# OPTIONS FOR MEETING REGULATORY REQUIREMENTS FOR CSO DISCHARGES

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## Introduction – The Regulatory Framework

Article 3 of the EC Urban Wastewater Treatment Directive (UWWTD) (Directive 91/271/EEC,1991) requires member states to ensure that communities with a population equivalent of 2,000 or more are provided with wastewater collecting systems. It also requires that the design, construction and maintenance of the systems shall be undertaken in accordance with the best available technical knowledge not entailing excessive costs (BATNEEC), notably regarding the limitation of pollution of receiving waters due to combined sewer overflows (CSOs). The Directive requires member states to draw up their own regulations in the context of the Directive, and the UK's response is set down in guidance notes for consenting intermittent discharges, sometimes referred to as the AMP 2 guidelines (NRA 1993).

The guidelines set out impact assessment criteria for CSO discharges for pollutants in suspension and solution, based on the significance of the discharge in terms of the size of the drainage area upstream, the dilution rate of the receiving water, and interaction with other discharges. Fixing the setting of a CSO, and hence its frequency and volume of spill, may vary from a simple formula approach (Formula A) to complex modelling, following procedures set out in the Urban Pollution Management Manual (FWR, 1994). In addition there are requirements for aesthetic pollutant control which require solids retention to be provided for CSO discharges according to the amenity classification of the receiving water (Table 1).

Traditionally, solids retention at CSO's has been provided by installing screens. It is clear from the guidelines that many CSO's would require screening if the traditional approach were to be adopted. However, development in sewer system modelling, and advances in CSO and other solids separation technology, indicate that alternative approaches may prove to be more cost effective. In the Spring of 1994, the authors were commissioned to undertake a pilot feasibility study for UK Water Industry Research Ltd into the cost effectiveness of alternative strategies. This lead to a more indepth study, due for publication this Autumn, and a new design guide, currently available in draft form. The research has shown that in order to meet the regulatory guidelines a structured approach is needed when upgrading CSO's, which evaluate alternatives in a logistical sequence consistent with the philosophy of SRM3 (WRc 1994) and the Urban Pollution Management Manual (FWR, 1994).

## Review of Alternative Options

Table 1 summarises the aesthetic pollutant control requirements, which set three levels of retention (no retention, 10mm solids retention, 6mm solids retention) depending on the amenity classification of the receiving water and the spill flow rate. Six possible options for meeting the requirements have been identified.

i) Provide a basic CSO chamber and install 6mm mesh screens and 10mm bar screens.

ii) Provide an enhanced CSO chamber to give 6mm 'screen equivalent' performance, plus 10mm bar screens.

iii) Provide an enhanced CSO chamber to give 10mm 'screen equivalent' performance, plus 6mm mesh screens.

iv) Provide sufficient storage to reduce the frequency of spill so as to eliminate the need for the 6mm solids separation and provide a basic CSO chamber plus 10mm screens.

v) As (ii) but with an enhanced CSO chamber to give 10mm 'screen equivalent' performance.

vi) Provide significant storage to reduce the frequency of spill so as to eliminate the need for the 6mm and 10mm solids separation and provide a basic CSO chamber.

## Evaluating the Options

Before evaluation could take place it was necessary to determine the performance of various screens and CSO designs at retaining aesthetic pollutants. This also required information on the composition of aesthetic pollutants in storm sewage. A substantial research programme was therefore undertaken to establish:

i) the nature and composition of aesthetic pollutants
ii) the performance of various designs of CSO chamber at retaining aesthetic pollutants
iii) the performance of 6mm mesh and 10mm bar screens
iv) the costs of constructing CSO chambers, storage tanks and screening installations
v) the effect of different sampling of time series rainfall on the apparent performance of CSO's.

