STORM WATER SCREENING TO MEET THE URBAN WASTE WATER TREATMENT DIRECTIVE

Huber Technology

INTRODUCTION

In the UK the Urban Waste Water Treatment Directive cites screening of storm overflows, to prevent aesthetic pollution of their watercourses, as a highly important issue.

In March 1998, Huber Technology commenced trials at North West Water's Wigan WWTW to evaluate the ROTAMAT RoK1 Storm Screen. These were carried out partly in conjunction with a trial program operated by UKWIR CSO Research Group, and partly under its own initiative.

The first tests were conducted with 6mm perforations on a side weir installation. Further tests were conducted during the year with the screen mounted in a stilling pond end weir configuration, and finally with a 4mm version, again on a side weir installation.

This paper concentrates on the performance of the screen, in side weir configuration, operating with incoming flows set at 30, 45, 60 and 100 l/s, each with continuation/spill flow splits of 0.1, 0.2, 0.4 and 0.6.

The conclusion will identify how current environmental demands are best served by equipment currently available.

BACKGROUND

A large quantity of solid matter often builds up in a sewerage system during periods of dry weather. Typically, under storm conditions, this solid matter will be flushed through the system to the works inlet, causing rapid blinding of the already hydraulically overloaded inlet screens, and consequent backing up and overflow of the sewage system. The effect of an unscreened storm water overflow is disastrous. The overflow of sewage and storm water conveys considerable quantities of solids into the receiving watercourse from the storm water discharge, causing large-scale visible pollution of the surrounding area.
The UWWTD requires member states in the UK to take action to limit pollution from storm water overflows [1]. This requires measures to be undertaken to improve unsatisfactory intermittent discharges. Unsatisfactory intermittent discharges can also contribute to failures to meet standards set in other Directives, such as the Bathing Water and Shellfish Waters Directives.

Guidelines were included in the guidance on the Urban Waste Water Treatment (England and Wales) Regulations 1994, which provided advice on identifying unsatisfactory CSOs and on consenting discharges in order to secure improvements. A brief summary is given in **Table A** below [2].

Amenity use category	**Expected frequency of spills**	**Discharge standard**
High Amenity	>1 spill/year 1 spill/year	6mm solids separation 10mm solids separation
Moderate Amenity	>spills/year spills/year	6mm solids separation 10mm solids separation
Low and Non Amenity	-	Good engineering design

High Amenity - Areas for bathing and immersed water-sport. Shellfish waters.

Moderate Amenity - Areas for recreation and non-immersed water-sport. Popular area adjacent to watercourse. Residential areas.

Low Amenity - Area with casual riverside access. Rural area.

Non Amenity - Remote or inaccessible area.

6mm solids separation - Removal from the effluent of a significant quantity of material greater than 6mm in any two dimensions.

10mm solids separation - Removal from the effluent of a significant quantity of material of a performance equal to a 10mm bar screen.

CSOs however are only one type of discharge. The following categories overflow have been identified and are termed collectively as intermittent discharges: CSOs on the sewerage system; emergency overflows and CSOs at pumping stations; storm overflows at the inlet to sewage treatment works and storm tank discharges.

Despite improvements, the EA has estimated that there will be 4,000 remaining unsatisfactory intermittent discharges in the year 2000. The rate of improvement however has been accelerated so that at least two-thirds of these remaining unsatisfactory intermittent discharges are to be brought up to standard by 2005.

ROTAMAT® ROK1 STORM SCREEN

The design philosophy for the RoK1 storm screen was straightforward: a simple but effective method of screening to the most stringent of the above requirements, while not increasing the headloss over the overflow.

The RoK1 thus comprises a half cylinder of stainless steel perforated plate, in which a transport auger, having a continuous brush fixed to the flight edge, is located.

Water spilling from the storm overflow passes through a perforated stainless steel screening medium positioned beneath the weir crest. This removes all solids greater than 6mm in two dimensions, before continuing to the watercourse. The screen is maintained in a clean condition by a rotating auger with brushes on the periphery of the flight, which transports the screenings towards the screening discharge arrangement downstream of the screening area.

