

Comparison between theoretical wastewater fine screen headlosses and those observed in practice

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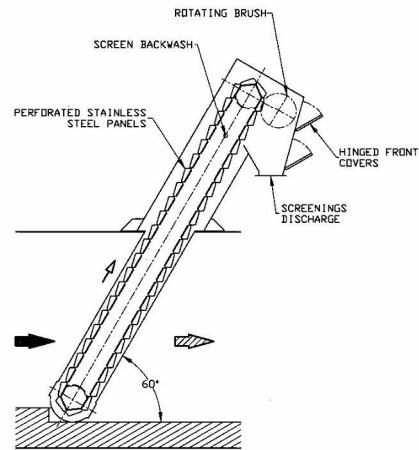
Inlet Screens – why are they needed?

- Screens are usually positioned at the inlet to a wastewater treatment works (WwTW)
- Regulatory requirement (Urban wastewater directive) to screen storm flows to 6mm in two dimensions.
- Protect downstream processes.

Inlet Screens – Types & Description

Escalator Screens

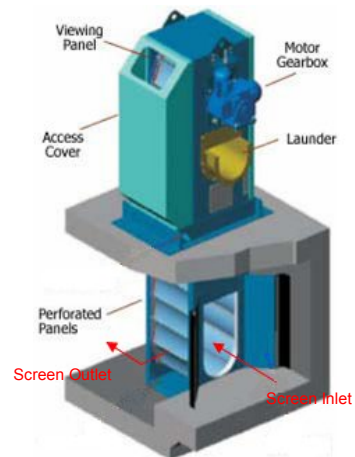
- Escalator screens consist of a series of stepped perforated plates placed across the line of flow and inclined at 45 - 60 degrees.
- The screen may be continuously operated or moved up incrementally, initiated by time intervals or differential headloss.



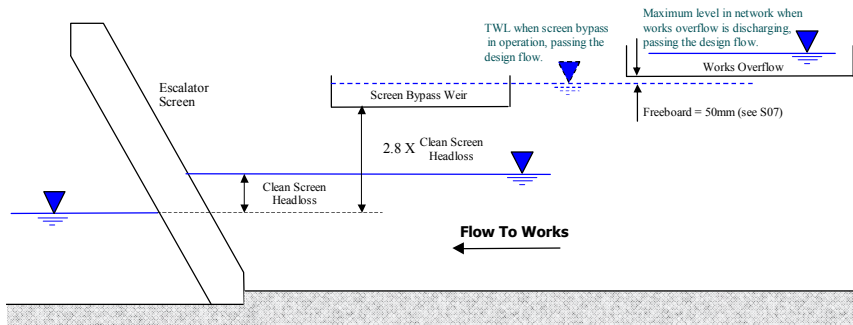
Inlet Screens – Types & Description

Band Screens

- Screening is achieved by passing the sewage through a vertical band shaped screen curtain, comprising an assembly of perforated panels which are in line with the direction of the incoming flow.
- The screenings enter the inside of the screen curtain where solids are retained and transported out of the flow by driving the band, moving the dirty panels from the screening zone to the panel cleaning area.
- Screened flows pass through the curtain into narrow outlet channels which run along both sides of the screen (see diagram below).



Inlet Screens – Design Requirements



- The velocity must not be too high through the screen openings (typically 0.8 m/s).
- At this velocity the clean screen headloss (i.e. 10% blinded) will be in the order of 150 mm.
- There is no reliable and consistent for what constitutes a "fully loaded" screen as the extent of solids loading is variable and may not be coincident with the maximum hydraulic loading for the screen. Consequently, an arbitrary factor of 2.8 times the 'clean' screen headloss is used to represent the maximum design headloss across the screen in normal conditions with the screen 'fully loaded' with solids.
- A screen bypass is required and is designed to pass the maximum flow through the screen.
- If the works overflow is passive, will need to consider the increase in max flow to works when all screens are in operation and clean, and check the downstream system.

Inlet Screens – Consequences associated with poor design

- Increased levels upstream of the screens resulting in localised flooding at the head of works and/or in the upstream network.



Normal Operating Condition



Flood Event

- Breach of consent due to premature spills at the works overflow.

