CHANGING SOURCE WATER TO URBANIZED ER-LIS EMBAYMENTS AND IMPLICATIONS FOR WATER QUALITY IMPROVEMENT USING CONSTRUCTED WETLANDS

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The urbanization of the New York City area has caused serious degradation of water quality in the NY-NJ Harbor Estuary, including the East River (ER) and western portion of Long Island Sound (LIS). Although overall water quality has improved in the Harbor Estuary since the 1970s with better wastewater treatment, embayments such as Little Neck Bay and especially Flushing Bay have among the worst water quality because of the numerous combined sewer outfalls (CSOs) that discharge into them. Recent improvements in stormwater retention infrastructure by the NYCDEP are expected to reduce the loadings of pathogenic bacteria such as fecal coliforms and enterococci. However, the changing surface water-groundwater inputs to these embayments and the restrictions in marine influence are converting the remaining wetlands in these watersheds from brackish to freshwater-dominated systems. Natural and constructed wetlands are now in worldwide use as wastewater and stormwater treatment systems for urban areas in what is termed an "ecohydrologic" approach to estuarine water resources management. With the increasing emphasis on wetland preservation, restoration and construction as stormwater best management practices (BMPs) like the Bluebelt on Staten Island, new opportunities exist for harnessing the treatment capacities of these systems for coastal water quality improvement.

The conversion of municipal water supply in Queens and Brooklyn from significant groundwater pumpage up until the 1980s to largely surface water from upstate watersheds at present has resulted in rebounding hydraulic heads in the Brooklyn-Queens and deeper aquifer system. Regional groundwater flow simulation has projected a significant increase in baseflow to major streams in western Long Island (Misut and Monti 1999, Buxton and Smolensky 1999), specifically a doubling in flow to Flushing Creek and Bay by 2020 (Figure 1). Such discharge to this embayment and similar groundwater discharge (Eaton, unpublished data) in the Alley Pond wetlands at the head of Little Neck Bay are supplanting the surface-water inflows previously dominated by CSO discharges. A large retention tank and improvements in in-line storage (40 MG capacity) of stormwater have now been brought on-line at the head of Flushing Creek and a similar facility is being completed at Alley Pond. These improvements are likely to reduce the current high levels of pathogen bacteria (total coliforms >500 CFU/100 mL, mean fecal coliforms >10000 CFU/100 mL, mean enterococci 10s to 100s CFU/100 mL, Dhar, unpublished data) routinely measured in Flushing Creek by Queens College students as part of ongoing environmental science and field hydrology classes.

However, the watersheds surrounding these embayments have been permanently transformed by urbanization, and restrictions on pre-development tidal flow are also contributing to a reduced salinity intrusion (Figure 2). As a result the upland ends of both

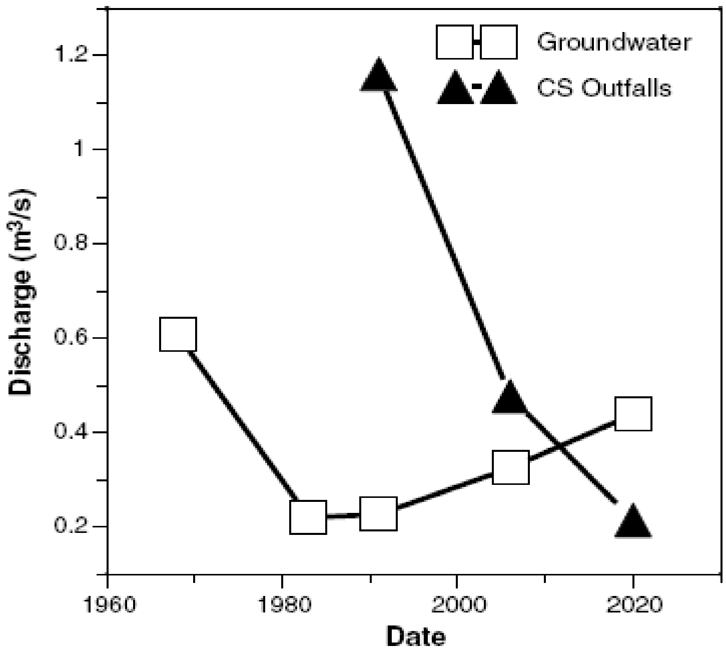

Figure 1. Changing trends of estimated freshwater discharges to Flushing Creek and Bay, data from USGS and NYCDEP (Eaton 2007)

the Flushing Bay and Little Neck Bay watersheds now appear to be dominated by freshwater discharge. Since the relative magnitude of freshwater and saltwater inflows and their timing determine wetlands hydroperiod, the evolution of wetland vegetation and faunal habitat in these watersheds is controlled by this change to a predominately freshwater input (Magee and Kentula 2005). This may explain in part the increasing growth of the invasive common reed species *Phragmites australis* in both locations, despite some success in the 1990s at establishing freshwater sedge-meadow species near Willow Lake in Flushing Meadows Park (Feller, McLaughlin pers. comm.).