The auger transports the captured screenings to one end of the screen where the perforations give way to solid plate. A discharge scraper either returns the screenings directly back into the flow to treatment, or discharges them for final disposal, by separate means.

PERFORMANCE TESTS

The RoK1 was tested for a range of steady state inflow and continuation flow conditions [3]. Inflows of 45, 60 and 100 l/s were used with the ratio of the continuation flow to the inflow (flow split) set at 0.1, 0.2, 0.4 and 0.6. However, the capacity of the continuation flow outlet was limited 54 litres/s due to the internal diameter of the pipe and therefore an inflow of 100 l/s was not tested at a flow split of 0.6. The duration of operation of the screen over the test period was in excess of 40 hours.

1. 6mm mesh sacks was used to collect solids and assess Total Solids Retention Efficiency.
2. The pollutant load at the test inflow was established by collecting all inflow solids for 20 minutes. The sacks were drained for 30 minutes before weighing.
3. After required flow conditions were established, tests were carried out for steady flows.
4. The solids in the spilled flow, the continuation flow and those collected on the screen were collected for 20 minutes. The solids collected were visually examined to measure any solids of size greater than 6mm in two dimensions.
5. Step 2 was repeated at the end of each test to compare the mass of solids in the flow before and after the test was compared (this procedure is referred to as a strength test).

The following definitions were used to evaluate the Storm Screen's performance:

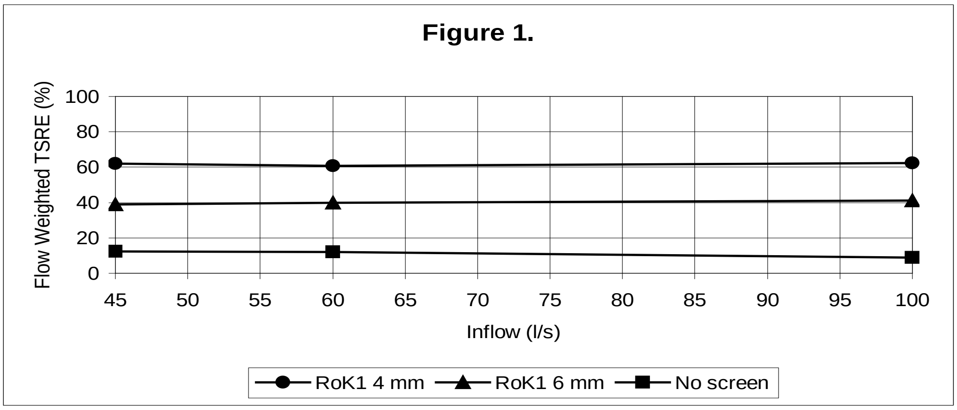
$$\text{Total Solids Retention Efficiency (TSRE)} = \frac{\text{Total Storm Load Retained by CSO (and Screen)}}{\text{Total Storm Inflow Load}}$$

$$\text{Flow Split (FS)} = \frac{\text{Continuation Flow}}{\text{Inflow}}$$

The solids captured in the spill flow consisted primarily of paper pulp and other fine matter. No solids larger than 6 mm in two dimensions were observed in the solids collected from the spilled flow, which had passed through the screen.

In all instances the Storm Screen allowed no solids greater than 6 mm to pass to the receiving water. Furthermore, the Storm Screen with 4 mm diameter perforations increased the add-on value of the screen, the improvement of the TSRE of the CSO chamber beyond that without a screen in place in the side weir, from 29% with 6 mm perforations to 50%.

Side Weir Performance, without/with 4 mm and 6 mm Storm Screen, at a flow split of 0.1



The difference in flow weighted TSRE between the 4 mm and 6 mm RoK1 units on the side weir, for a flow split of 0.1, is shown in **Figure 1**. With the angle of each device set at 0° to the horizontal, there was no head loss caused in the system upstream of the CSO as a result of the screen's presence.

