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Characterization of Nitrogen Discharge from Extensive Sedum Green Roofs with Multiple Amending Designs and Materials

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ABSTRACT
Green roofs are effective stormwater control measures for mitigating urban hydrology; however, their potential to manage nutrient discharges has not been consistently documented. Thirty-two pilot scale newly constructed experimental extensive green roof trays were established to evaluate the effect of substrate composition on total nitrogen (TN) discharge. Two lightweight-based green roof substrates are compared in combination with zeolite as either a mixed-in component in the substrate or a downstream permeable reactive barrier (PRB), or both. Wood and oat-hull-derived biochar are also tested as PRB materials. Precipitation, runoff volumes, and event mean concentrations (EMCs) of TN in runoff discharged from green and reference roofs were measured for 25 storm events during three growing seasons. TN discharge from newly established extensive green roofs demonstrates a strong temporal effect. The high substrate nitrogen (N) concentration at installation (~2.98–3.91 mg/L) generated elevated TN EMCs in storm event discharge (median 3.34 mg/L). The effect rapidly decreased within one growing season, such that green roof TN EMCs were comparable with the reference roof EMCs (median 1.32 mg/L), and substrate nitrogen was measured at ~1–1.98 mg/L after two years. Zeolite, mixed in at 10% v/v, has no influence on reducing TN EMCs; however, at 20% v/v (combination of mixed-in and PRB), zeolite significantly reduced TN EMCs in the first growing season. Neither wood biochar nor oat hull biochar was effective in TN mitigation. Mass load analysis estimated from measured storms that extensive green roofs discharge 33%–45% less N mass than did the reference roof due to significant runoff retention. The evidence that reflects the lack of a statistical difference between extensive green and reference roofs' TN EMCs and less nitrogen mass discharged from extensive green roofs in the latter two monitoring seasons suggests that atmospheric deposition is a likely source of TN in roof discharge over the long term.