- Premature operation of the screen bypass resulting in screenings passing through the works

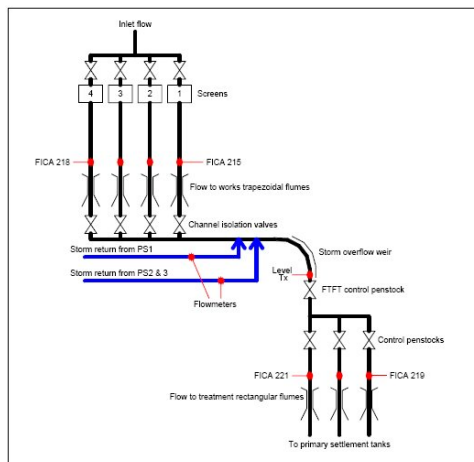


Rags blocking Detritor Inlet Vanes

Research Objective

- United Utilities have produced spreadsheets based on the orifice equation to calculate headloss across various types of fine screens (i.e. escalator and band).
- The spreadsheet assumes the open area of the screen plate has been reduced by 10% due to solids loading in order to calculate what is deemed to be a Clean Screen Headloss (CSH).
- There is currently no reliable and consistent data available on blinding factors during a first flush event and consequently UU apply an arbitrary factor of 2.8 times CSH to set upstream bypass levels.
- Some screen suppliers believe the method adopted by UU could provide a 100% over-prediction of CSH. If this is correct then applying a 2.8 factor to CSH will only exacerbate the over-prediction.
- The gathering of field data is therefore required in order to develop the hydraulic understanding of screens performance and also allow UU to respond more confidently to suppliers claims that our methods are overly conservative.

Oldham Inlet Works Schematic

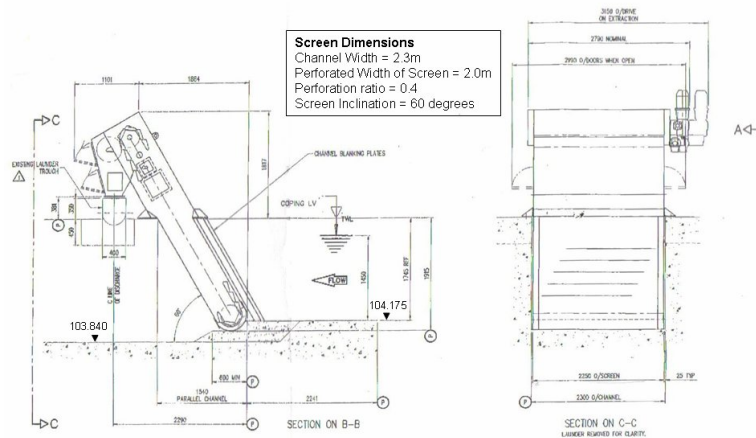


•Raw sewage is received at the works from three sewers – the Oldham Deep Interceptor Sewer and the two Chadderton pumping stations.

•The maximum Flow To Works (FTW) is 276.5 MI/d (3200 l/s) with any excess being discharged to the 6 times DWF storm tanks after screening via a CSO located immediately upstream of the inlet works.

•FtFT (Flow to Full Treatment) is 155 MI/d (1794l/s) with any excess being discharged over the 90 degree sweeping bend storm overflow weir.