COMPARISON WITH OTHER TYPES OF SCREEN

A summary of results for all types of current storm screening devices, tested at the UKWIR CSO Test Facility, Wigan, and presented by UKWIR at Church House, Westminster on 10th November 1999, is given in **Table B** below.

Screen Type **Powered - P** **Non-powered - N**	**Aperture (mm)**	**TSRE (%)**	**Add-on (%)**	**Solids (>6mm)**	**Comments**
Mechanical Perforated - P	6	39 - 65	18 - 32	No	Concern over scraper efficiency
Mechanical Perforated - P	4	61 - 86	23 - 56	No	None (With modified scraper)
Horizontal Bar - P	4	16 - 60	3 - 34	Yes	Concern over rake efficiency
Vertical Bar - P	4	30 - 60	19 - 33	Yes	Concern over rake efficiency
Rotary Brush - N	N/A	37 - 57	11 - 37	Yes	Build up on brush
Rotary Disc - P	5	11 - 43	unknown	Yes	High solids carry over
Air Powered Square Slot	6	26 - 79	18 - 36	No	Solids build up. Air required
Perforated Belt - P	6	58 - 73	27 - 53	No	Build up on scraper. Gap at base
Static Perforated - N	6	38 - 78	20 - 54	No	Requires cleaning
Self-clean Perforated - N	4	43 - 70	21 - 38	No	Cyclic discharge. No cleaning

CONCLUSION

The main arguments when considering screens for storm overflows are "perforated vs non-perforated" and "powered vs non-powered". Bar screens are notoriously inefficient with likely TSRE's being less than 50% [4]. As can be seen above, the case for the perforated screen over the non-perforated type is overwhelming, with virtually all non-perforated screens passing a significant amount of solids larger than 6mm in two dimensions. The powered vs non-powered argument has to be taken more on a case by case basis. Typically, non-powered screens take up more space, are less easily retrofitted and require more attendance for cleaning. The cleaning mechanisms of non-powered screens require a fairly high flow to operate and often cause undesirable pulsing of the continuation and spill flows. They do however have their uses on remote sites where electrical power is not available.

Where power is available on site, a powered perforated screen such as the RoK1 is the clear choice. This type of screen delivers the performance while also being the best option with regard to cost, operator friendliness and reliability.

REFERENCES

1. Department of the Environment, Transport and the Regions, 1998, *Raising the Quality,* 57. Pp. 20-23.
2. National Rivers Authority, 1993, *General Guidance Note for Preparatory Work for AMP2.*
3. SAUL A.J. and SIMS J., 1998, *Screen Performance Evaluation - Draft Report.*
4. MEEDS B. and BALMFORTH D.J., 1995, *Full-Scale Testing of Mechanically Raked Bar Screens.*

For further information regarding
the Rotamat® RoK Series Stormwater Screen
please contact:
marketing@hhusa.net

HUBER TECHNOLOGY
WASTE WATER Solutions

ROTAMAT® Storm Screen for stormwater discharges RoK 1

Automatically cleaned screen for solids retention in stormwater tanks and overflows

- Efficient solids separation
- Continuous automatic screen cleaning
- Defined solids removal
- For discharges with limited upstream head possibilities
- Sturdy, low-maintenance stainless steel design

