PERKFILTER™

Design Guide

TABLE OF CONTENTS

Description

The PerkFilter is a media filtration system that uses physical and chemical treatment processes such as sedimentation, filtration and sorption to remove Total Suspended Solids (TSS), metals, nutrients, gross solids, trash and debris, and petroleum hydrocarbons to significantly reduce the total pollutant discharge load in stormwater runoff. The PerkFilter is a media-filled, cartridge filtration system where the number and size of cartridges is tailored to accommodate the water quality flow rate and to meet the specific needs of the site. To allow maximum design flexibility, the PerkFilter is available in multiple configurations, including catch basins, precast concrete vaults, manholes, and curb inlets, and larger custom-designed concrete structures.

The PerkFilter consists of an inlet chamber for high-flow bypass and removal of gross pollutants, a treatment chamber for filtration through media-filled cartridges, and an outlet chamber for flow collection and discharge. A variety of filter media is available to target specific pollutants of concern. Standard configurations allow for internal high-flow bypass, so the PerkFilter can be designed as an online or offline system. As with any stormwater treatment system, the PerkFilter requires periodic maintenance to prolong the life of the system. The frequency of maintenance depends on the conditions of the site and performance of the system.

Function

The PerkFilter is a water quality treatment system consisting of three chambers: an inlet chamber, a treatment chamber with filter cartridges, and an outlet chamber (Figure 1). Stormwater runoff enters the inlet chamber through an inlet pipe, curb opening, or grated inlet. Gross solids are settled out and floating trash and debris are trapped in the inlet chamber. Pre-treated flow is then directed to the treatment chamber through an opening in the baffle wall between the inlet chamber and treatment chamber.
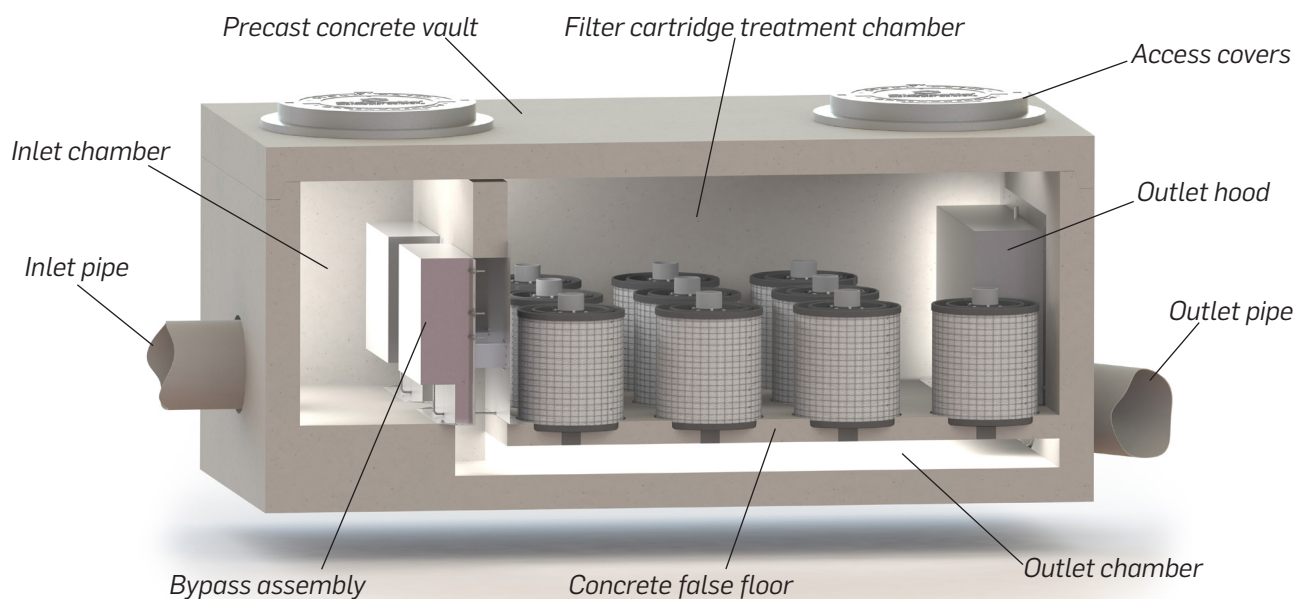

