast corner of the Bay had many narrow multicoloured bands possibly indicating various sedimentation processes. The top one-meter of sediment in general could be divided into an upper 30-40cm, wide greenish black region, a highly striated but predominantly dark grey mid-section, 30-40cm in width, and a greyish/reddish-brown lower 30cm.

Based on investigations on the correlation of sediment colour with chemical concentrations as a function of depth in the sediment of Hunts Bay, it was established that:

1. There exists a strong correlation between interstitial water sulphide concentrations and sediment colour as a function of depth. The black/greenish-black colours in the upper 30cm of sediment may be attributed to large amounts of precipitated iron sulphide species.
2. High concentrations of dissolved sulphide indicate areas of active sulphate reduction. The active areas correlated to the darker surficial sediment and as activity decreased the sediment colour lightened toward greyer shades.
3. As the colour lightened to light greenish-black-grey the dissolved sulphide disappeared.

An investigation of the effect of the improvement in water quality on the mobility of nutrients incorporated into the Bay sediment was carried out. The studies indicated the rates of nutrient release from the sediment and the overall changes in their concentrations as a consequence of the fluxes. The nutrient flux experiments were carried out using microcosms (chambers) in the laboratory. The fluxes out of the sediment were determined for ammonia, total nitrogen and total and inorganic phosphorus.

A gradual improvement in the quality of the overlying water was simulated in order to investigate the effect on nutrient sediment-water exchange. Fluxes were obtained from the changes in interstitial water nutrient concentrations over the duration of the experiment. The Ammonia and SRP fluxes were used in

Fick's Law calculations to estimate the respective average diffusive transfer depths x' and fluxes at the start and end of the experiment.

From these data it was concluded that the sediment would be a source of nutrients to the overlying waters for a period of time after the improvement of overlying water qualities. However, due to rapid exhaustion of nutrients from the sediment, the period of time that the diffusion could be sustained was lower than initially thought. The results suggest an overall decrease in the sediment influence on the overlying water pollutant status with time. Given cleaner inflows of water to Hunts Bay, the sediment should clean over time without the need for physical intervention.