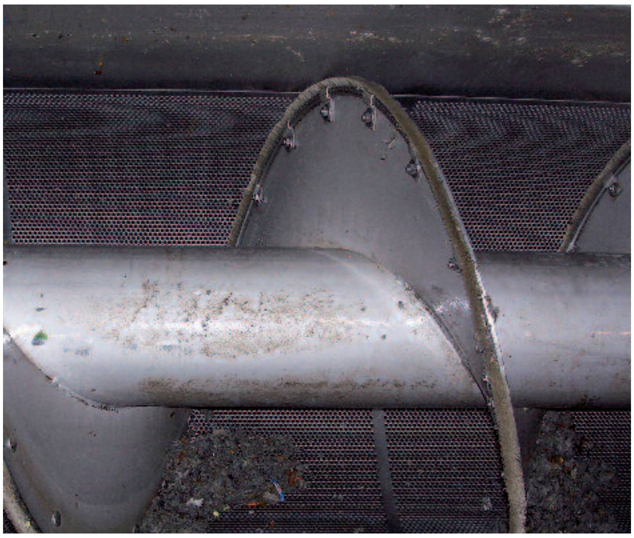
The situation

During and after storm events large amounts of debris are discharged to streams, rivers and lakes through storm water overflows of combined and sanitary sewer systems. Frequently, even the installation of scum boards is insufficient to prevent such pollution. The polluting items, such as sanitary products, toilet paper, faeces, plastic foils, etc. are not only unsightly but also responsible for considerable cleaning and/or disposal costs.
On the basis of the DWA sheet A 128 (an instruction issued by an association dealing with wastewater treatment) efforts to fundamentally improve the protection of waters in this sector have been increased. Particularly endangered receiving water courses and nature preservation areas require more extensive measures concerning the treatment of stormwater.

Unsightly matter discharged during storm events, typical for stormwater discharges without coarse material retention

The solution

The ROTAMAT® RoK 1 screen is the ideal solution for this task, whether for new structures or refurbishment. The screen belongs to a group of fine screens designed for high flow rates at an extremely low hydraulic resistance. Two-dimensional screening guarantees a very high solids retention combined with automatic, gentle cleaning of the perforated plate.



Gentle automatic cleaning of the semi-circular perforated plate

The function

RoK 1 screens are horizontally installed at the downstream side of overflow weirs. A screw flight is mounted on a half cylinder of perforated plate. As the stormwater flows through the horizontal perforated half-pipe of the screen trough the solids are retained. A screw, with a brush attached on its flights, rotates within the semicircular screen trough. It cleans the screen and pushes the screenings gently towards the end of the trough. At the end of the trough, the screenings are returned into the sewer and carried to the wastewater treatment plant. Alternatively, the screenings are removed from the plant with a pump for further disposal. During storm conditions the screen is automatically started and then works fully automatically.

Return of screenings into the sewer

The installation conditions

On the left or right side of the weir overflow – standard inclination angles 0° and 60°. To allow far different structural conditions and local hydraulic conditions it is necessary that the screen can be flexibly installed into existing buildings. The full screen surface is available already at the beginning of a storm event so that the hydraulic resistance is minimized with the result of a very high solids retention.

The applications

HUBER ROTAMAT® Screens RoK 1 can be used for a variety of applications in the combined sewage sector.