Figure 1. Schematic of the PerkFilter system

The treatment chamber contains media-filled filter cartridges that use physical and chemical processes to remove pollutants (Figure 2). The standard media consists of a perlite outer layer and a zeolite and carbon inner layer. During a storm event, runoff pools in the treatment chamber before passing radially through the cylindrical cartridges from the outside surface, through the media for treatment, and into the center of the cartridge. At the center of the cartridge is a center tube assembly designed to distribute the hydraulic load evenly across the surface of the filter cartridge and control the treatment flow rate through the cartridge. The center tube assembly discharges treated flow through the false floor and into the outlet chamber. A draindown feature built into each cartridge allows the treatment chamber to dewater between storm events.
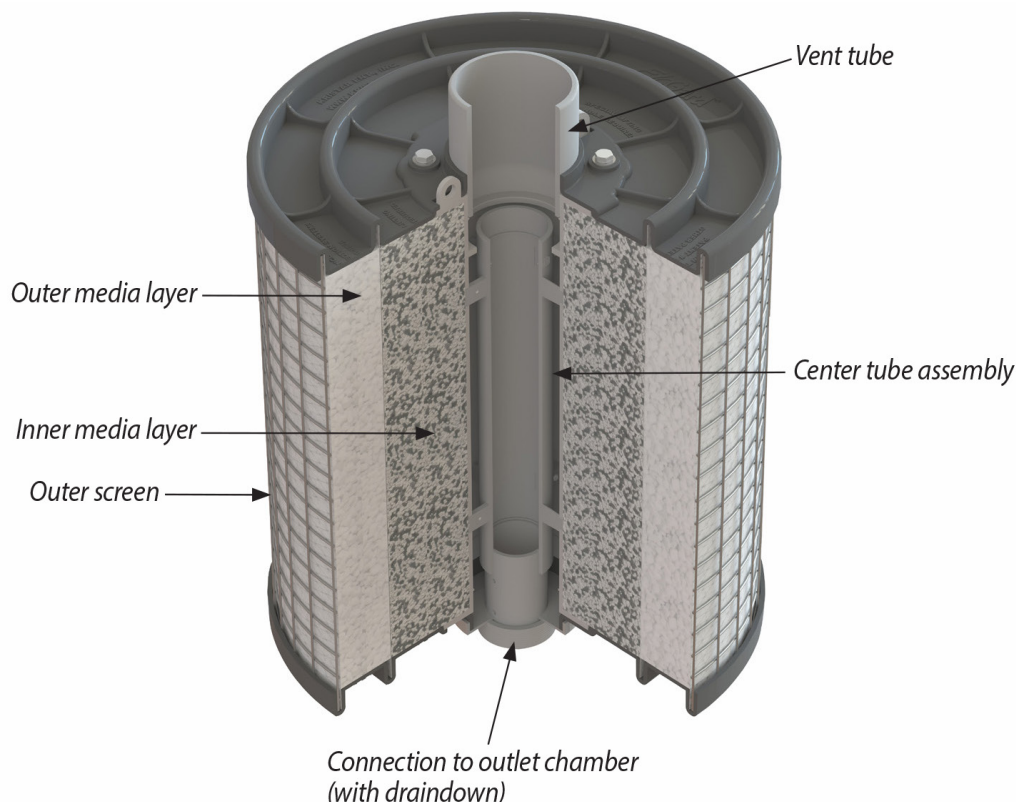

