

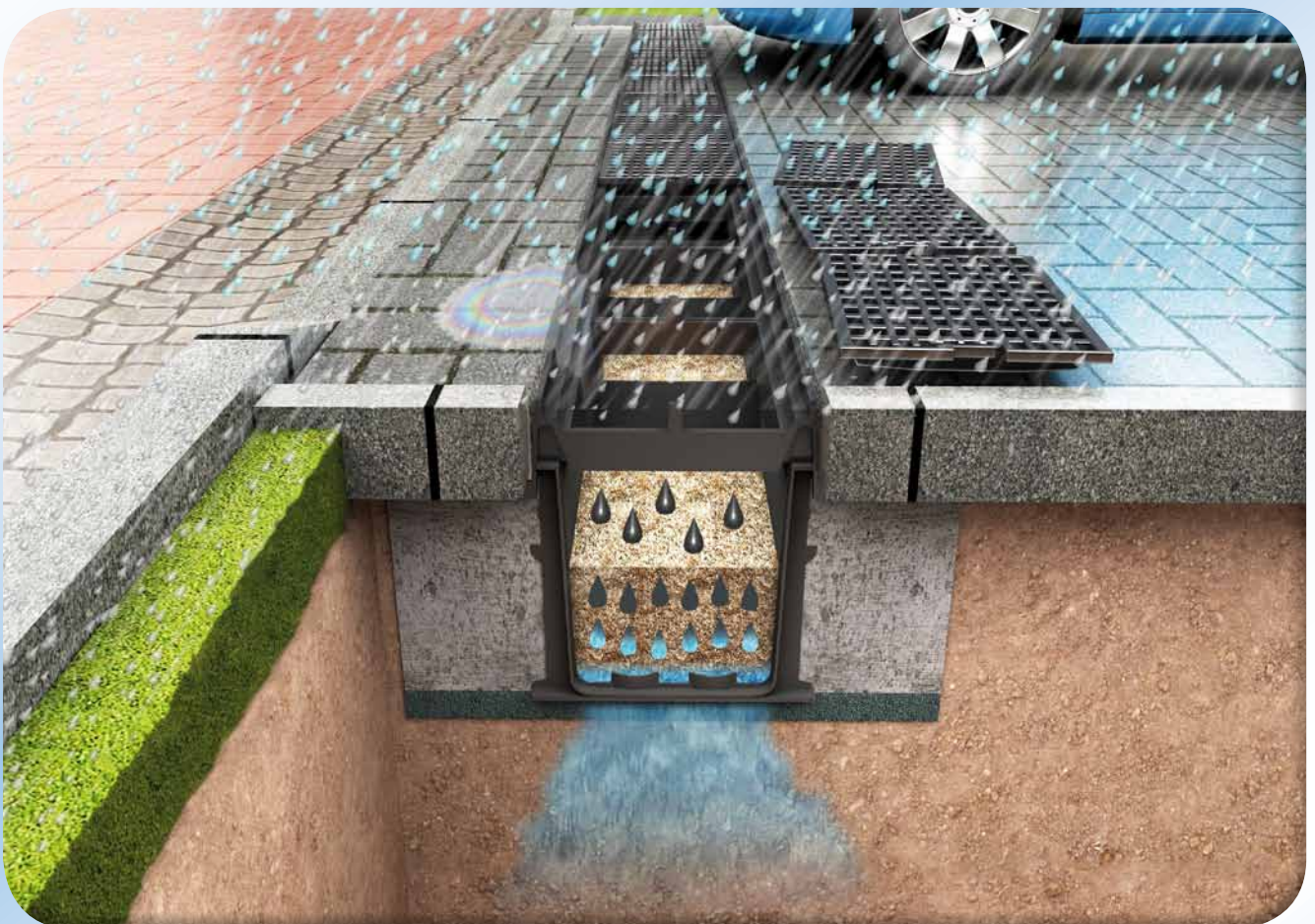
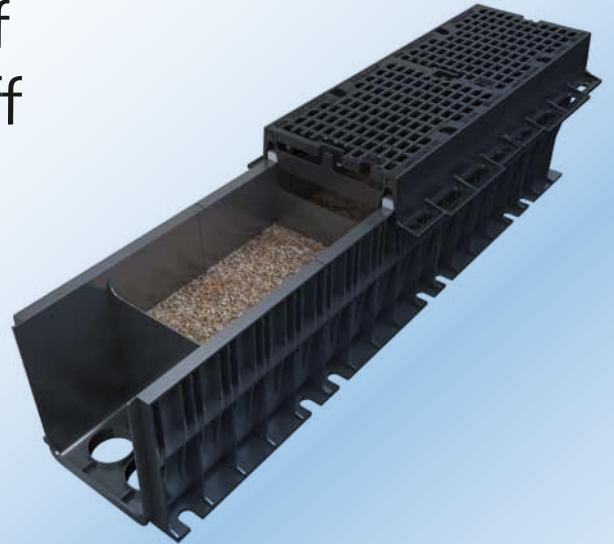
D-Rainclean®

Treatment and Drainage of
Polluted Rain Water Runoff

Including DIBt-Approval

New!

