

SuDS study summary

Interception of 5 mm of rainfall



Sustainable Drainage Systems do more than reduce runoff from rainfall. SuDS add value by using rainwater as a resource, treating the surface water runoff to reduce pollution, and enhancing biodiversity and amenity.

One of the most important criteria for designing sustainable drainage is Interception – the capture and retention of the first 5 mm of any rainfall event.

This statement is a summary of a study carried out by HR Wallingford for Asda, Sainsbury's and Tesco in September 2013 (MAM7091/RT001). The analysis derives practical methods to assess compliance with the Interception objective and will be of particular value where land usage is at a premium, as this tends to make its delivery more challenging.

The analysis looked at the use of the following drainage components in terms of their potential for intercepting and retaining runoff from rainfall events of all sizes, through the year:

- > Rainwater harvesting;
- > Green roofs;
- > Pervious pavements;
- > Swales.

Interception - The retention of the first part of a rainfall event to prevent surface water runoff occurring.

Interception – Key facts

- > The majority of rainfall events in the UK are less than 5 mm in depth
- > Rainfall runoff from paved surfaces contains a range of pollutants; many associated with vehicle emissions.
- > Pollutant concentrations tend to be highest in the early stages of a rainfall event
- > If the first 5 mm of every event was prevented from leaving the site, the total volume of runoff discharged into the receiving streams and rivers through the year would be a relatively small proportion of the total runoff generated by the site.



The method of analysis

Time series rainfall data and other parameters

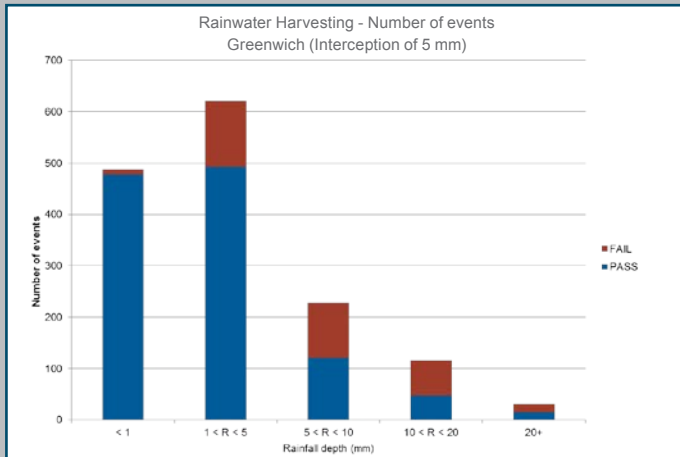
Data from a continuous period of 10 years of rainfall at a 2 minutes resolution has been used as the basis for determining a probabilistic (statistically based) approach to Interception design. For the purpose of this exercise a rainfall event was defined as any rainfall that follows a preceding dry period of at least 6 hours.

Evaporation rates are an important parameter for the analysis and 3 mm /day in mid-summer and 0 mm /day at mid-winter have been assumed.

The analysis

Each of the four SuDS components that were considered have their own unique design characteristics which are defined in the main report. Several model arrangements of each SuDS component type were then run to assess its effect on retention of the first 5 mm using 10 years of rainfall. The figures shown in this statement illustrate the performance of a few of the SuDS arrangements for a given set of assumptions and indicate the proportion of events for which the first 5 mm was successfully retained. Results for other SuDS design assumptions are available in the main report; some showing better levels of performance and others being less effective.

What the figures show



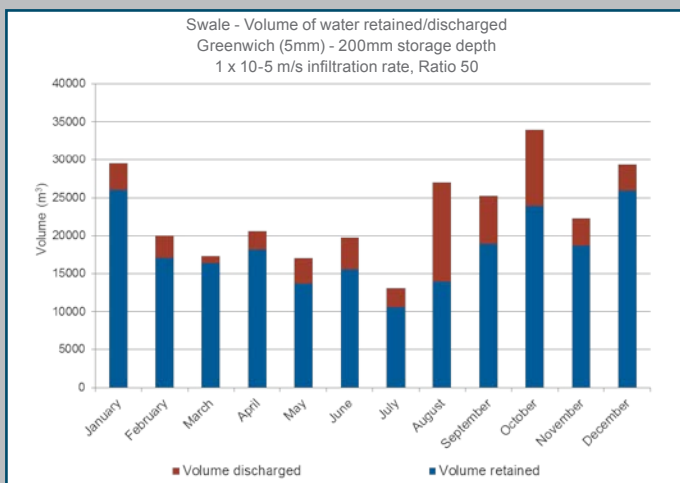
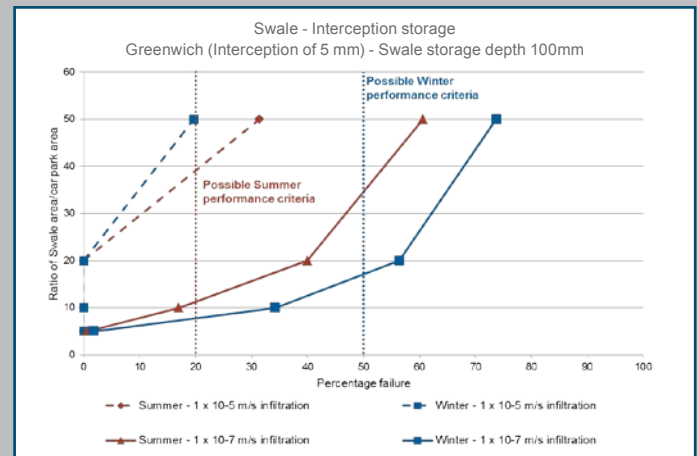
Rainwater harvesting