Figure 2. Schematic of the PerkFilter cartridge

All cartridges are 18 inches in diameter and are available in two heights: 12 inches and 18 inches. Cartridges may be used alone or may be stacked to provide a 24-inch combination (12" + 12") or a 30-inch combination (12" + 18") as shown in Figure 3. The capacity of each cartridge or cartridge combination is dictated by the allowable hydraulic loading rate of the media and the outer surface area of the cartridge. Thus, taller cartridges have greater treatment capacity than shorter cartridges but they require more hydraulic drop.
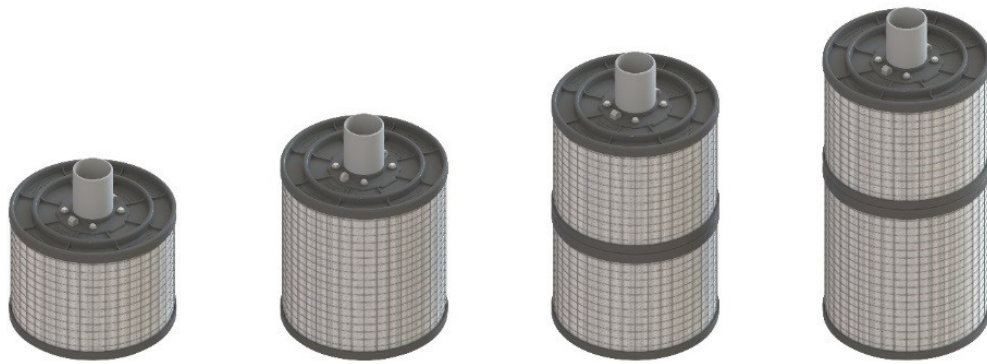
Figure 3. Cartridge Stack Configurations

Treatment Processes

The PerkFilter provides water quality treatment through physical and chemical unit processes. Treatment is achieved through separation, sedimentation, filtration and sorption.

Separation: A floatables baffle located in the chamber prevents the majority of floatable gross solids and oils from entering the treatment chamber or going to bypass. Water must pass under the baffle to move past the weir, which prevents floatable materials such as trash, litter, surfactants, oils and greases from exiting the inlet chamber. If the system is located downstream of a storage facility, the outlet control of the storage facility may provide the function of the inlet gallery without the use of the floatables baffle.

Sedimentation: The PerkFilter is designed to reduce flow velocities in the inlet chamber and in the treatment chamber, around the filter cartridges. This promotes gravity settling of entrained particles. Sedimentation of larger particles in the inlet chamber acts as a pre-treatment mechanism that improves system performance and extends the life of the filter cartridges. The amount of sedimentation attained is a function of particle size and density, water density, residence time and turbulence.

Filtration: Particulates are physically removed from suspension as they come into contact with the filter media. The filter retains those particles that are unable to follow the tortuous channels of connected void space within the filter. Pollutant removal rates achieved through filtration are a function of the stormwater composition and media properties including permeability, grain size and hydraulic conductivity.

Sorption: Unlike filtration, where physical processes control removal of sediment from suspension, sorption relies on opposing surface charges of media and dissolved species to remove pollutants from stormwater. The granular media contains material with a high surface area so that binding sites are numerous and not easily exhausted. In addition, the filter media has a high cation exchange capacity which promotes the removal of positively charged dissolved pollutants (including metal ions) from solution.

System Hydraulics

The PerkFilter can be designed to operate at hydraulic loading rates ranging from 1.5 gpm to 2.5 gpm per square foot of media surface area. The hydraulic loading rate is typically dictated by regulatory requirements and/or pollutant removal goals. The PerkFilter system is designed to meet regulatory and site-specific requirements to ensure full treatment of the water quality flow rate or water quality volume by the cartridges prior to bypass.

The PerkFilter requires hydraulic driving head to push water through the filter media and to account for other hydraulic losses across the system. The maximum head loss varies from 1.7 feet to 3.5 feet, depending on the cartridge stack configuration as shown in Table 1 below. If the drop across the system, as measured from the invert

of the inlet pipe to the invert of the outlet pipe, is greater than or equal to the maximum head loss shown in Table 1, the PerkFilter will not induce significant backwater in the collection system upstream. If the drop across the system is less than the head loss shown in Table 1, backwater may occur and the design team at Oldcastle Precast should be consulted for guidance. Given the physical constraints of the system, the drop across the system cannot be less than 9 inches.

The minimum installation depth as measured from rim to invert of the outlet will vary depending on the cartridge configuration. These specifications are comparable to other cartridge-based filter systems.

Cartridge Stack Configuration	Maximum Head Loss (ft)	Cartridge Flow Rate (gpm) at 1.5 gpm/ft^2	Cartridge Flow Rate (gpm) at 2.5 gpm/ft^2
12-inch	1.7	6.8	12
18-inch	2.3	10.2	18
12-inch + 12-inch	2.9	13.6	24
18-inch + 12-inch	3.5	17.0	30

Table 1. Cartridge Stack Configuration Details

System Sizing

The PerkFilter can be designed as either a flow-based or volume-based stormwater practice, depending upon the requirements established by the regulatory jurisdiction to meet their water quality standards.

