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Stormwater Treatment At Critical Areas

Evaluation of Filtration Media

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Notice

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Foreword

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E. Timothy Oppelt, Director
National Risk Management Research Laboratory

Abstract

This is one volume in the report series entitled “Stormwater Treatment at Critical Areas” and describes the work conducted on filtration media for stormwater treatment between 1994 and 1996. Other volumes in this report series describe the results of field investigations to determine sources of urban stormwater runoff pollutants, field investigations of storm drain inlet devices, and development of a prototype treatment device that could be installed at the storm drain inlet in critical source areas.

Filtration, especially ‘slow’ filtration, is of interest for stormwater runoff treatment because filters will work on intermittent flows without significant loss of capability. This work was initially planned to be the optimization of a sand filter to be installed in the filter chamber of the Multi-Chambered Treatment Train (MCTT). However, the poor removals provided by newly constructed sand filters led to the investigation of other media that had the potential to more ‘permanently’ retain pollutants.

Stormwater filters currently in operation typically use the following media – sand, compost, and peat. This research tested the capabilities of the media currently in use, plus others with known filtering capability (activated carbon, zeolite, a cotton milling waste, and a wood waste), in both controlled laboratory and field conditions. Influent and effluent samples from each filter column were analyzed for toxicity, turbidity, conductivity, pH, major anions and cations, and particle size distribution for each test.

This research demonstrated that physical clogging of the filters occurred well before the sorptive capacity of most media is reached when stormwater runoff is filtered without adequate pre-treatment. If adequate pre-settling is done, the solids remaining in the runoff are generally very small (colloidal). These filters are capable of removing many of the colloidal sized particles; however, the percent removals (measured as suspended solids removal) are smaller when there are fewer larger particles in the influent. Testing using laboratory-scale columns showed that an activated carbon-sand filter is the best at removing the stormwater pollutants. The range of cumulative suspended solids loadings is from 200 g/m^2 (peat-sand) to 2,000 g/m^2 (carbon-sand) before the hydraulic capacity is reduced to 1 m/day. Because these tests were performed using small columns (4.76 cm diameter and 45.72 cm depth) and were not able to completely dry between most of the tests, it is expected that the suspended solids loadings in full-scale filters will be about five times greater than these values before the filter clogs.

In terms of chemical capacity, results of the testing showed that the activated carbon, peat moss, zeolite and compost were the most efficient media at removing the toxicants from the runoff and retaining them during subsequent flushings with clean distilled water. Sand, the most common filtering media currently in use, effectively removed toxicants from the runoff; however, the effluent from subsequent distilled water flushings through newly constructed sand filters indicated that the toxicants were displaced from their "trapped" pores by the water. The flushing effluent was significantly more toxic than the flushing influent clean water. Based on historical full-scale installations, aged sand, after being exposed to field conditions for some time, apparently ripens due to deposition of organic and mineral material and can be much more effective that when first installed. The compost, although an effective filter, added an undesirable color to its effluent. The peat moss, also an effective filter, increased the turbidity of and added color to the runoff. The activated carbon was found to be the most effective at removing the toxicants while not increasing the turbidity and color. In all cases, the media had to be mixed with sand to maintain adequate flow rates.

Research is continuing regarding the ability of filters to treat stormwater runoff and it is anticipated that a future volume in this series will detail the results of the ongoing work. This new phase of the filter project has two purposes: 1) quantify the effects that pH, ionic strength and influent concentration will have on the removal ability and capacity of the filter media; and 2) perform pilot-scale studies using several selected media in order to determine the applicability of the bench-scale results to full-scale operations.

These two steps are required in order to develop design guidelines for stormwater filters that will be useful for the engineering community and stormwater management planners.

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- Shirley Clark's *Evaluation of Filtration Media for the Treatment of Stormwater* (1996),
- Brian Robertson's *Evaluation of a Multi-Chambered Treatment Train for Treatment of Stormwater Runoff from Critical Pollutant Source Areas* (1995),
- Ali Ayyoubi's *Physical Treatment of Urban Storm Water Runoff Toxicants* (1993), and
- Patricia Barron's *Characterization of Polynuclear Aromatic Hydrocarbons in Urban Runoff* (1990).

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