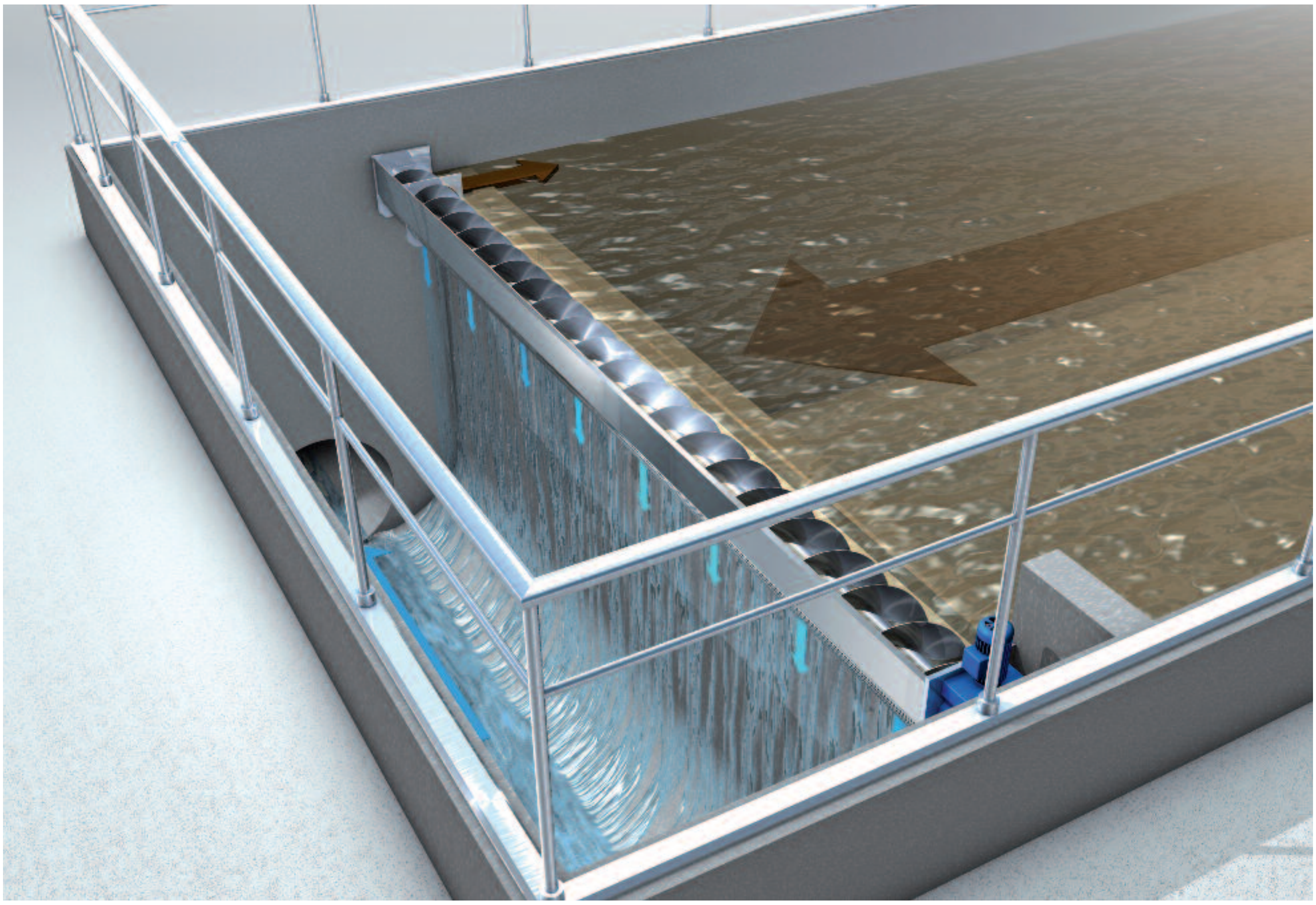
To avoid another point of maintenance it is generally not intended to remove screenings from the structure. Instead, the screenings remain within the sewer or tank and are introduced into the wastewater treatment plant after the storm event.

However, there is also the possibility of removing the screenings by pump and return them elsewhere to the wastewater flow.

The user's benefits

The screen is installed behind the weir overflow. This design results in the following favourable benefits:

- Optimal solids retention by means of two-dimensional screening (perforated plate)
- Low hydraulic resistance due to installation at weir height
- The perfect solution for discharges with limited upstream head possibilities
- Defined screenings discharge
- For problem-free retrofitting into existing structures
- Possibility of completely submerging the screen



Flow diagram of a ROTAMAT® Storm Screen RoK 1

Installation examples

A selection of installation examples will convince you of the HUBER ROTAMAT® Storm Screen RoK 1:

ROTAMAT® Storm Screen RoK 1 installed at an overflow weir

Combination of two HUBER ROTAMAT® RoK 1 screens to handle very high combined water flows

ROTAMAT® RoK 1 screens installed at an angle of 60° on both sides of an overflow

HUBER ROTAMAT® Screen RoK 1 installed in a stormwater discharge channel

Screen sizes

Screen selection and sizing depends on specific hydraulic requirements and structural conditions.