TABLE 1 AESTHETIC CONTROL REQUIREMENTS

| Amenity Classification | Spill Frequency | Aesthetic Control Requirement |
|---|---|---|
| <u>High Amenity</u><br>i) Receiving water passes through formal public park<br>ii) Formal picnic site<br>iii) Influences area where bathing and water contact sport (immersion) is regularly practised (wind surfing sports canoeing)<br>iv) Shellfish waters | > 1 spill per annum | 6mm solids separation(1) |
| | 1 spill per annum | 10mm solids separation (2) |
| <u>Moderate Amenity</u><br>i) Boating on receiving water<br>ii) Popular footpath adjacent to watercourse<br>iii) Watercourse passes through housing or frequented town centre area (bridge, pedestrian / shopping area)<br>iv) Recreation and contact sport (non-immersion) area | > 30 spills per annum | 6mm solids separation (1) |
| | 30 spills per annum | 10mm solids separation |
| <u>Low Amenity</u><br>i) Basic amenity use only<br>ii) Casual riverside access on a limited/infrequent basis (bridge in rural area, footpath adjacent to watercourse)<br><u>Non-Amenity</u><br>i) Seldom or never used for amenity purposes<br>ii) Remote or inaccessible area | Not applicable | Solids separation achieved through "best engineering design" of CSO chamber (high side weir, stilling pond, vortex) |

Notes

1 For spill flow rates up to and including the design flow [3], separation from the effluent, of a significant quantity of persistent material and faecal/organic solids greater than 6mm in any two dimensions. Spill flow rates in excess of the design flow [3] shall be subject to 10mm solids separation [2].

2 For spill flow rates up to and including the flow resulting from a 1 in 5 year return period storm, separation, from the effluent, of a significant quantity of persistent materiel and faecal/organic solids giving a performance equivalent to that of a 10mm bar screen.

3 Where Time-Series data is available, the design flow for 6mm separation[1] shall be the flow equivalent to 80% of the flow volume that would be discharged in an annual time series. Where Time-series data is not available, the design flow for 6mm solids separation[1] shall be the flow *equivalent to 50% of the volume that would be discharged in a 1 in 1 year return period design storm.*

In undertaking the research it became apparent that it was necessary to establish a method of directly comparing the performance of screens with the performance of CSO chambers. This lead to the concept of 'screen equivalent' performance, defined as the CSO producing the same overall separation of aesthetic pollutants over TSR event 1 with first spill at the design setting, compared with a basic overflow fitted with screens over TSR event 1 with first spill set at Formula A.

To ensure that the research findings were representative of all UK situations the study involved analysing over 200 overflow events on eight different drainage areas, chosen to represent the full range of topographical, climatic and receiving water features likely to be encountered.

## Discussion of the Results

Testing of screen meshes both in the field and in the laboratory has confirmed that overall retention efficiencies of well designed 6mm mesh screens are unlikely to exceed 60%, but that the retention efficiency varies greatly with the type of solid being retained. However, a survey of the results of industry field trails has shown that there is considerable variability between different screen designs in terms of capital costs, operational costs, reliability and performance.

Engineers should be aware that the alternative methods of arriving at the design flow for 6mm treatment set out in the regulatory guidelines are not comparable. Although more time consuming to produce, the design flow retaining 80% of the spill volume from the annual time series events will in general, though not always, lead to a lower cost solution.

Whereas sampling of the time series events can be used reliably to predict spill volumes at CSO's the methodology becomes less reliable when used to determine the 80% volume design flow used in designing 6mm treatment. Although scaling factors can be used, better reliability is achieved by use of the full time series. To avoid tedious long hand analysis the application of spreadsheet analysis or specially designed software applications to arrive at the design flow is recommended.

Although the general findings are unaffected by the types of drainage area or its geographical location, the use of locally adjusted rainfall is recommended when dealing with a particular CSO design. Significant under or over design can occur if this is not done.

A wide range of options have been considered for meeting aesthetic regulatory requirements, these being the use of screens (option 1), the use of hydraulic separation as an alternative to screens (options 2 & 3) and the use of storage (options 4, 5 & 6) to change the banding of regulatory requirements, as the three broad strategies. When evaluating the performance of alternative options to screens, the concept of 'screen equivalent' performance, as defined above, should be used.

The use of additional storage should always be evaluated as a cost-effective alternative in moderate amenity areas (options 4 & 5). It is unlikely, however, to provide a cost-effective alternative in high amenity areas (option 6) unless storage is also being provided to meet other regulatory requirements.

Enhanced CSO chambers that have 10mm 'screen equivalent' performance will almost always meet the 6mm 'screen equivalent' performance, so that option 3 is redundant. If a vortex CSO can be accommodated it should always be evaluated as it has been demonstrated that in a substantial number of cases it can achieve both the 6mm and 10mm requirements at the lowest cost.