- Cover Class A/B
- Higher degree of connection
- Modified Filter-Media
- Increased cleaning capacity



D-Rainclean® – The Filter Chan



D-Rainclean® consists of a plastic Channel filled with a Filter-Media for the treatment and drainage of water from sealed surfaces. The plastic channel has internal dimensions of H/W/L = 366/300/500 mm and is provided with 8 holes 100 mm diameter in the base. The rain-water flowing from the surface contaminated with pollutants passes through the D-Rainclean Filter-Media layer where it is treated before being discharged through the base holes.

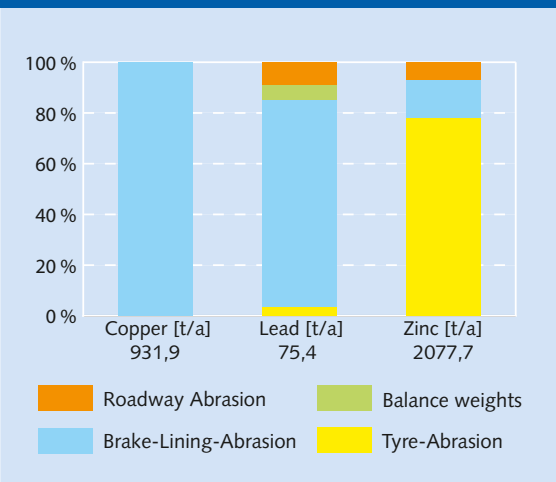
The D-Rainclean® remarkable treatment performance is due to selected natural minerals with a high exchange capacity and filtration effect. Diffuse hydrocarbons (oil drops) occurring from trafficked areas are nearly completely degraded. In case of an oil spill accident up to 10 liter of oil can be held within 1 linear metre of channel for up to 24 hours.

The Product

Current analyses entrusted by the Federal Environment Office* show that the load of heavy metals in waters and soil will have to be considerably reduced by appropriate treatment. Approximately 930 t/a copper, 80 t/a lead and 2078 t/a zinc in waters and soil originate in Germany from car traffic, only.

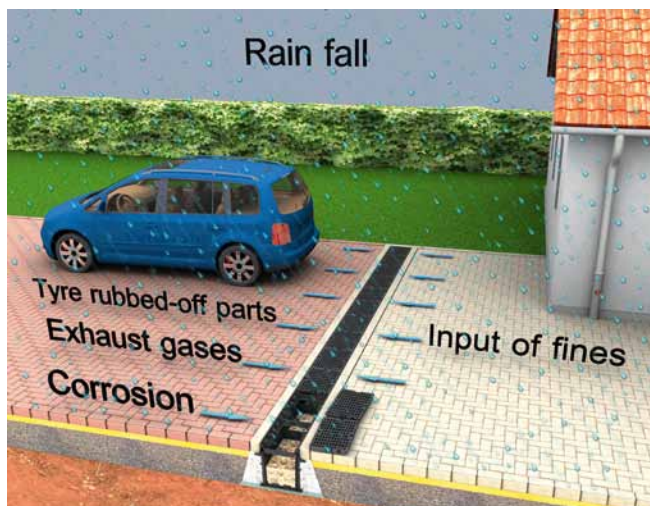
With the development of D-Rainclean®, a combination consisting of a filter channel made from PP and a Filter-Media, Funke offers a professional solution for the treatment of polluted surface run off water. D-Rainclean® absorbs the partly heavily polluted rain water of streets, parking areas, court- and roof areas and releases it in harmless condition into the soil. This means that D-Rainclean® meets the requirements of the German DWA datasheet A 138, which specifies how to deal with heavily contaminated rainwater prior to infiltration.

Material sources from roadways: Heavy-metal emissions resulting from road traffic
(from UBA-Scheme (FKZ 202 242 220/02)), Source: Lange



*Report UBA-FB „Entries of Copper, Zinc and Lead into Waters and Soils – Analysis of Emission, Pathways and possible Emission Reduction Measures“ 11.2004

nel with Filter-Media



Pathways

System optimized

In the latest product generation, Funke has optimized the system still further, both with regard to the performance, which in the first instance protects and safeguards the environment, as well as with regard to the technical design properties. This means that, with improved performance, it has also been possible for the catchment surface area to be increased at the same time. This makes the use of the system even more financially attractive. Thanks to the improved Filter-Media formulation, the height of the Filter-Media layer in the system can be reduced from 30 cm to 20 cm. And there's more: As well as the open version for subsequent addition of vegetation, and the closed version with a cast iron covering of class D 40 t, which can support the weight of heavy vehicles, the channel is now also available with a cast iron covering of class A/B, for up to 12.5 t. This means another significant extension to the range of applications. The system can now be used economically in areas which are not used by heavy vehicles.

In regularly conducted laboratory tests and in-situ trials, the performance capacity of the D-Rainclean® system becomes very clear. The innovations applied by the manufacturers have been examined and tested to their very limits at the German Institute for Construction Technology (DIBt). The result of these tests is an extension of the DIBt approval until January 2016.