This graph shows that the rainwater harvesting system retained nearly 500 of the 610 events between 1 mm and 5 mm depth. Furthermore, the first 5 mm of rainfall was retained for 67 percent of all events larger than 1 mm and 50 percent of events larger than 5 mm.

Swales

This figure illustrates summer and winter Interception performance for the swale, based on assumptions of swale storage depth of 100 mm and two infiltration rates: one moderately low (which would be considered marginal for soakaway design), and a further very low infiltration rate (which would not be considered viable for an infiltration device).

The vertical dotted lines are suggested as possible compliance levels for Interception components (i.e. 20 percent failure to retain 5 mm in summer and 50 percent in winter might be considered to be a reasonable level of performance).



Swales

This graph shows the total volume of runoff from all rainfall events which is retained and not discharged from the site. The storage depth in the swale in this case is 200 mm. This performance was achieved based on the paved area being 50 times the area of the swale serving it. In this case it can be seen that the proportion of water discharged from the site in August, September and October is higher because these months tend to have the largest rainfall events in the year.

Conclusions and recommendations



The provision of Interception is critical to ensure a more sustainable approach to drainage design, affecting both runoff quantity and quality. It inherently requires surface based systems where evaporation is a key component of the performance of the drainage component particularly where infiltration is minimal, and thus supports further desirable aspects of SuDS such as pollution treatment, biodiversity and amenity.

This analysis shows that:

- > It is impossible to ensure that SuDS achieve Interception of 5 mm for every rainfall event during particularly wet periods.
- > Meeting the Interception criterion requires agreement on two aspects: the use of a probabilistic approach for compliance, and the selection of an appropriate proportion of events for which the Interception depth has to be successfully retained.
- > Each SuDS type has different strengths and weaknesses in delivering Interception.
- > The ability to provide effective Interception for a site does not require large amounts of space, even where infiltration rates are as low as 1×10^{-7} m/s.
- > All SuDS types demonstrate considerable opportunities for providing Interception, though green roofs were the least effective of the four options tested as evaporation is low in winter, and the normal amount of storage available is small.
- > Very high levels of compliance are achievable through the use of rainwater harvesting systems where the volume of non-potable water is greater than the amount the roof runoff can supply.
- > Very high levels of compliance are achievable through the use of pervious pavements, providing there is a nominal level of infiltration available.
- > Very high levels of compliance are achievable through the use of relatively small swales, providing infiltration rates are sufficient and a limited amount of storage is provided.

It is suggested that compliance criteria should differentiate between summer and winter periods. The reason for this is that the receiving streams and rivers are likely to be under greater stress during summer months, with lower available dilution levels reducing their capacity to accommodate polluted inflow. There is therefore a need for a higher probability of Interception compliance during the summer. Conversely, winter runoff will be more diluted, thus allowing a relaxation of compliance levels. The proposal is that 80 percent and 50 percent compliance for summer and winter respectively would generally be appropriate. It should be noted that this study has focussed on assessments using an Interception depth of 5 mm. This means that systems achieving 80 percent compliance will be achieving higher levels of compliance for the first 3 mm or 4 mm.

To enable widespread adoption of the method, this work needs to be developed into a simple set of tables and graphs for use in the UK. This requires running models for several other locations across the United Kingdom to allow interpolation of the results and enable a generic application to be developed.

As very low levels of infiltration make these methods viable, it will be important that reasonably accurate field tests are made to support the assumptions made on infiltration rates.

As this work is based on a theoretical analysis, even though it is very detailed, field trials should be carried out on a few systems designed to provide Interception to support these findings.

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