The transition from brackish to freshwater wetlands notwithstanding, the increasing interest in these systems for wastewater and stormwater treatment holds great promise to remediate runoff and the remaining CSO discharges that flow into these coastal waters. Along the lines of the successful Bluebelt program on Staten Island, the expansion of restored and constructed wetlands in these two watersheds has the potential to reduce contaminant loadings. Using the tidal fluctuation to calculate hydraulic loading in a conceptual treatment wetland profile (Figure 3), concentrations of fecal coliform bacteria in adjacent coastal waters, for example, are estimated to be reduced by 27% to 94% depending on hydroperiod and vegetation density (Eaton and Yi, in review).

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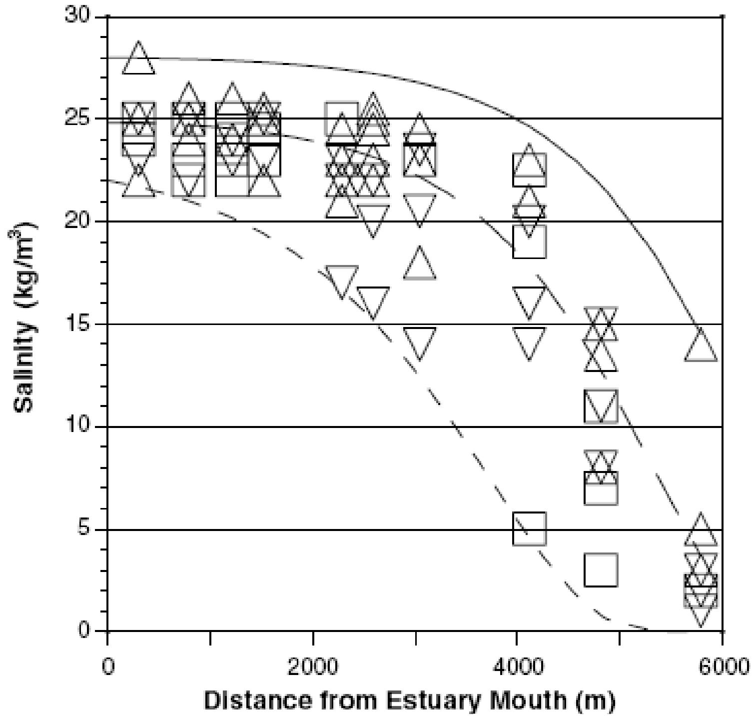

Figure 2. Salinity intrusion curves fitted to field data showing mixing of brackish water from the East River with freshwater from the upland end of the Flushing Bay watershed. Symbols indicate estimated tidal stages at sample collection locations (Eaton 2007)

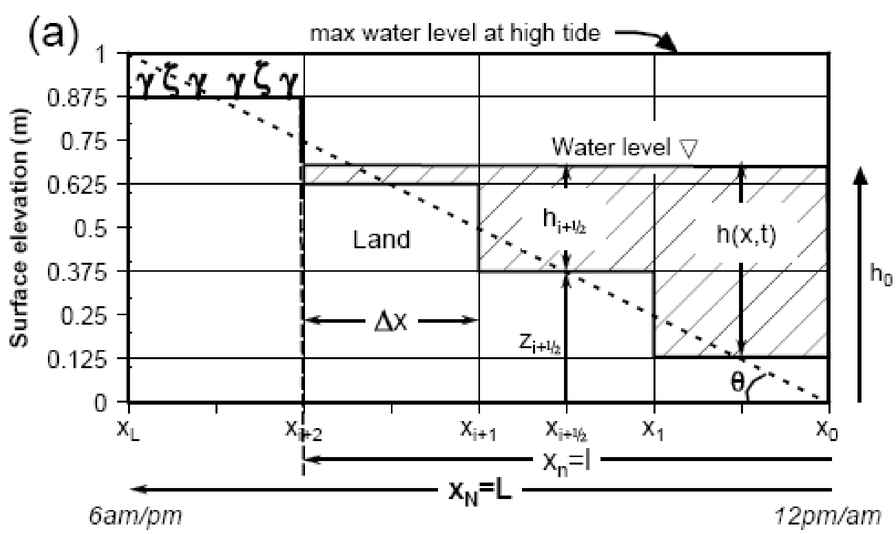

Figure 3. Conceptual model of a terraced constructed wetland profile from which hydraulic loading based on tidal fluctuation was used to estimate potential reduction of contaminants in coastal waters (Eaton and Yi, in review)

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