

# CMP SAND FILTER TECHNICAL INTRODUCTION



*Ever changing storm water regulations continue to emphasize the importance of Best Management Practices to address water quality issues ... Lane's CMP Sand Filter provides a solution to those needs ...*



## INTRODUCTION

Lane's CMP sand filter (CMP<sub>SF</sub>) provides a mechanism to intercept storm water flow, remove pollutants, and discharge treated flow in a manner suitable for today's storm water regulators. Ever-changing storm water regulations continue to emphasize the importance of Best Management Practices to address water quality issues and associated mandates

set forth by the EPA. Simply put, the CMP sand filter is a tried-and-true means of providing treatment that not only meets the EPA's standard for treating the "first flush," but serves as the performance benchmark for other types of water quality devices.

## GENERAL

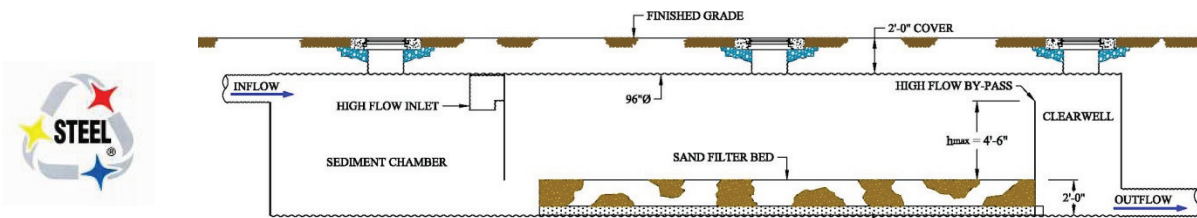
The underground sand filter is a design variation of the surface sand filter, where the sand filter chambers and media are located in an underground vault. Initially, underground sand filters were typically reinforced concrete rectangular structures. However, since the 1980's, CMP alternates

CIRCULAR OR ARCHED-PIPE SHAPES WITH THE APPROPRIATE COATING MAKE CMP THE STRUCTURE OF CHOICE FOR SAND FILTERS.

have demonstrated a market preference to the concrete vault due to less costly and obtrusive shipping, handling and

installation issues. Depending on any grade limitations, a circular or arched-pipe shape may be used. With the benefit of today's premium coatings (e.g. Aluminized T2), CMP sand filters have the added value of meeting the most stringent durability requirements.

Lane's CMP sand filter is a three-chamber system consisting of a sediment chamber, a sand bed filter and a clear well. Although multiple configurations are possible, the figure below shows a typical 8-ft diameter model with an internal bypass.



The sedimentation (pretreatment) chamber temporarily stores runoff and captures sediment. The sedimentation chamber is connected to the sand bed filter by a submerged wall that protects the filter bed from oil and trash. The filter bed is 12 to 24 inches deep and may have a protective screen of gravel or permeable geotextile to limit clogging. The filter bed includes an underdrain that discharges filtered runoff into a third chamber.

An in-line configuration must be able to bypass flows that exceed the filter bed capacity. Some design standards may allow an internal bypass (as above); however, regulations vary and may require an external bypass to prevent commingling with the "first flush" (i.e. water quality volume). Sand filters may also be constructed parallel to a storm drain in an off-line configuration, thereby utilizing the storm drain as a bypass provision.

## POLLUTANT REMOVAL PERFORMANCE

Water quality regulations are typically associated with what is commonly referred to as the “*first flush*.” The first flush occurs at the beginning of each rain event, as sediment and pollutants deposited from the previous rain event, as well as any oil or floatable debris that have since accumulated, is collected and carried away with the initial rain water flow. Lane’s CMP sand filters are designed to meet the permit requirements of the NPDES Phase II program by completely treating the first flush.

The underground sand filter is a non-proprietary device with EPA recognized pollutant removal efficiencies. Being verified in practice before testing protocols came to the fore, the underground sand filter has an EPA recommended design procedure and is recognized in all storm water quality manuals. In essence, a correctly designed underground sand filter will meet all water quality performance requirements.

NON-PROPRIETARY, VERIFIED IN PRACTICE, EPA RECOMMENDED DESIGN PROCEDURE, RECOGNIZED IN ALL STORM WATER QUALITY MANUALS.