Flow-Based Design Methodology: The flow-based design methodology is typically used in jurisdictions that specify a design storm event and are looking for treatment of a specific water quality flow rate. To design a PerkFilter as a flow-based system, a design storm event would first be used to calculate a water quality flow rate (WQf) off the site. The flow rate is usually calculated using the Rational Method, an SCS unit hydrograph, or a continuous simulation hydrology model. The treatment flow rate would then be divided by the design, per-cartridge operating flow rate (see Table 1) to determine the number of cartridges or cartridge stacks required. The PerkFilter structure would then be selected to accommodate the required number of cartridge stacks.

Volume-Based Design Methodology: The PerkFilter can also be designed as a volume-based system. This methodology is typically used in jurisdictions that specify a design rainfall and are looking for treatment of a specific water quality volume or when the PerkFilter is located downstream of detention.

Some jurisdictions specify a water quality volume (WQv) that must be captured and treated instead of a water quality flow rate. To ensure that the WQv is indeed captured and treated, the system must consist of two components: a storage component with outlet control followed by a filtration component. The WQv would first be calculated according to local regulatory guidance. The storage component would be sized to contain the WQv or some portion thereof (as specified by the jurisdiction) with an outlet control device, and the filtration component would be sized to ensure treatment of the pollutant mass load.

Other jurisdictions require the reduction of peak flows from new or redeveloped sites to meet pre-existing conditions or reduce hydromodification of downstream waterbodies. Detention facilities are designed to detain stormwater to an allowable release rate using an outlet control structure. Often, this allowable release rate is very low. The PerkFilter can be designed downstream of the detention system, however the flow-based method it not typically applicable in this case, as it does not account for the total volume of stormwater that passes through the PerkFilter during each storm and the associated pollutant loading.

To design a PerkFilter as a volume-based system, the number of cartridges is determined using a mass-loading calculation (or other calculation as specified by the jurisdiction) to account for the anticipated annual runoff volume and pollutant load. A mass-loading sizing typically targets a 1-year maintenance cycle and requires the calculation of an expected annual pollutant mass load off a developed site. This is typically calculated using a regional TSS

event mean concentration (EMC) multiplied by the annual volume of runoff (annual rainfall depth multiplied by the site area). Once the annual pollutant mass load is known, the number of cartridges required can then be calculated using the mass-load capability of each cartridge and the targeted mass-load reduction, which is typically 80%. If sedimentation is provided in the storage or detention component using a sump or dead storage, the mass load to the cartridges may be reduced.

If a volume-based treatment system is required, Oldcastle Stormwater can provide a StormCapture storage system that can be used in conjunction with the PerkFilter. The StormCapture is a modular, structural precast concrete storage system that may be used to capture the water quality volume or provide detention upstream of the PerkFilter. If pre-treatment is needed, Oldcastle can also provide a hydrodynamic device called the Dual-Vortex Separator to keep heavy solids and gross pollutants out of the storage system.

Oldcastle Stormwater's Engineers can assist in the calculations to determine the appropriate number of cartridges for either design methodology.


PerkFilter Configurations

There are many ways to configure the PerkFilter system. The structure types included below are the most common. Standard drawing details for each configuration are available and provide specific dimensions and depth constraints for each structure.