Trough diameter:
300, 500, 700, 1000 mm

Perforation:
6 mm standard,
other perforations available on request

Trough length:
up to 10 m

Capacity:
up to 10 m^3/sec

Subject to technical modification
1,0 / 3 – 8.2010 – 4.2004

ROTAMAT® Storm Screen
for Stormwater Discharges RoK 1

ROTAMAT® Storm Screen for stormwater discharges RoK 2

Automatically cleaned screen for solids retention in stormwater tanks and overflows

- Efficient solids separation
- Continuous automatic screen cleaning
- Maximum adaptability
- Ideal for combination with water retention elements
- Sturdy, low-maintenance stainless steel design

The situation

During and after storm events large amounts of debris are discharged to streams, rivers and lakes through storm water overflows of combined and sanitary sewer systems. Frequently, even the installation of scum boards is insufficient to prevent such pollution. The polluting items, such as sanitary products, toilet paper, faeces, plastic foils, etc. are not only unsightly but also responsible for considerable cleaning and/or disposal costs. On the basis of the DWA sheet A 128 (an instruction issued by an association dealing with wastewater treatment) efforts to fundamentally improve the protection of waters in this sector have been increased. Particularly endangered receiving water courses and nature preservation areas require more extensive measures concerning the treatment of stormwater.

Unsightly matter discharged during storm events, typical for stormwater discharges without coarse material retention

The solution

The inverted upward flow storm screen ROTAMAT® RoK 2 is the ideal solution for this task, whether for new structures or refurbishment. The screen belongs to a group of fine screens designed for high flow rates at an extremely low hydraulic resistance. Two-dimensional screening guarantees a very high solids retention combined with automatic, gentle cleaning of the perforated plate.

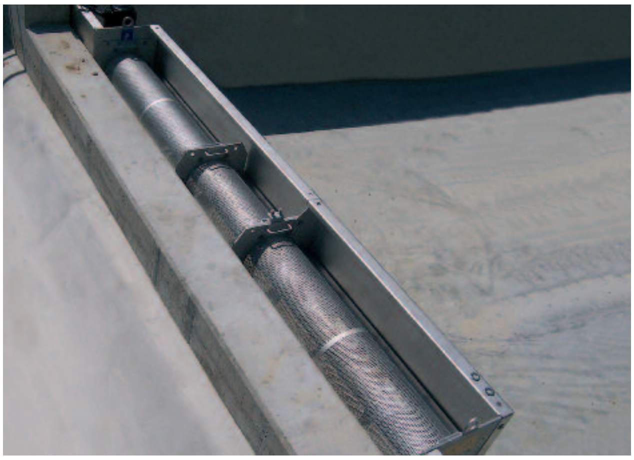
The function

RoK 1 screens are horizontally installed at the upstream side of overflow weirs. A screw flight is mounted on a half cylinder of perforated plate. As the stormwater flows through the horizontal perforated half-pipe of the screen trough the solids are retained. A screw, with a brush attached on its flights, rotates within the semi-circular screen trough. It cleans the screen and pushes the separated solids gently towards the lateral discharge. The screenings remain on the polluted water side of the screen from where they are taken along with the wastewater flow. During storm conditions the screen is automatically started and then works fully automatically.

ROTAMAT® Storm Screen RoK 2 installed at a stormwater discharge

The installation conditions

The HUBER ROTAMAT® Storm Screen RoK 2 can be flexibly installed on the left or right side of the weir overflow to optimally meet different local hydraulic conditions. Even if the flow rate is low, the oncoming flow approaches the full screen basket length and the screenings are removed gently without blockage so that a high separation performance is achieved and the headloss minimized mechanically.