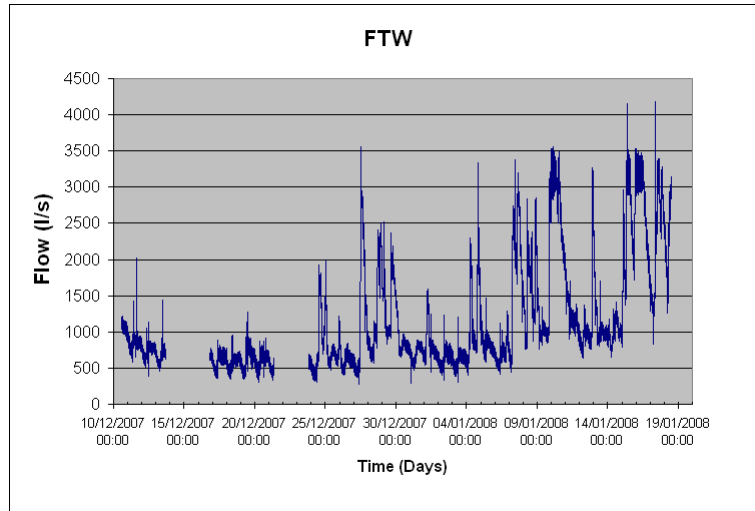
Screen Dimensions



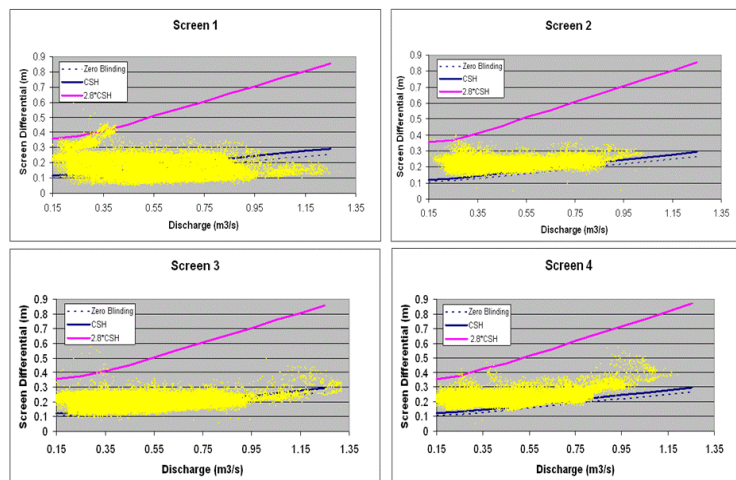
Operational Procedure

- The number of screens/lanes in use is dependant on FTW readings taken at the trapezoidal flumes.
- There is always a minimum of two screens/lanes in use.
- According to the operator the 1st assist screen/lane is brought online, by opening its inlet and outlet penstocks, when flows exceed 1400 l/s.
- The 2nd assist screen/lane is apparently only brought online when flows exceed 1800 l/s.
- The operation of the screens is controlled by level difference across individual screen read by a PLC which is placed upstream and downstream of each screen.
- When the differential is above 250mm the screen starts running (stepped run) till the differential across the screen falls below 250mm again and then the screen stops.
- If the differential still increases and exceeds 300mm the screen starts running continuously on the high speed until the differential falls below 300mm.

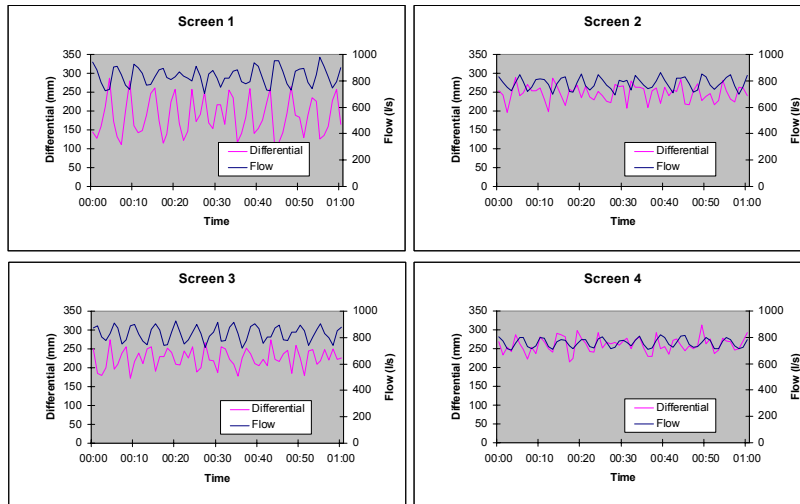
Flow To Works Readings



Screen Differential Results



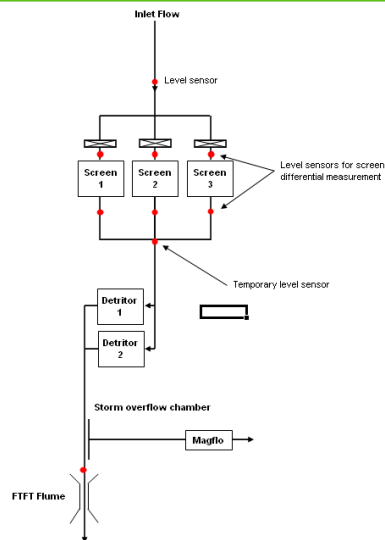
Screen Differential Results



Escalator Screen Survey Conclusions

- The results obtained from this study generally suggest that the current UU method of calculating CSH across escalator screens is good.
- The cases in which lower differentials were observed are thought to be due to deterioration of screen performance rather than an over-prediction of CSH.
- Maximum differentials generally appeared to be a function of the setting at which the screens run continuously.
- There was some evidence to suggest that larger differentials can occur but in this study they fell well below the UU design case of 2.8 x CSH.
- However, this is only a pilot study and much more data is required at different catchments and for longer periods during both summer and winter periods before anything more conclusive can be presented on CSH and how maximum differentials across escalator screens compare to the UU design case of 2.8 x CSH.**

