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Further Developments in Sand Filter Technology

"The design of sand filters is evolving rapidly, and promises to remain a fertile ground for innovation in the years to come. Some experimental approaches will prove successful, while others will doubtless be discarded. The arrival of new monitoring information should help to standardize the most effective design concepts."

Since these lines were written in *Techniques* in 1994, no less than a dozen research studies have been launched to improve on the performance of the basic sand filter design. These efforts include field and bench studies on a wide array of alternative design configurations and filter media. A few of these efforts have been reported in *Techniques* (see articles 107 and 108), but this large body of emerging research is best assessed as a whole. Towards this end, this article profiles the pollutant removal capability and operational experience reported for this new generation of stormwater filters.

For comparison, it is helpful to begin with a recent performance study of a traditional sedimentation/sand filter monitored by the City of Austin (1997). Known as the Barton Creek Plaza (BCP), this sand filter served just less than three acres of a shopping center parking lot in Austin, Texas, and treated approximately 0.65 watershed-inches of runoff. Stormwater runoff first entered a large sedimentation basin (7,000 cubic feet) before discharging over a sand filter bed (390 square feet). The filter bed was three feet deep, and was composed of 0.02 to 0.04 inch diameter concrete sands. The sand filter was located off-line, and was estimated to bypass about 30% of the annual runoff volume without effective treatment. Three automated samplers were deployed to measure pollutant concentrations entering the sediment basin, leaving the sediment basin, and leaving the sand filter. Nine paired storms were monitored in 1996 and 1997, and the computed removal efficiency is reported in Table 1.

Research findings from the BCP sand filter generally reinforce prior monitoring research on the potential and limitations of traditional sand filter treatment. Generally, the removal of particulate pollutants, such as total suspended solids, trace metals and organic nutrients, was quite high. However, removal rates for soluble pollutants, such as ortho-phosphorus, nitrate-nitrogen, and total dissolved solids, were quite low, and sometimes even negative. Removal of bacteria was also quite variable, as evidently the warm, dark and damp environment of the sand filter sometimes served as a source for bacteria. It is interesting to note that much of the observed pollutant removal occurred in the sedimentation basin rather than within the sand filter at the BCP facility (see Table 1), which suggests that both sedimentation and filtration must be combined for optimal treatment. In general, the outflow concentrations from the BCP system were on the low end of those reported for most stormwater treatment practices (see article 65).

The pollutant removal capability of traditional sand filters may not be high or reliable enough for watershed managers that desire higher levels of nutrient or bacteria removal (Glick *et al*., 1998). Consequently, researchers have had a strong interest in testing whether organic media may be a more effective substitute for sand as a filter medium. In this regard, the use of compost or peat-sand mixes has frequently been proposed.

Performance of Peat Sand Filters

Two peat sand filters were recently tested by the Lower Colorado River Authority (LCRA, 1997). The first system, known as McGregor Park, treated the runoff from a 3.8 acre office parking lot. Before entering the peat sand filter, runoff was pre-treated in a small extended detention pond. The peat sand filter had a surface area of more than 200 square feet, and had a three-foot deep bed, composed of 18 inches of hemic peat over 18 inches of sand, with a layer of calcitic limestone interspersed between. The entire off-line facility was designed to treat the runoff from the first inch of rainfall. A schematic of this peat sand filter design is portrayed in Figure 1.

A second system, known as the underground facility, served a 1.5 acre office parking lot, but had a much different configuration. Runoff first entered an expanded catch basin with a small permanent pool (about 0.05 site-inches of capacity) and floating sorbent pillows for enhanced oil/grease removal. After this initial pretreatment, runoff was then directed into a series of "infiltrator" tubes which spread it over a large but shallow underground filter bed. The bed was about 3,200 square feet in area, and was composed of a mix of hemic peat and sand that was typically only 12 to 18