D-Rainclean® as open channel



D-Rainclean® with cast iron cover, Class A/B 12.5 t



D-Rainclean® with cast iron cover, Class D 40 t

D-Rainclean® – The



Channel

Colour: Black
 Dimensions: 500 x 400 x 366
 with integrated middle bulkhead
 Material: PP

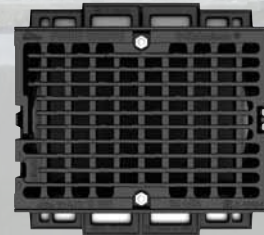


Filter-Media
 14 l/Sack



Cast-Iron Cover

Class D 400 kN,
 incl. cast-iron frame
 and child safeguard



(subsequent securing
 by bolting possible)



Along with Channel and Filter-Media, further components of the D-Rainclean®-System offer ideal solutions for different installation situations. There is an open version for the subsequent introduction of vegetation, and a closed version with a cast iron cover of D 40 t which supports the weight of heavy vehicles. As well as this, a version is now available with a cast iron cover of class A/B up to 12.5 t. In this variant, the cast iron frame is connected securely to the channel by means of special steel springs, and the cast iron cover is tensioned by means of a clamp spring after being laid in the frame. It is worth mentioning, too, that the pressure is relieved into the surrounding earth exclusively via the D-Rainclean® channel. This means that with soil capable of bearing a load there is no need for the application of a concrete back support.

The middle bulkhead integrated into every 500 mm of channel ensures safety and security. For example, in the event of an oil spillage accident, any uncontrolled dispersing of the oil

System Components



Big Bag Filter-Media
1.5 m³ (for large-scale applications)



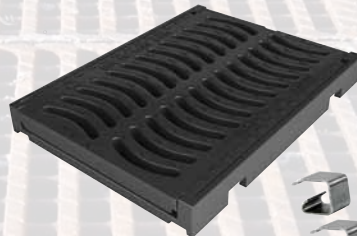
End Piece
for the left or the right side, respectively
Dimensions: 250 x 400 x 366



Emergency Overflow Unit
with connection DN/OD 110,
left or right, DN/OD 110
Dimensions: 500 x 400 x 366



Installation Wrench



Cast-iron cover
Cl. A/B 125 kN,
incl. cast-iron frame and
connection clamps made of spring steel
incl. child safeguard



in a longitudinal direction will be prevented. Likewise, the Filter-Media only needs to be replaced in the segment which is affected. And there's another advantage, too: Even when laid with a longitudinal gradient, there is no risk of the Filter-Media migrating to the lowest point.

Systems for the treatment and infiltration of rainwater flows are calculated in accordance with the German DWA-A 138.

¹**Exceeding volume frequency n in 1/a:** Number of events which, on a statistical average taken over many years, attain or exceed a value within one year (reciprocal value of the recurrence interval)

²**Recurrence interval T_n in a:** Mean time span in which an event attains or exceeds a value (reciprocal of return period)
(Source: DWA-A 117)

For the dimensioning, an exceeding volume frequency*¹ is applied, which with decentralized systems is, as a rule, $n = 0.2 \text{ a}^{-1}$ (corresponding to $T_n^{*2} = 5 \text{ years}$) up to $n = 1,0 \text{ a}^{-1}$. To bypass the surplus rainwater under the most extreme heavy rain conditions, which extend beyond the dimensioning frequency, optional emergency overflows can be provided. The end piece element allows for a proper and effective closure of the channel system to be created. The structural and technical properties of the D-Raintank® swale elements create extra void needed for the D-Rainclean® system to be installed even in soils with low water permeability. Further accessories as nails and installation wrenches facilitate the installation and maintenance on site.



The Filter-Media

The D-Rainclean® Filter-Media consists of selected components, each of which fulfils one or more function. This means that the finished Filter-Media mixture provides a wide range of effects, such as filtration, adsorption, ion exchange, phosphate retention, and many others.

Filter effect

A large proportion of the contaminants in the surface water flow is bound to particles and, as a rule, adheres to fine solids (FAS). This means that the solids, and therefore also the contaminants adhering to them, are retained by the excellent filter effect of the D-Rainclean® Filter-Media. This is achieved thanks to what is referred to as depth filtration. In this situation, the fine grains are distributed in the upper 5 – 10 cm of the Filter-Media. By comparison with surface filtration, this has the advantage that the risk of surface clogging (colmatage) is reduced, in particular in time of intense rain, and there is accordingly also less risk of water pondage.

Heavy Metal Sorption/ Desorption and Precipitation

Dissolved heavy metals are subject to different processes in D-Rainclean®: Whereas nickel is mainly retained by sorption, lead, cadmium, copper and zinc remain within the Filter-Media by sorption and precipitation. Cadmium, together with zinc and nickel are classified heavy metals being mobile and shifted relatively easy. As for cadmium, a constantly high pH-value within the D-Rainclean® Filter-Media is very important. Just like copper, the bonding of lead is achieved by specific adsorption processes. Mercury, however, which is known to be very immobile, is bonded to the organic

substances contained in the D-Rainclean®. Chromium with higher pH-values is bonded to very hardly soluble $\text{Cr}(\text{OH})_3$ and Cr_2O_3 is mainly bonded to iron ions.

