

## **Effects of stormwater management and stream restoration on watershed nitrogen retention**

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Restoring urban infrastructure and managing the nitrogen cycle represent emerging challenges for urban water quality. We investigated whether stormwater control measures (SCMs), a form of green infrastructure, integrated into restored and degraded urban stream networks can influence watershed nitrogen loads. We hypothesized that hydrologically connected floodplains and SCMs are “hot spots” for nitrogen removal through denitrification because they have ample organic carbon, low dissolved oxygen levels, and extended hydrologic residence times. We tested this hypothesis by comparing nitrogen retention metrics in 2 urban stream networks (1 restored and 1 urban degraded) with SCMs and a forested reference watershed at the Baltimore Long-Term Ecological Research (LTER) site. At all 3 sites, we used a combination of: (1) longitudinal reach-scale mass balances of nitrogen and carbon conducted over 2 years during baseflow and storms ( $n = 360$ ) and (2)  $15\text{N}$  push-pull tracer experiments to measure in situ denitrification in SCMs and floodplain features ( $n = 72$ ). The SCMs consisted of inline wetlands installed below a storm drain outfall at one urban site (restored Spring Branch) and a wetland/wet pond configured in an oxbow design to receive water during high flow events at another highly urbanized site (Gwynns Run). The SCMs significantly decreased total dissolved nitrogen (TDN) concentrations at both sites and significantly increased dissolved organic carbon (DOC) at one site. At Spring Branch, TDN retention estimated by mass balance (g/day) was  $\sim 150$  times higher within the stream network than the SCMs. There were no significant differences between mean in situ denitrification rates between SCMs and hydrologically connected floodplains. Longitudinal N budgets along the stream network showed that hydrologically connected floodplains were important sites for watershed nitrogen retention due to groundwater-surface water interactions. Overall, our results indicate that hydrologic variability can influence nitrogen source/sink dynamics along engineered stream networks. Our analysis also suggests that: (1) surface area, (2) hydrologic residence time, and (3) streamwater and groundwater flux are major predictors of the potential for stream/wetland restoration features to retain nitrogen at the watershed scale.