TSS	70-85%
TP	50-60%
TN	30-40%
HYDROCARBONS	70-85%
FECAL COLIFORM	75-85%
HEAVY METALS	50-65%
PATHOGENS	40-50%
BOD	70-80%

## POLLUTANT REDUCTION RANGES

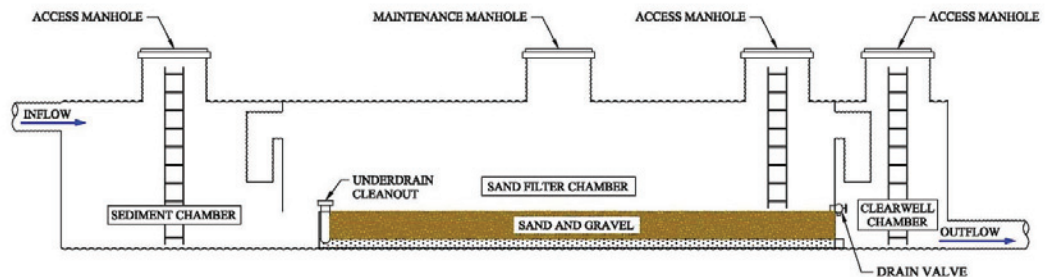
Storm water pollutants are removed through a combination of gravitational settling, filtration and adsorption. The filtration process effectively removes suspended solids, biochemical oxygen demand (BOD), and other pollutants. Underground sand filters are able to remove up to 85% of the total suspended solids (TSS), with research supporting acceptable pollutant removal reductions in total phosphorous (TP), total nitrogen (TN), fecal coliform and heavy metals. Supplementing the sand filter media with other materials (e.g. peat, bioretention soil) can dramatically enhance water quality treatment.

## INSPECTION & MAINTENANCE

Lane’s CMP sand filter includes adequate access to each compartment for inspection and maintenance. The inclusion of an underdrain cleanout and a filter chamber drain valve will help facilitate maintenance should the filter bed become dysfunctional.

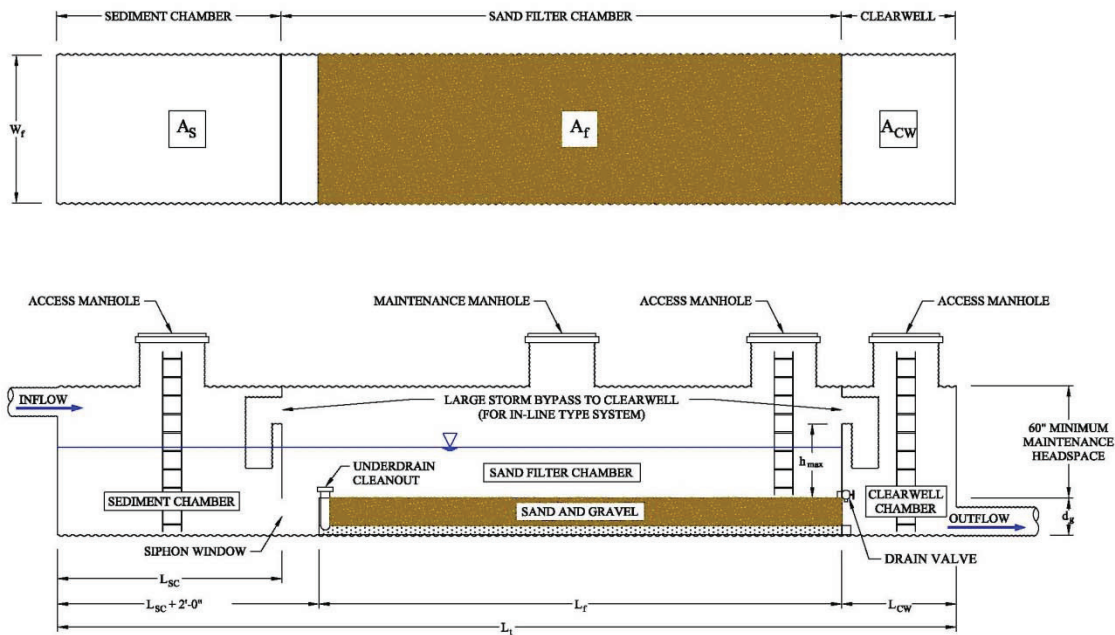
Typically, sand filters begin to experience maintenance demands within 3 to 5 years, although local ordinances may require more frequent maintenance. A filter bed should drain completely in about 40 hours after the end

of a rain event. Periodically monitoring dewatering times will help determine when maintenance measures are needed. Standard maintenance operations include removing accumulated sediment and raking the first inch of sand. Usually, cultivating the top layer of sand will restore the drainage and filter characteristics of the filter bed, but at times the top few inches of media may require removal and replacement.



## DESIGN & DEVELOPMENT

Lane's CMP sand filter design closely resembles what is commonly known as the **DC Sand Filter** (i.e. Washington DC). The DC filter is intended to treat storm water that is conveyed by a storm drain system.