Water Holding Capacity

The soil-microbiology produces a very important degradation performance, especially during the warm seasons. Sufficient moisture of the D-Rainclean® Filter-Media is an indispensable condition for this process. The retentive power is attained by a big pore space, an appropriate rate of organic substances and a high ratio of water absorbers in the D-Rainclean® Filter-Media. Additionally, the D-Rainclean® Channel provides for a water reservoir of 3.0 l per metre on the bottom of the channel.

Sorption of Pollutants

After the water has passed the Filter-Media, the testing values with regard to the evaluation of the pathway soil – ground water according to § 8 chapter 1, sentence 1 of the German Federal Soil Conservation Law (Bundes-Bodenschutzgesetz) go below values determined in the law (see table 1). The sorption isotherms of the appropriate heavy metals lead and zinc have been recorded for soil and D-Rainclean®.

Contaminant	Symbol	Limiting Value (µg/l)
Arsenic	As	10 µg/l
Lead	Pb	25 µg/l
Cadmium	Cd	5 µg/l
Chromium	Cr	50 µg/l
Copper	Cu	50 µg/l
Nickel	Ni	50 µg/l
Mercury	Hg	1 µg/l
Zinc	Zn	500 µg/l

Laboratory Testing

Compared with “good soil” the D-Rainclean® Filter-Media shows considerably better adsorption results. On average, 90 % of the zinc is adsorbed. The proportion of lead being adsorbed is at approx. 99 % and thus considerably higher. As soon as the threshold concentration is attained, the uptake of the D-Rainclean® Filter-Media is exhausted. This arises after approx. 15 – 20 years depending on the volume of traffic (see graph page 8). Thereafter it is advisable to exchange the Filter-Media.

Hydraulic capacity

The D-Rainclean® Filter-Media has a water permeability coefficient in operation of 9×10^{-4} m/s, and accordingly has sufficient permeability capability. The high permeability performance is the result of a widely-spaced particle size

distribution curve with stepped grain size. The value of 9×10^{-4} m/s represents a reduced permeability-curve, which is set after a brief period of operation. At the same time an appropriate detention period of the polluted water within the D-Rainclean® system provides for a sufficient adsorption of pollutants.

A water reservoir at the base of the channel ensures that the Filter-Media will not dry out, even after lengthy periods of dry weather, and the soil microbiology which is important for "revitalized soils" will be retained.



Water reservoir in the lower section

Organic Harmful Materials

The D-Rainclean® Filter-Media has an organic matrix and a specific activated carbon, supporting the bonding and the degradation of organic pollutants. Mineral oil hydrocarbons and lightly volatile halogenated hydrocarbons in a concentration and a physical condition (residual spreading) occurring on trafficked areas normally, are well degradable. As the micro-organisms in the D-Rainclean®-Channel settle on moistened surfaces, the size of the total surface is a vital criterion for the biodegradation of organic substances. D-Rainclean® has an extremely large total surface.

De-Icing Salt

The question came up if by the use of de-icing salt (normally NaCl) adsorption places will be blocked by sodium and if already bonded hazardous material will be washed out again. This is why the short- and long-term effect of de-icing salt to the capacity and the life of D-Rainclean® Filter-Media were tested. The results reveal that the adsorption capacity of heavy metals in the D-Rainclean® Filter-Media is influenced to a very little extent only by sodium chloride. Even shock loads with sodium chloride in step with actual practice do not cause a rinse flush of already bonded heavy metals into the ground. Heavy metals remain bonded in the Filter-Media permanently, even if sodium chloride is used. The life of D-Rainclean® is little depending on the quantity and the frequency of de-icing procedures. Tests show, however, that

the predicted life of about 15 years can be attained in the side area of a road with an average daily traffic volume (DTV) of 5,000 to 15,000 (Category 9 – 11 ATV A 138) even if sodium chloride is used in winter times for de-icing.

Oil Bonding and – degradation

Oil drops penetrating into the D-Rainclean® Filter-Media will find a big void space within the water unsaturated area. The oil loses its fluidity and covers the surface of the pore space like a thin film. This way the oil provides a good target for the micro-organisms. With a minimum of 60 % of pore space, D-Rainclean® Filter-Media offers ideal premises in this respect.

The D-Rainclean® Filter-Media has excellent oil binding characteristics. Even if saturated in case of an accident the material immediately absorbs up to 10 l of oil per linear meter channel and retains it for 24 hours. The polluted Filter-Media should be taken out of the channel and disposed professionally within this period of time.

Phosphate bonding

D-Rainclean® has enhanced absorption capacity for phosphate, a capacity which is particularly important for keeping bodies of water clean.