In order to arrive at the most cost-effective solution in particular circumstances engineers should evaluate all potential options in a structured way. To help action this the authors have devised a planning process which is shown in diagrammatic form in figure 1. This flow diagram, together with charts for the design of enhanced CSO chambers produced as part of the research, form the basis of a new CSO design guide to be published in 1996.

## Acknowledgements

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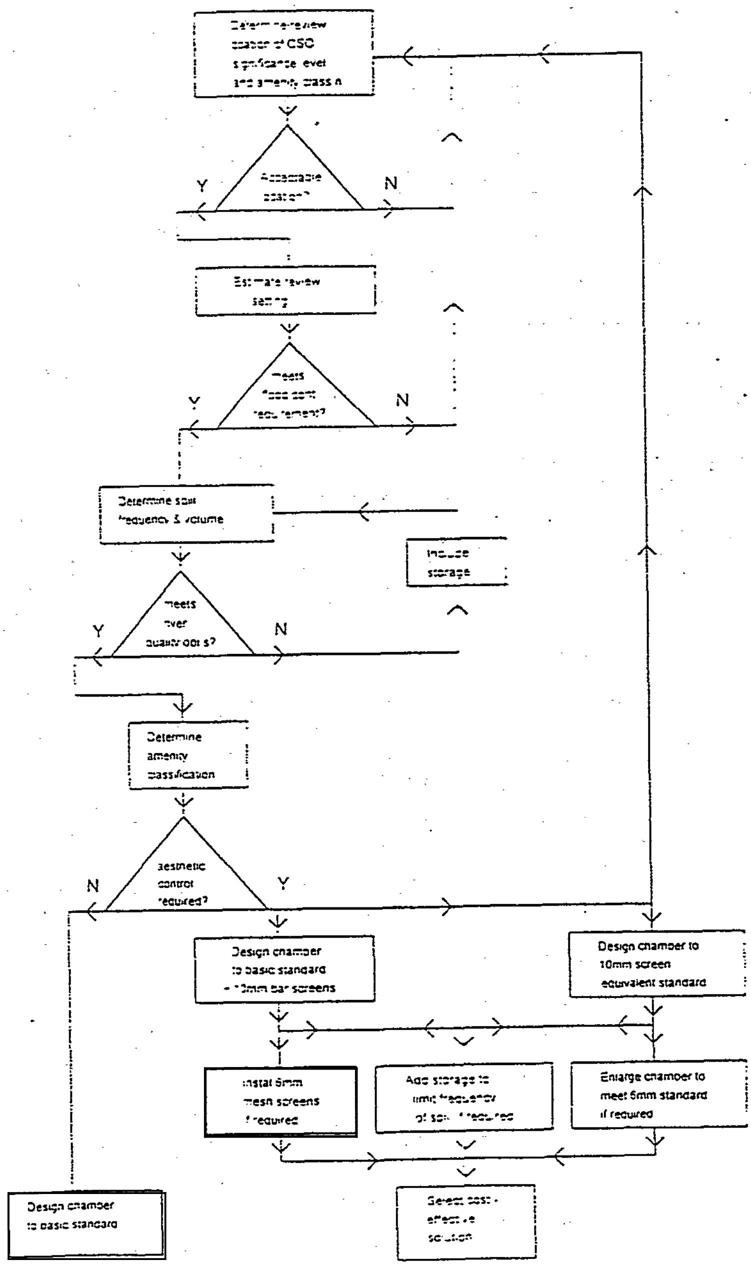


Figure 1

Options for Meeting Regulatory Requirements for CSO Discharges
David Balmforth & John Blanksby     Sheffield Hallam University

Question     Adrian Saul     Sheffield University
Did you identify the difference between floaters and sinkers ?
Answer
Yes looked at both, measured floating and settling characteristics, it compares well with other research.

Question     Gerard Morris     NRA
Is the information in the public domain
Answer
Yes but there will be a charge design guide on trial basis is out now, the final version will be out in June 1996 after beta testing and software development.

Question     Brian Downes     P. J. Tobin & Co.
In comparing the cost effectiveness of the various CSO design options were cleaning and maintenance costs included or was the comparison carried out on capital costs only. ?
Answer
Yes data collected on costs before evaluation.