Catch Basin: The Catch Basin PerkFilter contains from one to four cartridge stacks and is housed in a precast concrete or powder-coated steel structure. The standard design includes a grated inlet to capture stormwater runoff from paved surfaces like roadway gutters and parking lots.
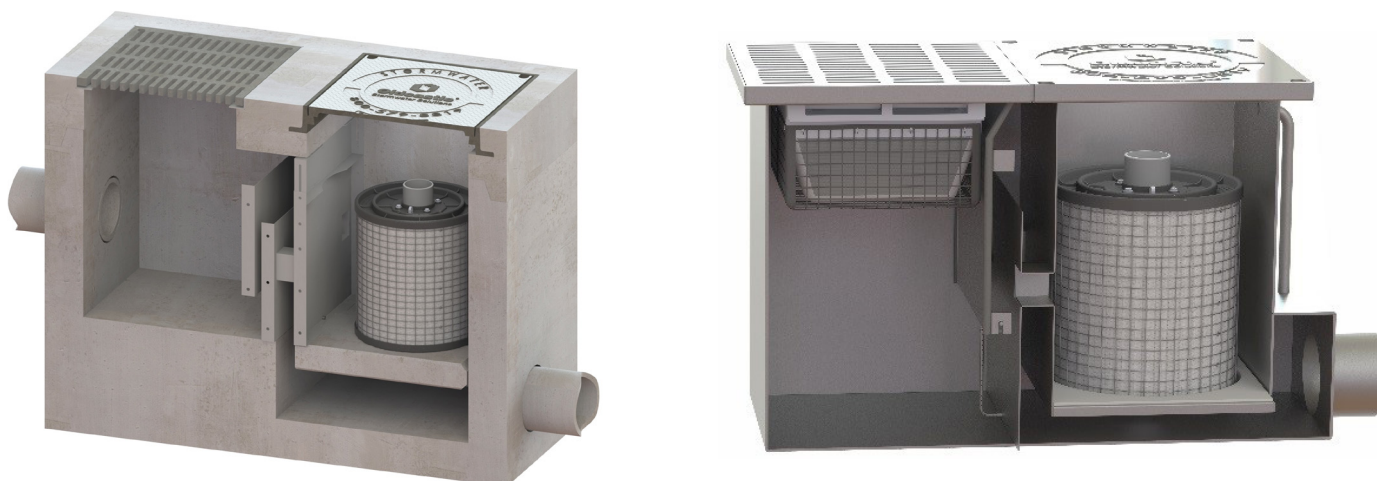
These systems have a maximum depth of 5 feet from the rim to the invert of the outlet pipe. The minimum depth is dictated by the cartridge stack height. The catch basin configuration can also accommodate an inlet pipe if needed, and includes a high-flow bypass that routes peak flows around the treatment chamber to discharge.

Curb Inlet: The Curb Inlet PerkFilter contains up to 24 cartridge stacks and is provided in a precast concrete vault ranging in size from 4' x 4' up to 8' x 16'. The standard design includes a 3.5', 4' or 7' curb inlet opening to capture stormwater runoff from roadways at the curb face. The Curb Inlet PerkFilter includes a high-flow bypass that routes peak flows around the treatment chamber to discharge.
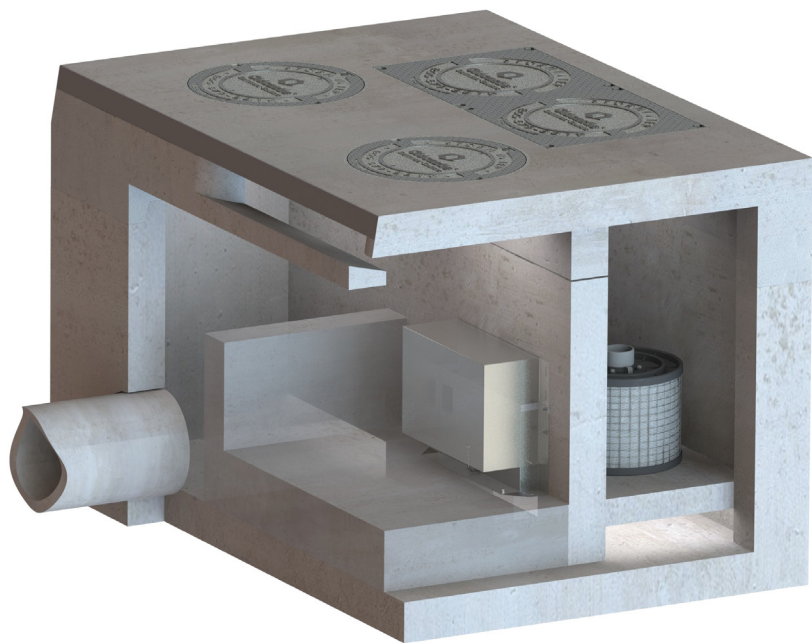
Manhole: The Manhole PerkFilter contains from one to eleven cartridge stacks and is provided in a concrete manhole structure that can range from 48" to 96" in diameter. Stormwater is typically delivered to the Manhole PerkFilter through an inlet pipe connection. The Manhole PerkFilter includes a high-flow bypass that routes peak flows around the treatment chamber to discharge.