Soil live: Spiders, nematodes, acarides, spring-tails, collembola, oligochaeta, beetle larva (10,000/m channel to 30,000/m channel)

Planting of the D-Rainclean®-Channel

It is not generally necessary to plant the D-Rainclean®-Channel. It is, however, possible if desired. Even though the Filter-Media is extremely oligotropic, there is enough nutrient content for selected plants. The open channel may for example be planted with 2 pachysandra or 2 mahonia and 2 vinca minor or 1 cotoneaster.

pH-Value

The carbonate buffer range of the D-Rainclean® Filter-Media is above pH 7.2.



The Cation Exchange Capacity

The cation exchange capacity (KAK_{pot}) defines the maximum quantity of cations absorbable, like heavy metals for example. Concerning exchange processes characterized by the type of ions, a KAK_{pot} of min. 20 $cmol_c/kg$ is aimed at. This value is mainly achieved by adding adsorptive components and zeolites.

The property of the D-Rainclean® Filter-Media to function as an ion exchanger ensures the bonding of heavy metal ions. An active contribution to ground water protection!

Disposal

Clean D-Rainclean® Filter-Media fulfils the requirements of the classification soil "Z0" according to information no. 20 of the Länderarbeitsgemeinschaft Abfall – LAGA, (National Waste Consortium). Saturated Filter-Media always meets the classification value Z2, with the exception of effluents originating from pure metal roofs. Depending on the input of contaminants and after the respective testing it is even possible to attain a classification value of Z1.

The classification of used D-Rainclean® Filter-Media to certain dump categories – classifications between DK 0 and DK 5 are possible – arise from the load case of the Filter-Media. The latter depends on the life cycle and the intensity of the input of contaminants. Normally charged Filter-Media can be discharged on dumping grounds class II or if moderately charged disposed even on dumping grounds class I (Decisive for the choice of the dumping ground class is not the total contamination value but the eluate value).

Useful Life

Light Impact – approx. 20 years

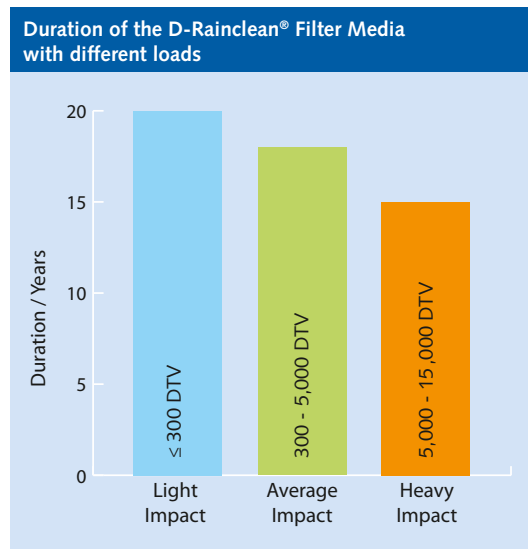
Water from roof areas, yard areas, bicycle and pathways, car park areas, streets with max. 300 DTV
(Category 1 – 5 ATV A 138)

Average Impact – approx. 18 years

Water of roof areas in industrial areas with significant air pollution, streets with a max. of 300 to 5,000 DTV,
(Category 6 – 8 ATV A 138)

Heavy Impact – approx. 15 years

Areas in industrial estates, trafficked parking lots, streets with 5,000 to 15,000 DTV per day (Category 9 – 11 ATV A 138)



DTV = average daily traffic volume

The functional performance and performance capacity of D-Rainclean® channel, which have been installed since 2002, are confirmed by the results from accompanying tests carried out in construction projects.



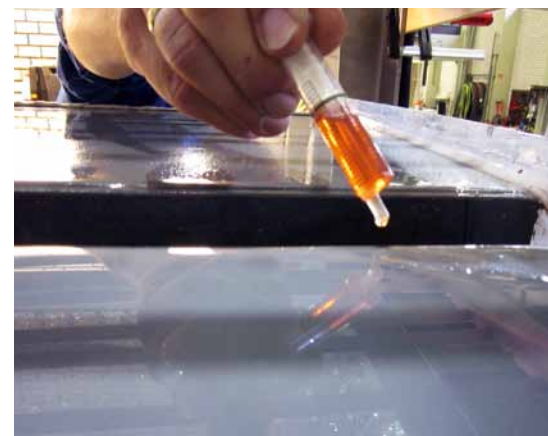
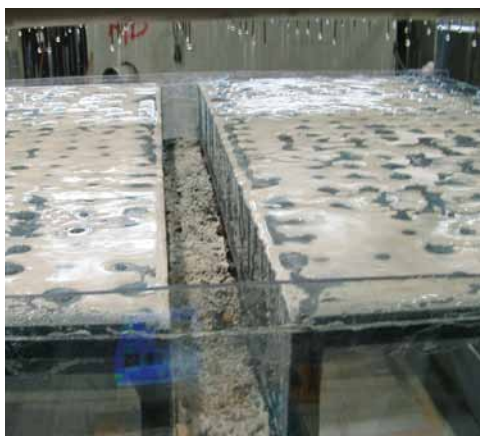


