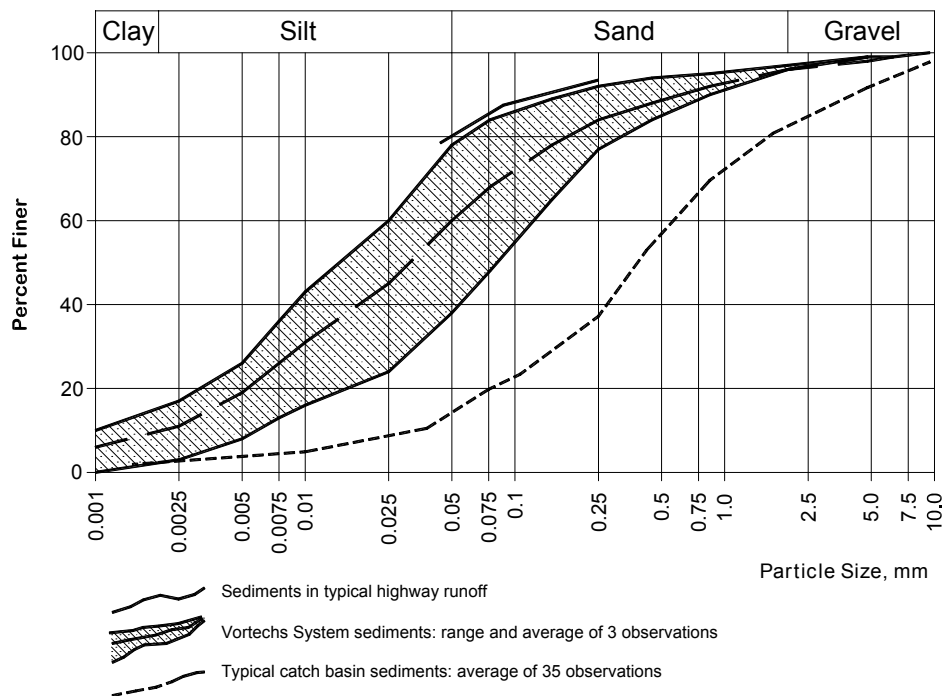




# TECHNICAL BULLETIN NO. 2

## Particle Distribution of Sediments and the Effect on Heavy Metal Removal

Sediments removed from Vortechs® Stormwater Treatment System installations in Portland and South Portland, Maine were analyzed by a soil testing laboratory to determine size and distribution. These results were compared to similar tests done on sediments carried in highway runoff<sup>1</sup> and on material removed from catch basins by “Vactor” truck<sup>2</sup>. The highway runoff sediment data is useful in characterizing typical total stormwater sediment loading. The catch basin data is indicative of sediment removed by typical plug-flow tanks. This data is plotted below for graphical comparison:



The curves describing sediments extracted from Vortechs® Systems show enhanced effectiveness across the entire range of particle sizes. In the “mid-range” for example, over 80% of the sediment retained by a Vortechs® System is approximately 250 microns (“medium sand”) and finer particles, compared with less than 40% of the sediment in catch basin sumps. The difference between the curves may be interpreted as sediment loss from the catch basins due to turbulence and the resuspension of previously deposited grit. These problems are widely recognized to occur in catch basins and, for that matter, conventional oil/grit separators during brief periods of high flow.

The curve describing the particle size distribution of sediments found in highway runoff from the study by Dr. Yousef is the result of averaged samples taken from highway sites across the U.S. and is therefore

<sup>1</sup> Yousef, Y. A. et.al., 1991, Maintenance Guidelines in Accumulated Sediments in Retention/Detention Ponds Receiving Highway Runoff, Florida Department of Transportation, Tallahassee, FL, p. 17 The study included samples from Highway 50, (Sacramento), I-81, (Harrisburg), I-94, (Milwaukee) and I-85, (Effland). The curve shown is the average of the four samples.

<sup>2</sup> Analysis of sediments from 35 catch basins performed under the direction of Steven Lazoff, Laboratory Director, Aquatic Research, Inc., Seattle, WA and reported to Bob Storer, King County Surface Water Management Division, Seattle, WA, June 21, 1993.

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representative of sediment loading. The curve describing sediments in highway runoff and the curves describing sediments in the Vortechs® Systems are very similar. This shows that the Vortechs® System is highly effective in capturing sediment particles found in highway runoff. The fact that the curves are of such similar shape suggests further that Vortechs® System removal efficiency applies equally to the full spectrum of particle sizes and that the Vortechs® System never washes out.

A catch basin or virtually any tank with a sump where particles can be stored can effectively settle particles out of stormwater runoff if the flow rate is low enough. In most wet weather the flow rate is low enough to achieve high efficiency. But the converse is also widely recognized to be true; that is, when the flow rate is high, the efficiency is low, often dropping to negative efficiency with the result that the overall efficiency over time approaches zero, especially for fine-grained particles.

Fine-grained sediments pose the greatest environmental threat. Heavy metals, nutrients, and hydrocarbons adhere to the surface of suspended particles and are transported by stormwater runoff. A large number of small particles will provide a larger total surface area for substances to adhere to than a smaller number of larger particles of the same total volume. Trapping this material will significantly reduce the presence of these harmful contaminants in surface waters.

For example, a 1.0 mm cube has a surface area of 6 square millimeters. Dividing that one cube into a thousand 0.1 mm cubes increases the total surface area tenfold to 60 square millimeters. Seventy percent of sediments found in catch basins are 1 mm or smaller, and seventy percent of the sediments removed by Vortechs® Systems are 0.1 mm or smaller, so the potential for pollutant capture is much greater.

Relative to more traditional Best Management Practices (BMP's) for stormwater quality improvement, the Vortechs® System compares very favorably with respect to dry weight concentrations (mg/kg) of metals found in captured sediments<sup>3</sup>.

|                               | Detention Basin | Sand Filter | Sand Filter w/ Sediment Chamber | Wet Pond | Grassed Swale | BMP Average | Vortechs® Average | Variation |
|-------------------------------|-----------------|-------------|---------------------------------|----------|---------------|-------------|-------------------|-----------|
| <b>Cadmium</b>                | 4               | 1.3         | 4.6                             | 6.4      | 1.9           | 3.6         | 2.8               | -22%      |
| <b>Chromium</b>               | 30              | 30          | 52                              | 36       | 30            | 36          | 55                | 53%       |
| <b>Copper</b>                 | 59              | 43          | 71                              | 24.5     | 27            | 45          | 85                | 89%       |
| <b>Lead</b>                   | 161             | 81          | 171                             | 160      | 420           | 199         | 417               | 110%      |
| <b>Nickel</b>                 | N/A             | 30          | 49                              | 38       | 13            | 33          | 37                | 12%       |
| <b>Zinc</b>                   | 448             | 182         | 418                             | 299      | 202           | 310         | 470               | 52%       |
| <b>Number of Observations</b> | 11              | 1           | 1                               | 38       | 8             | N/A         | 3                 | N/A       |

Research now indicates that the greatest environmental risk appears to occur when metal and hydrocarbon-laden sediments are deposited in downstream lakes and estuaries. This material has a long-term negative impact on the health of surface waters. The data presented in this report shows the Vortechs® System is approximately 50% more effective in capturing these sediments than conventional BMP's.

<sup>3</sup> Schueler, Thomas R. and Yousef, Y. A. 1994. Pollutant Dynamics of Pond Muck. Watershed Protection Techniques. Vol. 1, No. 2, p. 44.