The controlling parameter associated with sand filter design is the water quality volume (WQv), obtained by multiplying a depth of rain water by the area tributary to the structure. The depth used varies among local storm water ordinances, and the tributary area often includes a reduction for pervious areas. The sediment chamber is typically sized to retain a percentage of the water quality volume (usually 25%) before spilling into the filter chamber.

Dimensioning the filter bed utilizes principles of Darcy's Law. A coefficient of permeability, taken as 3.5 ft/day, is used to ensure the filter bed completely drains in less than 40 hours. The filter media consists of an 12 to 24 inch layer of clean washed medium aggregate concrete sand over a 4 or 6 inch perforated underdrain in a gravel layer.

Dimensioning the sand filter is dependant on appropriately sizing the filter bed. With  $A_f$ ,  $W_f$  and  $L_f$  determined,  $L_{SC}$  is calculated to accommodate a required storage volume in the sediment chamber, while  $L_{CW}$  shall be sufficient to accommodate any working space requirements.

### Dimensioning the Filter Bed

$$A_f [ft^2] = \frac{(WQv)d}{k(h_{avg} + d)t}$$

$$W_f = 2[2rd - d^2]^{1/2}$$

$$L_f = A_f W_f$$

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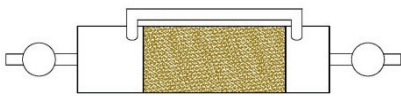
- WQv = water quality volume (ft<sup>3</sup>)
- d = depth of filter media (ft)
- k = coefficient of permeability of filter media (ft/day)
- h = average height (ft) of water over filter bed ( $h_{max} + 2$ )
- t = filtration time (days)
- r = radius of pipe (ft)

Typical values to use when calculating the filter bed area needed for water quality treatment

WQv = (1 in)(% impervious)(contributing acreage)(43,560 ft<sup>2</sup>/ac)  
 d = use 2 ft  
 k = use 3.5 ft/day  
 t = 1.67 days (40 hours)

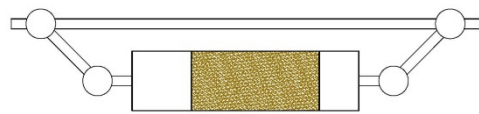
## DIFFERENT CONFIGURATIONS & VARIOUS APPLICATIONS

Manufactured from Lane corrugated metal pipe, with the same quality custom fabrication that's been Lane's trademark on fittings, risers, trash racks, flow control structures, etc., the CMP sand filter may be suited for any number of applications or site restrictions.



**The commonly used DC Filter** is used as Lane's standard CMP sand filter design. The DC Filter is intended to treat storm water that is conveyed through a storm drainage

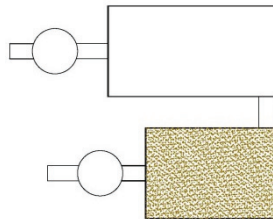
system. Configurations in an in-line configuration may contain an internal bypass, but more likely may require an external bypass (as above) to prevent co-mingling the higher flows with the water quality volume.



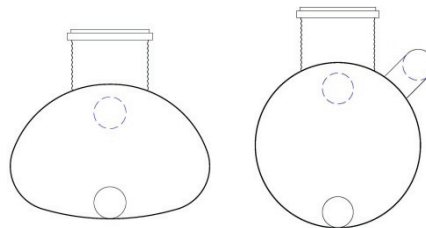
**Lane's CMP sand filter** may be used in an offline configuration with the use of an upstream diversion chamber. In effect, the storm drain

serves as an external bypass for when flows exceed the filters hydraulic capacity. This configuration is becoming increasingly popular among today's designers for providing water quality treatment prior to discharging into a CMP storm water detention system.

CMP affords design flexibility unmatched by other construction materials. Equipped with experienced welders, Lane's custom fabricated sand filters are not confined to a linear arrangement. Geometric flexibility allows Lane's CMP sand filter to be retrofitted to any completed design.



**Lane can design and manufacture CMP sand filters** in standard circular or arched-pipe shapes, depending on height of cover limitations.



### LANE'S CMP SAND FILTERS PRESENT A NUMBER OF FEATURES AND BENEFITS THAT HELP SET THEM APART FROM THE COMPETITION

- Quality Lane CMP fabrication work
- Meets EPA water quality treatment standards
- Recognized by all storm water quality manuals
- Geometric flexibility
- Less obtrusive than comparable concrete sand filters
- Non-proprietary design
- Tried-and-true, verified in practice
- Lightweight, installation friendly and durable
- Less costly than comparable products
- Can be used in different configurations to meet site restrictions
- Complete engineering and CAD support

With complete engineering design and CAD support, Lane is equipped to provide any assistance necessary. **Please contact your Lane representative for assistance in selecting the appropriate design to meet the needs of your site.**