Rainwater Treatment with DIBt-Approval

In 2006 the DIBt (German Institute of Structural Engineering) have issued a general technical approval for D-Rainclean® to Funke Kunststoffe GmbH. DIBt-Approvals are accorded either to construction products and design within the scope of the State Building Regulations, considerably differing from generally accepted rules of engineering or for which no DIN standard is existing. They prove the applicability of construction products and design with respect to structural engineering requirements of buildings. A decisive point of view, as a general technical approval stands for an additional surplus of security for the client and the user alike. With D-Rainclean®, they obtain a defined and approved system for

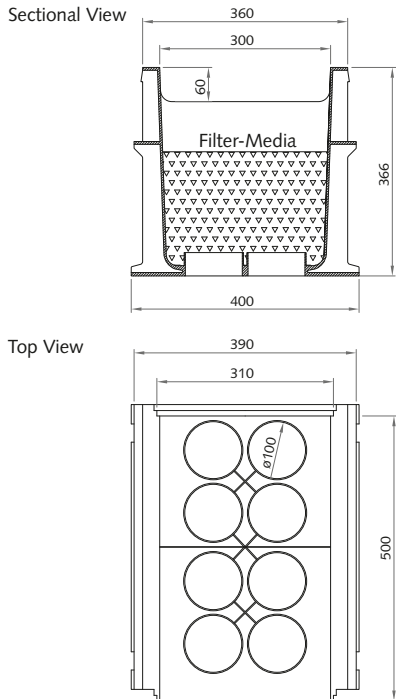
the professional treatment of polluted rain water. Funke Kunststoffe GmbH is proud of being the first company to achieve this approval for a system used for the treatment of polluted rain water.

The DIBt approval for the D-Rainclean® channel was extended in 2011 for a further five years, against a background of years of positive experiences. All the tests included within the framework of the DIBt approval procedure were carried out for the connection ratio $A_s:A_u = 1:40$, corresponding to a connection surface of 12 m² per metre run of D-Rainclean® channel.

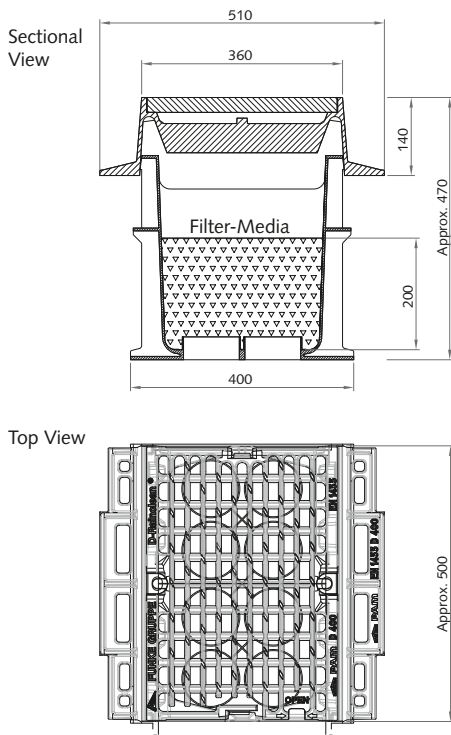


D-Rainclean® – The Applications

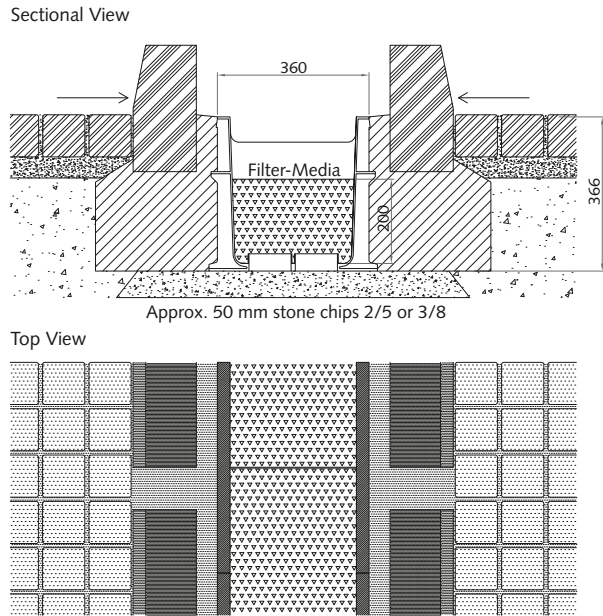
1) D-Rainclean® without cast-iron cover (open)