Hazel Grove Inlet Schematic

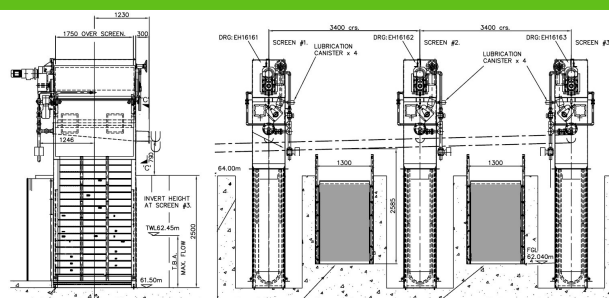


- The inlet works receives flows from the three gravity sewer networks of Marple, Stockport and Hazel Grove. It also receives flows from Dooley Lane PS.

- The works was designed to pass a maximum Flow To Works (FTW) value of 90.7 MI/d (1050 l/s).

- The current FTFT EA consent is 32.3 MI/d (374 l/s).

Screen Dimensions



Screen inlet width	(m)	0.488
Screen inlet radius	(m)	0.244
Screen panel band width	(m)	0.600
Screen panel radius	(m)	0.300
Screen panel depth	(m)	1.750
Screen dead area	(m)	0.150
Screen panel dead area	(m)	0.094
Perforated panel area	(%)	34.00%

Operational Procedure

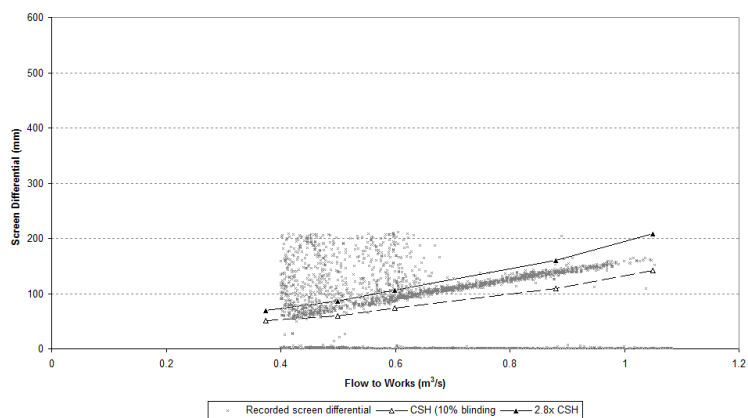
- The number of screens in use is dependent on the water level in the common inlet channel upstream. The level is recorded as a percentage from the channel invert level (61.65mAOD) to the ultrasonic (62.93mAOD) a 1280mm range.

- Screen operation is controlled by the difference between the water level immediately downstream and upstream of each screen. When this differential rises above 200mm the screen will start to operate until the differential falls below 100mm.

Description	Setpoint value	Level in u/s channel
Inlet screen assist 1 start	62.50 %	62.45mAOD
Inlet screen assist 2 start	74.22 %	62.60mAOD
Inlet screen assist 1 stop	27.34 %	62.00mAOD
Inlet screen assist 2 stop	39.06 %	62.15mAOD
Inlet screen differential level screen start	200mm	n/a
Inlet screen differential level screen stop	100mm	n/a
Bypass inlet penstock start level	85.94 %	62.75mAOD
Bypass inlet penstock stop level	83.98 %	62.725mAOD

