

A Breakthrough in Total Phosphorus Removal:

The Science behind SorbtiveTMMEDIA



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Sorbitive™MEDIA captures high levels of Total Phosphorus (TP) and thus achieves low TP effluent concentrations, dramatically outpacing conventional stormwater management media. TP consists of both dissolved phosphorus and particulate-bound phosphorus. The total phosphorus in stormwater runoff is typically composed of 50% particulate-bound and 50% dissolved phosphorus.

Unlike conventional Stormwater Best Management Practices (BMPs), SorbtiveMEDIA captures *dissolved phosphorus* (DP) through sorption, allowing high levels of TP removal to be achieved. With a high specific surface area that sorbs and retains large pollutant loads, SorbtiveMEDIA provides between 100 and 1,000 times more pollutant removal capability compared to conventional media; unlike other media, it does not desorb, nor (leach) other pollutants.

This paper explains the science behind SorbtiveMEDIA, and its immediate and long-term advantages over conventional stormwater management media.

What is SorbtiveMEDIA?

SorbitiveMedia is applied as part of a variety of Stormwater BMPs to capture high levels of TP, as well as Total Suspended Solids (TSS), and other sediment-associated pollutants.

SorbitiveMEDIA is distinct from conventional stormwater filtration media in part because of its fast-reactive kinetics and its long-lasting Bed Volume capacity for capturing dissolved phosphorus. SorbtiveMEDIA utilizes a high surface area and oxide coating, which sorbs dissolved phosphorus and physically filters particulate-bound phosphorus by capturing fine sediment (TSS).

It achieves high TP removal through two phosphorus removal mechanisms:

- **Physical Filtration** – removal of particulate-bound phosphorus and sediment; and
- **Sorption** – physio-chemical removal of dissolved phosphorus, which is the biologically available portion.

SorbitiveMEDIA provides a cost effective solution due to its high sorption capacity, fast reacting kinetics and superior treatment life-cycle.

Capturing Dissolved Phosphorus

BMPs relying only on physical removal mechanisms such as sedimentation or filtration typically have a TP removal efficiency of just 40 to 50% because they do not capture dissolved phosphorus – which comprises 50% of the total phosphorus load.

When using SorbtiveMEDIA, much higher TP removal rates (up to 90%) can be achieved. For critical watersheds, SorbtiveMEDIA can also achieve low TP effluent concentrations (< 0.1 mg/L), providing a cost effective means to ensure that water quality objectives are being met, no matter what the Total Maximum Daily Load (TMDL).

SorbtiveMEDIA is available in various forms – from small granular particles to large stone-size pieces – to deliver high TP removal and low TP effluent concentrations in constrained sites.

Applications

SorbtiveMEDIA can be applied with a broad range of stormwater filtration and infiltration treatment systems and Low Impact Development (LID) practices (e.g., permeable pavement bedding) to achieve water quality goals. It can also be used to retrofit existing proprietary and non-proprietary structural BMPs like sand filters and proprietary filter systems by replacing conventional media.

Each SorbtiveMEDIA application is designed to meet the site's specific water quality objective (% TP removal, effluent mg/L discharge limit, or annual load reduction pounds/acre/year), local hydrology, BMP type, water quality design requirements, desired maintenance frequency, site type and associated loadings.

SorbtiveMEDIA is available in several gradations to accommodate any stormwater treatment system or phosphorus regulation, and is a practical for application in the following BMPs:

- Proprietary filter systems
- Radial stormwater filter cartridges
- Sandfilters
- Infiltration trenches & dry wells
- Bioretention cells

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- Permeable interlocking paver bedding or joint fill
- Soil amendment
- Decorative / Functional landscaping

To achieve high removal levels of critical pollutants such as phosphorus, commonly a minimum of 85% to 90% Water Quality Volume (WQ_v) will need to be treated. Local hydrology, BMP type, pre-treatment upstream, water quality design requirements, desired maintenance frequency, site type and associated loadings are also considered in the implementation of SorbtiveMEDIA and sizing of systems. Consult your local Imbrium representative for assistance.