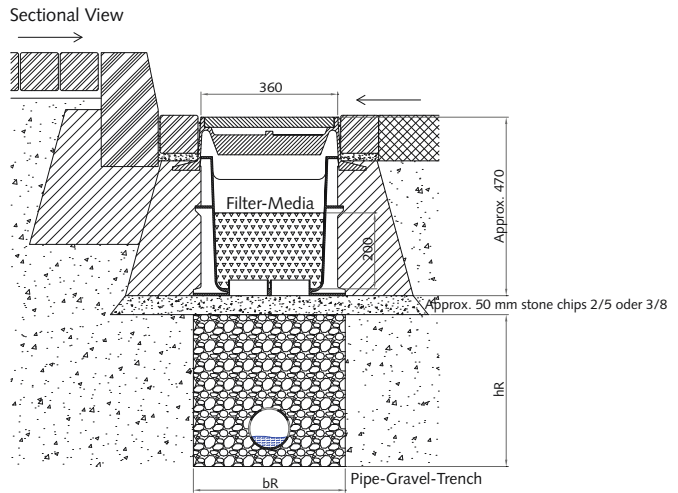
2) D-Rainclean® with cast-iron cover, Class D, 40 t (closed)



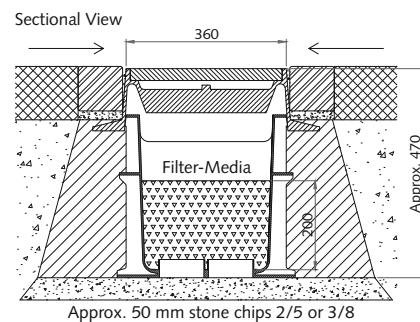
3) D-Rainclean® with high rised kerbs (open)



4) D-Rainclean® Class D, 40 t, with HS®-Partly Drain Pipe

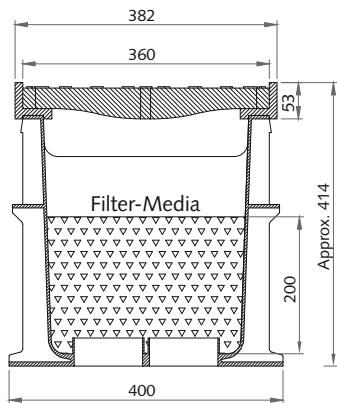


5) D-Rainclean® with cast-iron cover, Class D, 40 t

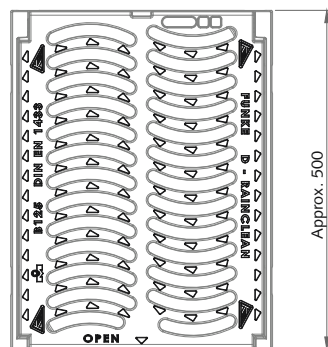


6) D-Rainclean® with cast-iron cover, Class A/B, 12.5 t (closed)

Sectional View

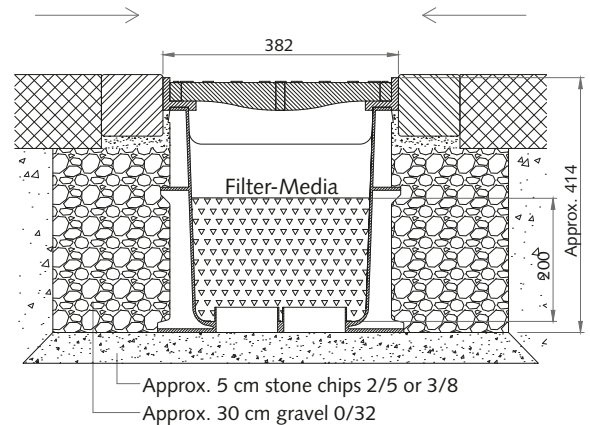


Top View



7) D-Rainclean® with cast-iron cover, Class A/B, 12.5 t (closed)

Sectional View



– can also be combined with HS®-Partly Drain Pipe

Drawing 1: D-Rainclean® filter channel without cast-iron cover (open) – section/view from above

Drawing 2: D-Rainclean® filter channel with cast-iron cover, Class D, 40 t (closed) – section/view from above

Drawing 3: Installation example, D-Rainclean® filter channel with high raised kerbs (open)

The separation from D-Rainclean® by a Raised kerb is an option for example between rows of car parks.

Drawing 4: Installation example, D-Rainclean® filter channel, Class D, 40 t, with HS®-Partly Drain Pipe

The combination with a HS®-Infiltration Pipe allows for the D-Rainclean® System to be installed in soils characterized by low water permeability.

Drawing 5: Installation example, D-Rainclean® filter channel with cast-iron cover, Class D, 40 t

The D-Rainclean® filter channel with cast iron cover (500 mm x 360 mm) is particularly suitable for the use in connection with trafficked areas. The filter channel