Vault: The standard Vault PerkFilter can contain up to 31 cartridge stacks and is provided in a precast concrete vault ranging in size from 4' x 4' up to 8' x 18'. Stormwater is typically delivered to the Vault PerkFilter through an inlet pipe connection. The Vault PerkFilter includes a high-flow bypass that routes peak flows around the treatment chamber to discharge.
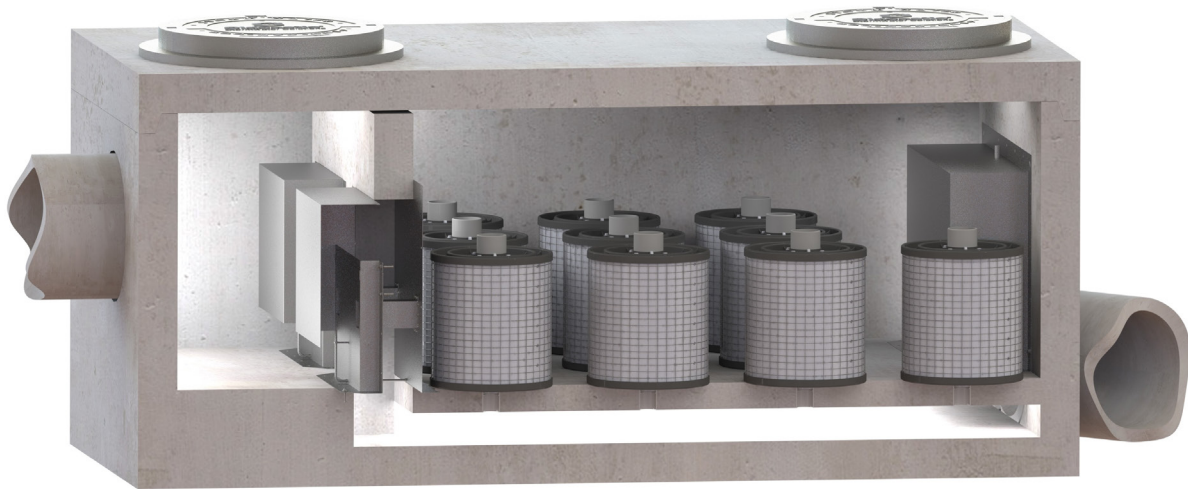
Larger Systems, Shallow Applications and Custom Configurations: Custom structures can be constructed that can contain any number of cartridges for any required treatment flow rate. Panel vault and box culvert designs can be provided when more treatment capacity is necessary. The PerkFilter can also be designed with a full access hatch when site constraints do not allow standard minimum depths. In summary, a custom configuration may be provided to accommodate most site conditions. The Engineering team at Oldcastle Stormwater is prepared to work with you to develop the most cost-effective and functional configuration for your site.

Redmond Regional Water Treatment Facility, Redmond, WA

Inspection and Maintenance Requirements

As with any stormwater treatment system, the PerkFilter requires periodic maintenance to prolong the life of the system. The PerkFilter should be inspected once or twice per year and maintained as needed. Standard maintenance includes removal of gross pollutants from the inlet chamber and treatment chamber, and replacement of the filter cartridges. Frequency of maintenance depends on the conditions of the site and performance of the system. Owners can typically expect at least 12 months of service from a PerkFilter before maintenance is required but the maintenance frequency may extend up to five years in regions with limited rainfall or at sites with minimal pollutant loading.

More detail on inspection and maintenance procedures can be found in the PerkFilter Inspection and Maintenance Guide.

Verification and Approvals

The PerkFilter has been rigorously tested in the laboratory and in the field. After extensive field investigation, the PerkFilter received a General Use Level Designation (GULD) from the Washington Department of Ecology (Ecology) for both Basic (TSS) and Phosphorus Treatment in 2010. Systems receiving a GULD are approved for stand-alone treatment in the state of Washington. In addition, the Virginia Department of Environmental Quality has included the PerkFilter on the Virginia BMP Clearinghouse list as an approved filtration device with a total phosphorus removal efficiency credit of 50%.

Project Design Assistance

Oldcastle Stormwater offers design assistance for your project offering site specific details and written specifications. Please visit our website for detailed product information, drawings, design tools and local contacts.

www.oldcastlestormwater.com
(800) 579-8819

From the start of construction to the completion of any project, Oldcastle Stormwater offers a comprehensive approach to meet your stormwater management needs.

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