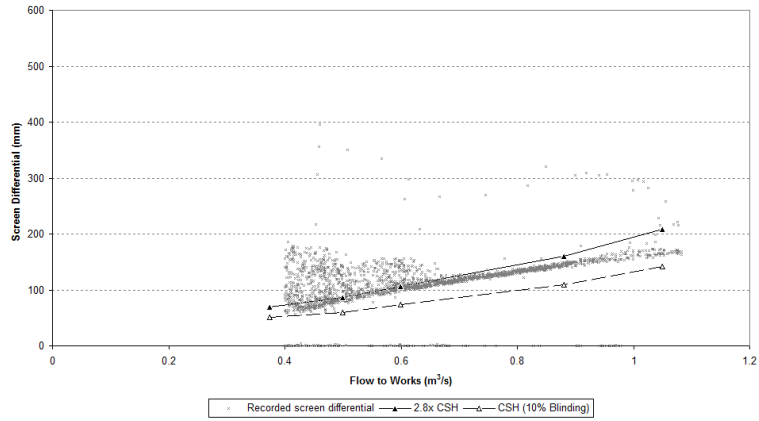
Screen Differential Results

Hazel Grove Screen No.1 Differential - November 2009



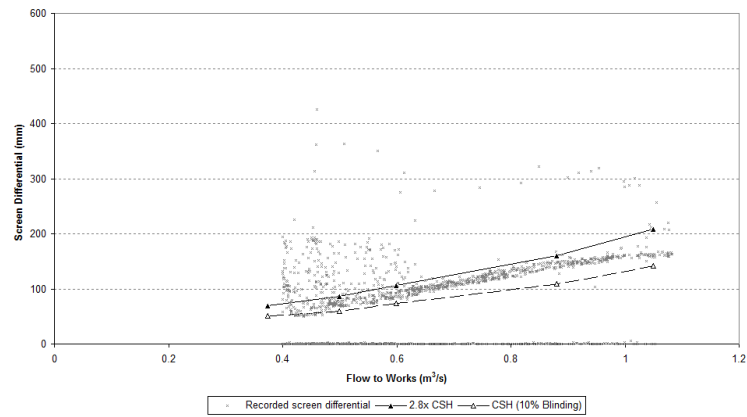
Screen Differential Results

Hazel Grove Screen No.2 Differential - November 2009

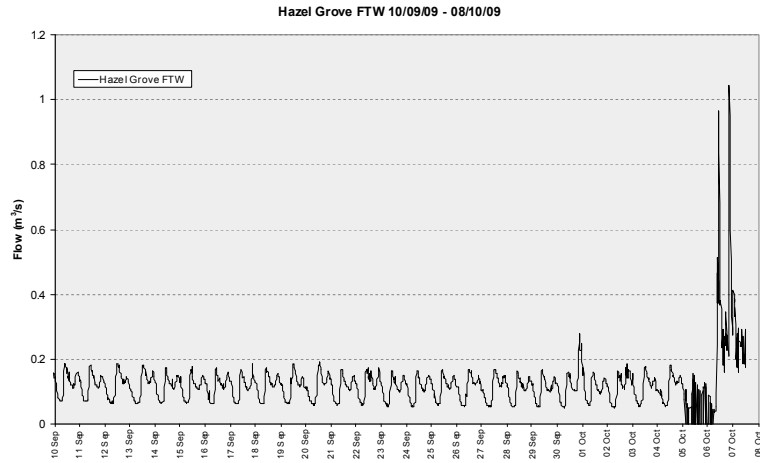


Screen Differential Results

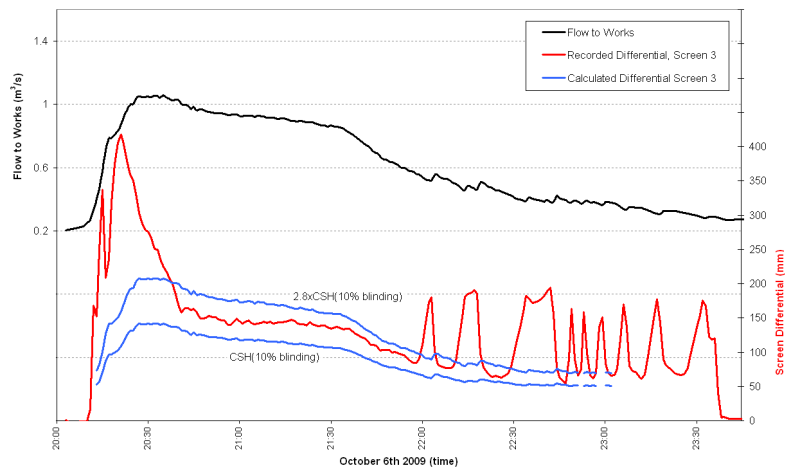
Hazel Grove Screen No.3 Differential - November 2009



Flow To Works Readings showing First Flush Event



First Flush Event Results



Further Points of Interest - Band Screen Rag Roll Problem



Further Points of Interest - Band Screen Flow Bias Through Clean Plates



Band Screen Survey Conclusions

- The data shows that recorded screen differentials across band screens are higher than the calculated CSH. This suggests that the UU calculation method for determining band screen headlosses under-predicts CSH.
- A comparison of the theoretical 2.8*CSH and the recorded screen headlosses during the first flush event shows that recorded headlosses can be significantly higher than predicted.
- Calculations have determined that recorded headlosses during a first flush event were approximately equal to 11*CSH.
- However, this is only a pilot study and much more data is required at different catchments and for longer periods during both summer and winter periods before anything more conclusive can be presented on CSH and how maximum differentials across band screens compare to the UU design case of 2.8 x CSH.**