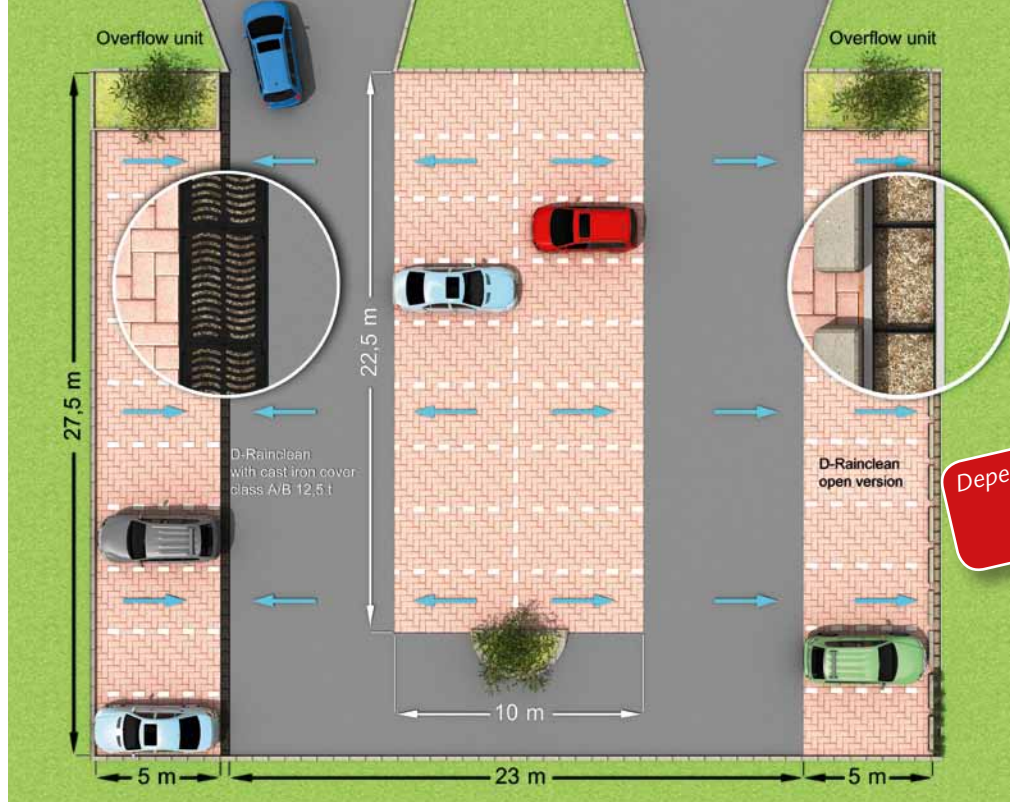
is equipped with a cast iron frame and adapted for class D/400 kN.

Drawing 6: D-Rainclean® with cast-iron covers, Class A/B, 12.5 t (closed) – section/view from above

Areas which are driven over occasionally or constantly, but exclusively by cars, are the installation situations for the installation of cast-iron covers Class A/B (500 x 382 mm). When fitted with a cast-iron frame and cast-iron grid, these are also suitable for load class A/B 125 kN.

Drawing 7: Installation example D-Rainclean® filter channel with cast-iron cover, Class A/B, 12.5 t (closed)

With this design (Class A/B cover) no supporting concrete bearings are needed. It is sufficient to use compactable materials (e.g. gravel 0-32) installed and compacted in layers along both sides of the channel.



Example for the drainage of a parking area

Calculation of Area

With a car park area of 900 m^2 ($A_{\text{red}} = 590 \text{ m}^2$), which is sufficient for some 38 car parking spaces, and with the anticipated rain data for Hamburg ($n = 0.2 \text{ a}^{-1}$), about 55 m D-Rainclean® channel will be needed. In this example, 27.5 m in a closed design with cast-iron cover for the load class A/B and 27.5 m as an open channel have been taken as the basis. With this design variant, the material costs run to some 12,000 Euro (plus statutory V.A.T.). By contrast with water drainage via the communal pipe network, this represents the more economical solution, with savings of up to 25%!

Considering the different components as oil separator, silt trap, control chamber, drainage pipes etc. costs with conventional drainage of the surface water without the use of the D-Rainclean® filter channel will add up to about 16,000 Euro (plus VAT and rainwater fees where applicable).

Further advantage of a D-Rainclean® Solution:

- Load reduction of the sewer system and the sewage treatment plant
- Modest maintenance costs
- The rain water is percolated on site – leading to an improved ground water recharge

Funke Kunststoffe GmbH

Siegenbeckstraße 15 • D-59071 Hamm-Uentrop
(Industriegebiet Uentrop Ost)

Tel.: +49 (0) 2388 3071-0 • Fax: +49 (0) 2388 3071-550
info@funkegruppe.de • www.funkegruppe.de

Advantages

- high proven hydraulic capacity, lasting for decades
- excellent solids retention
- low clogging risk thanks to optimized grain size distribution
- high retention of dissolved pollutants, thanks to the use of very efficient adsorber agents
- active soil microbiology, which means vitalized soil
- not only retention, but also decomposition of organic pollutants
- resistant even when de-icing salt is used
- simple replacement of Filter-Media in individual trough sections in the event of contamination of the Filter-Media, for example as a consequence of an oil spillage
- can be laid on a gradient thanks to integrated middle bulkhead in every channel section, without any extra procedures needed
- easy laying of plastic elements
- open version and suitable for classes A/B and D, traffic, all possible
- with open design and with class A/B cover, no concreting work required
- Filter-Media extremely well-suited for large-scale applications (ponds, swales)
- infiltration directly at ingress point
- no formation of a hydraulically incalculable dirt layer on the filter medium

Note

You will find further information on D-Rainclean® in our "Technical Information" which is available on request.