Performance

SorbitiveMEDIA can be applied to stormwater treatment systems to passively deliver very high TP removal rates or very low TP effluent concentrations (< 0.1 mg/L). For example, field demonstrations of SorbtiveMEDIA in proprietary stormwater filtration radial cartridges have shown TP effluent concentrations of less than 0.1 mg/L. This performance was achieved in addition to achieving over 60% DP removal and nearly 90% sediment removal (Suspended Sediment Concentration) at a maximum hydraulic loading of 2 gpm/ft² (1.4 L/m²-s).

SorbitiveMEDIA's high sorption capacity, fast reaction kinetics and optimal treatment life-cycle is also evidenced by its Breakthrough Bed Volumes (BV) in comparison to conventional media.

Performance objectives include: Percent (%) TP or DP removal; TP or DP effluent mg/L discharge maximum limit; TP or DP annual load reduction pounds/acre/year; and maintenance frequency (media replacement).

Specifications

SorbitiveMEDIA is available in wide range of granular sizes all delivering high levels of specific surface area. A common media gradation for radial stormwater filtration cartridges and infiltration BMPs is 0.8mm to 5mm (800 to 5000 microns), and for sand filters and bioretention an ASTM C 33 based gradation 0.150mm to 4.75mm (150 to 4750 microns) would be used.

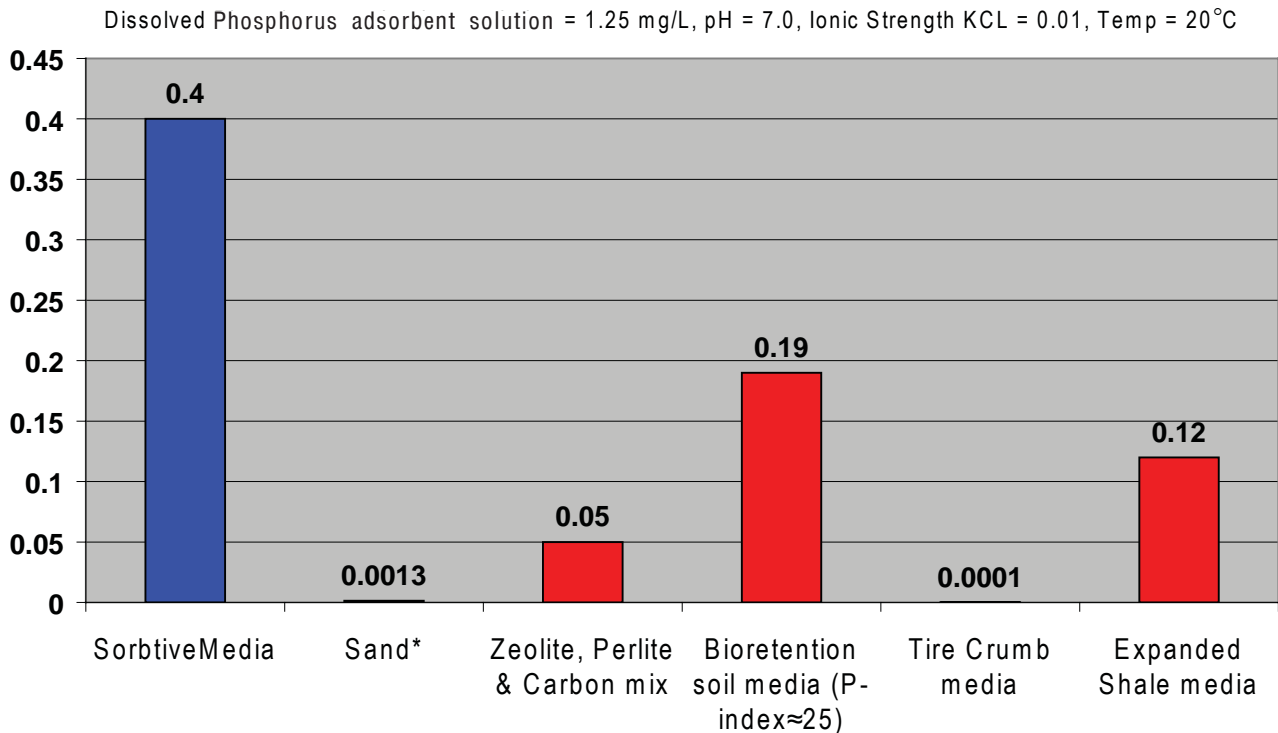
Typical properties of the 0.8mm to 5mm gradation are:

Bulk Density: 46 pounds/ft³ (0.74 g/cm³)
Specific Surface Area: 75 to 100 m²/g
Hydraulic conductivity: 1.5 cm/s



Test Results

Adsorption 1-point Isotherm Equilibrium Capacity (mg/g) of Dissolved Phosphorus (DP)



Adsorption Equilibrium Isotherm Testing was conducted on various media over a wide range of dissolved phosphorus concentrations to determine the sorption capacity for dissolved phosphorus available per media under realistic stormwater conditions. Sorption capacity using the Freundlich Isotherm model, and selecting

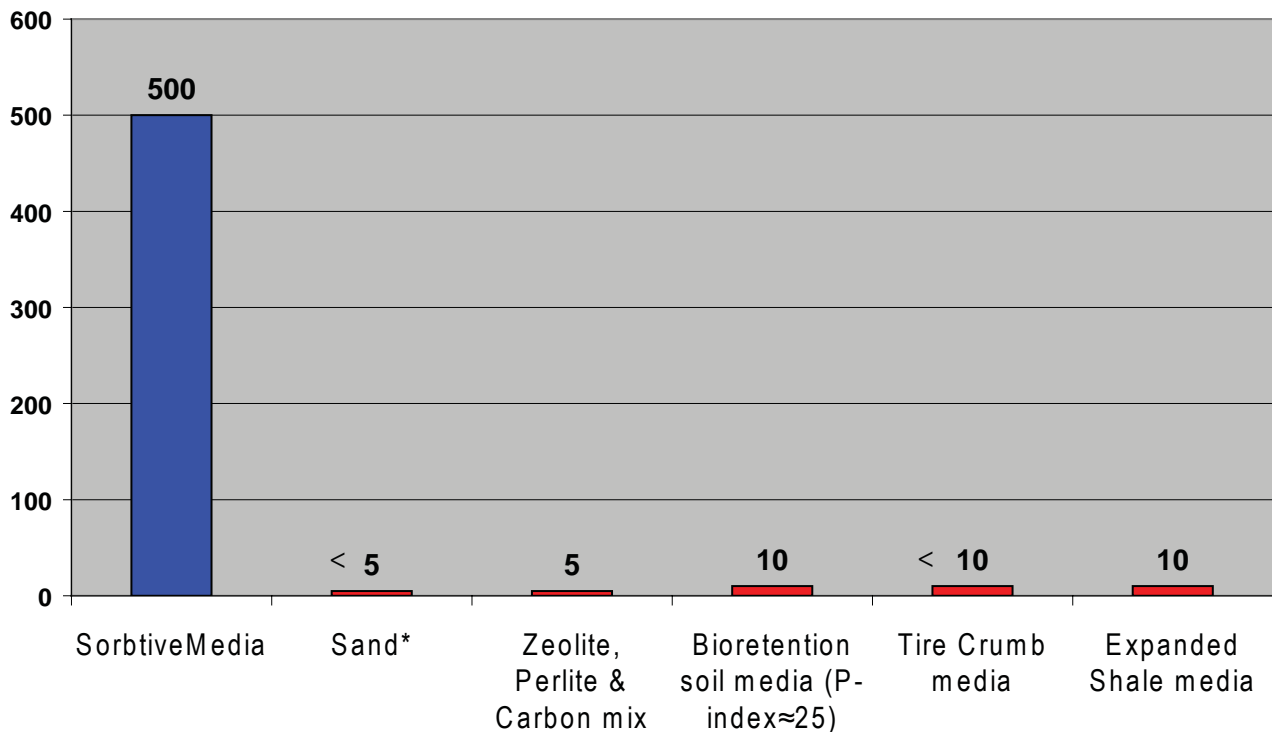
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a single point from the isotherms conducted is indicated by milligrams of dissolved phosphorus sorbed per gram of media based on an initial absorbent concentration of 1.25 mg/L of dissolved phosphorus.