ROTAMAT® Storm Screen RoK 2 after completed installation

The applications

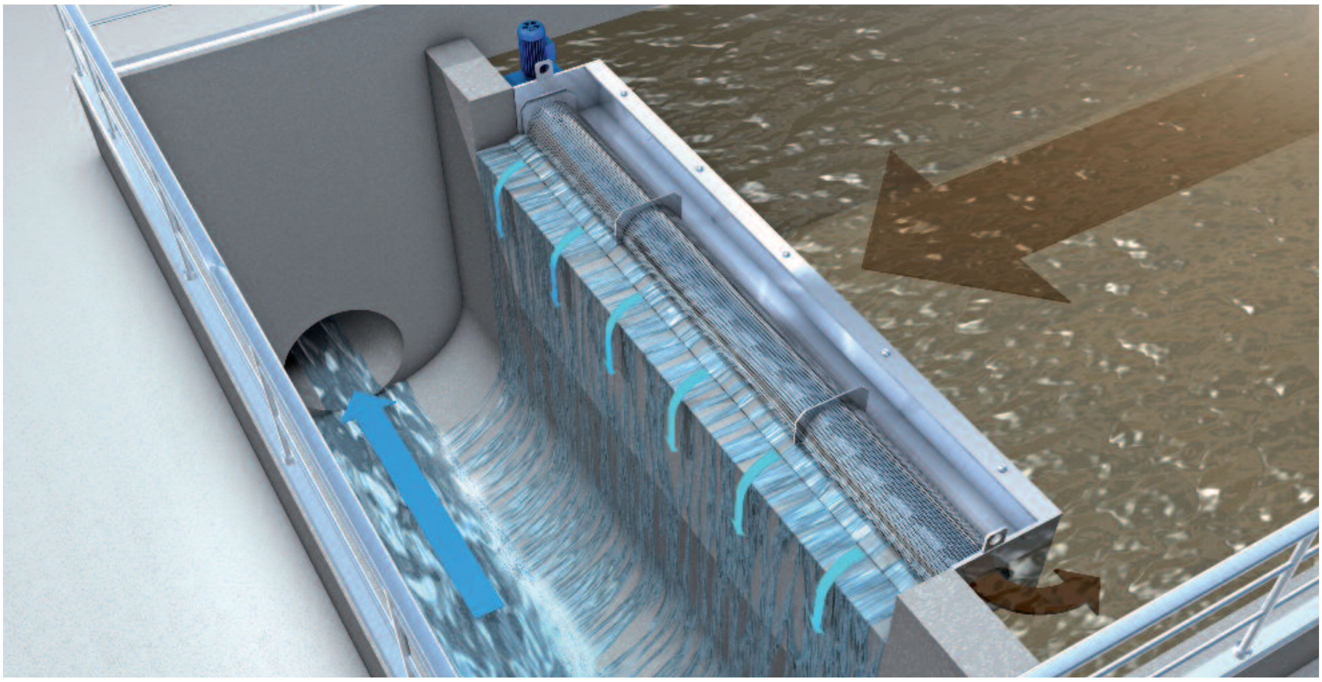
HUBER ROTAMAT® Storm Screens RoK 2 can be used for a variety of applications in the combined sewage sector.

To avoid another point of maintenance it is generally not intended to remove screenings from the structure. Instead, the screenings remain within the sewer or tank and are introduced into the wastewater treatment plant after the storm event.

The user's benefits

The screen is installed in front of the weir overflow.
This design results in the following favourable benefits:

- Optimal solids retention by means of two-dimensional screening (perforated plate)
- Screenings remain on the polluted water side
- No downstream impact on the screen efficiency
- For problem-free retrofitting into existing structures
- The perfect solution for discharges with limited upstream head possibilities
- Possibility of completely submerging the screen



Flow diagram of a ROTAMAT® Storm Screen RoK 2 installed at a weir overflow

Installation examples

A selection of installation examples
will convince you of the HUBER ROTAMAT® Storm Screen RoK 2

HUBER ROTAMAT® Storm Screen RoK 2 before overflow

ROTAMAT® Storm Screen RoK 2 with an integrated gauging weir for overflow measurement

View of the downstream side of a ROTAMAT® Storm Screen RoK 2

View of the upstream side and lateral screenings discharge opening

Screen sizes

Screen selection and sizing depends on specific hydraulic requirements and structural conditions.

Trough diameter:
300, 500, 700, 1000 mm

Perforation:
6 mm standard,
other perforations available on request

Trough length:
up to 10 m

Capacity:
up to 10 m^3/sec

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1,0 / 4 – 8.2010 – 9.2004

ROTAMAT® Storm Screen
for stormwater discharges RoK 2