VERMONT
AGENCY OF TRANSPORTATION

Advancing the use of DWTRs in stormwater treatment features to enhance phosphorus removal for transportation projects

PROJECT TITLE

Advancing the use of DWTRs in stormwater treatment features to enhance phosphorus removal for transportation projects

STUDY TIMELINE

September 2022 – August 2024

INVESTIGATORS

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KEYWORDS

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Introduction or Problem Statement

Previous laboratory and field research at University of Vermont suggests that drinking water treatment residuals (DWTRs) have high phosphorus (P) sorption capacity and can aid in the removal of dissolved P in stormwater treatment systems such as roadside bioretention.[1,2] Additional field verification of effective P removal from stormwater in full-scale treatment practices is needed to inform use of DWTRs in transportation projects. Two stormwater treatment sand filters were recently constructed with a uniformly mixed filter media consisting of ≥95% sand and ≤5% DWTRs in Chittenden County, VT. One filter receives runoff from a small catchment (< 2 acres) and the other from a larger catchment (> 2 acres) (Fig. 1) The DWTRs used are alum-based and were obtained from a local drinking water treatment facility. The UVM research team is studying P inputs to and outputs from these DWTR-amended sand filters during rain events.

Figure 1. Photos of the small catchment and large catchment sand filter systems and associated sampling.

Methodology or Action Taken

Storms are monitored by taking uniform time-based sub-samples of stormwater inflow to, and outflow from, the sand filters using auto-sampler equipment. Sub-samples are composited for each storm event and analyzed for concentrations of total phosphorus (TP), total dissolved phosphorus (TDP), particulate phosphorus (PP), soluble reactive phosphorus (SRP), dissolved organic phosphorus (DOP), and chloride (Cl^-). Concentration data, paired with flow data recorded from a combination of pressure transducers and volumetric weirs, are used to estimate influent and effluent P loads for each event. A total of 45 storms between the smaller and larger sites will be monitored as part of this project.

Conclusions or Next Steps

The study's preliminary results from the small catchment sand filter indicate that the DWTR-amended sand is performing well in terms of dissolved P removal (~70% reduction in SRP concentration on average). Reductions have been observed even when influent SRP concentrations are <0.1 mg/L. Event mean SRP concentrations of treated effluent have been approximately 0.025 to 0.050 mg/L regardless of influent concentration, except in cases where filter bypass is observed (e.g., overflow). The large catchment sand filter has not yet been monitored due to construction delays. This second site will also be studied to evaluate P removal efficacy. Including DWTRs at a proportion of 3-5% of sand filter media is not anticipated to impact system performance negatively and is expected to substantially increase the longevity of P treatment by the filter media.

Potential Impacts and VTrans Benefits

Mixing DWTRs into sand media-based stormwater infrastructure can enhance P removal before stormwater from transportation projects reaches downstream lakes. A conventional sand filter primarily removes P through filtering of *particulate P*. However, DWTRs chemically sorb *dissolved P*, which is often not removed or may even be exported in conventional stormwater treatment systems.[3] As the first field study of sand filters enhanced with DWTRs in VT, this study will clarify anticipated P load reductions for DWTR-amended sand filters and provide guidance for future stormwater treatment practices used in transportation projects. Anticipated benefits of this practice include: 1) no substantial additional cost, 2) reuse of local residual material that would otherwise be discarded/landfilled, and 3) substantial increase in the longevity of P removal in sand-based treatment practices, targeting dissolved P that often passes through or is exported from stormwater treatment practices.

References

[1] Ament, M. R., Hurley, S. E., Voorhees, M., Perkins, E., Yuan, Y., Faulkner, J. W., & Roy, E. D. (2021). Balancing hydraulic control and phosphorus removal in bioretention media amended with drinking water treatment residuals. ACS ES&T Water, 1(3), 688-697.

[2] Ament, M. R., Roy, E. D., Yuan, Y., & Hurley, S. E. (2022). Phosphorus removal, metals dynamics, and hydraulics in stormwater bioretention systems amended with drinking water treatment residuals. Journal of Sustainable Water in the Built Environment, 8(3), 04022003.

[3] The Water Research Foundation. International Stormwater BMP Database: 2020 Summary Statistics.

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