Media quantities of 0.5 g and 40 ml of dissolved phosphate solution were mixed in a 50 ml polyethylene centrifuge tube on a bench shaker for 24 hours at a rate of 100 rpm and 20°C. The centrifuge tube's contents were then filtered through 0.45 µm syringe filter and the total dissolved phosphate concentration in the filtrate was measured. The amount of dissolved phosphorus adsorbed by the media was then calculated from the difference between the initial and final equilibrium concentrations, indicating the Adsorption Capacity (mg/g).

Number of Bed Volumes (Bv) at Breakthrough of 50% Dissolved Phosphorus (DP) Removal

Dissolved Phosphorus test solution = 0.5 mg/L, pH = 7.0, Ionic Strength KCL = 0.01, Temp = 20°C



A Column Breakthrough Study was conducted on various media evaluating phosphorus adsorption under continuous loading to determine removal capabilities. A known mass of media was packed inside a Teflon PEA column. A continual influent solution (0.5 mg/L DP concentration) flowed through the media column, allowing for adsorption to occur. Dissolved phosphorus concentrations were periodically measured at the effluent to determine removal capability and the number of Bed Volumes loaded prior to Breakthrough occurring.

Breakthrough indicates the number of liquid Bed Volumes (equal to the volume of media being tested) the media can be introduced to before a certain level of performance is no longer obtainable. In this case, 50% dissolved phosphorus removal was the indication of Breakthrough, quantified by the number of Bed Volumes.

Consistent test conditions were maintained for all testing; pH = 7, Ionic Strength (KCl)= 0.01, 20 deg C. Phosphorus was measured by HACH DR/5000 Spectrophotometer using PhosVer 3 Ascorbic Acid Method (Standard Method 1998). The ascorbic acid method was used to detect orthophosphate and a persulfate digestion was used to convert any other forms of phosphorus to orthophosphate. All measurements were duplicated and high repeatability was assured by controlling experimental error within $\pm 5\%$. Note (*) results for the sand media are conservatively estimated based on previous testing under similar conditions.

The 5-Point Advantage

1. Hydraulic Conductivity

Filtration and infiltration stormwater treatment BMPs are primarily hydraulically design dependent on the granular media particle sizes. SorbtiveMEDIA's fast reaction kinetics allow for maximum hydraulic conductivity, while still achieving high levels of performance. This optimizes the design, and reduces the BMP's "footprint" compared to other conventional media. SorbtiveMEDIA has a wide range of gradations – from small sand to gravel – which allows it to be used in virtually any stormwater treatment application.

2. Flexibly Sized & Long Lasting

With significantly higher sorption capacity and longevity as indicated by Bed Volumes compared to other technologies, use of SorbtiveMEDIA offers sizing flexibility. Either the total space or "footprint" requirement to remove the same amount of phosphorus is much smaller when using SorbtiveMEDIA, or sized with an equal volume of media will result in higher levels of phosphorus and lower maintenance frequency requirements.

3. Simple

Installation and replacement of SorbtiveMEDIA is simple and safe, not requiring special training or equipment. Switching to SorbtiveMEDIA is as simple as replacing the existing media in an existing stormwater filtration system. Whether SorbtiveMEDIA is used in residential, community or industrial applications, it is easy and safe to use.

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4. Robust

Unlike other filtration media used in filtration cartridges (such as granulated perlite) SorbtiveMEDIA is not friable, so it does not crumble and disintegrate with transit, installation and use. It also does not decompose and leach captured pollutants, unlike compost-based materials, preventing the long-term migration of pollutants downstream.

5. Safe

SorbitiveMEDIA is a safe, non-hazardous solid granular material both before use and after use. Spent media can be easily disposed of in a landfill as per local regulations. Captured Phosphorus is bound tightly to and within the Sorbtive media, so under typical water chemistry conditions it does not leach or desorb. Imbrium will also be investigating the potential to regenerate spent media, allowing for re-use in the near future.

SorbitiveMEDIA is an oxide-coated, high surface area reactive engineered media that performs absorption, surface complexation and filtration of stormwater for total phosphorus removal.

For more information on **SorbitiveMEDIA** contact an Imbrium Systems representative or visit www.imbriumsystems.com or call **USA: 888.279.8826 / CANADA: 800.565.4801.**