Appendix C

Regulatory Aspects

APPENDIX C NUMERICAL PERFORMANCE DESCRIPTIONS OF DEVICES ACHIEVING STANDARDS FOR PROTECTING AMENITY USES

This Appendix provides numerical information about the performance of conventional types of devices which, when properly designed, meet the 6mm standards for protecting amenity use presented in Section 2 of the UPM3 Manual. The numerical information relates to the performance of the devices under specific test conditions which are described in the Appendix. This information may be used to compare and assess the performance of novel or unconventional devices which are intended to achieve compliance with the amenity use standards.

C.1 Introduction

The framework of emission standards in common use is presented in Table 2.6 in Section 2.5. There are three basic standards which are defined as follows:

- Good engineering design: defined as "design of combined sewer overflow structures in accordance with the recommendations of FWR report FR0488 (Balmforth et al, 1994)".
- 10 mm solids separation: defined as "separation, from the effluent, of a significant quantity of persistent material and faecal/organic solids giving a performance equivalent to that of a 10 mm bar screen".
- 6 mm solids separation: defined as "separation, from the effluent, of a significant quantity of persistent material and faecal/organic solids greater than 6 mm in any two dimensions".

All types of devices described in FWR report FR0488 are known to be capable of achieving compliance with these standards. Other devices may also be accepted to achieve compliance with these standards through common usage and experience. However, when/if it is desired to use novel or unconventional technology, a problem exists in interpreting the requirements of the standards. This is because the definitions are partially subjective and cannot be readily translated into numerical values against which to test the performance of new or novel devices or structures. Hence, designers have tended to be constrained to the use of conventional, recommended technology to be sure of achieving compliance with the standards. This situation is contrary to the widely held desire to develop and apply new and improved methods of achieving effective solids separation at reduced cost.

To counter this problem, an extensive programme of field testing has been undertaken to provide a numerical quantification of the performance of acceptable devices under specified conditions. The resultant numerical descriptions are presented in Section C.2. Explanation of how they were derived is provided in Section C.3 and a protocol for designing and testing the performance of novel devices in a manner comparable to that used to develop the graphs is described in Section C.4.

C.2 Numerical performance descriptions

Figure C.1 illustrates the performance of a conventional CSO 6mm screen evice tested in the manner described in Section C.3.

Explanatory Notes

The x-axis represents "Inflow" which is the rate at which sewage enters the CSO chamber. The calibration is in terms of Q_{design} , which is the design peak inflow rate for the structure or device in question.

On the y-axis, "Total Efficiency" is the percentage of the total mass of solids entering the CSO chamber during an event that is retained within the sewer system. This includes solids passed on to treatment in the continuation flow and solids remaining in the chamber itself at the conclusion of the event.

The "Continuation Flow" is the rate at which flow is passed forward for treatment from the structure or device. It is expressed as a proportion of the design peak inflow rate for the structure or device.

Hence, these graphs illustrate the solids retention efficiency of conventional technology for a range of spill events and flow splits. Each graph suggests the target level of performance (in terms of overall solids retention efficiency) for alternative forms of technology designed and tested in the same way. Technology achieving equivalent or better performance than these graphs might reasonably be expected to achieve compliance with the standards "6 mm solids separation" when constructed in accordance with appropriate design guidance.

C.3 Derivation of the numerical descriptions

The numerical descriptions were derived on the basis of an extensive programme of field testing sponsored by the Environment Agency and carried out at the National CSO Test Facility at Hoscar (Wigan) Wastewater Treatment Works. The methods employed were specifically developed for the purpose.

The Wigan facility can deliver untreated raw sewage to the test rig at rates of up to 500 l/s from the Wigan combined sewer system. Inflow to the test facility is controlled by a computer controlled valve, allowing steady state or time variant inflow hydrographs to be generated as required. Downstream of the test rig there is facility to collect and measure two separate flow streams before the flow is returned to the treatment works inlet.

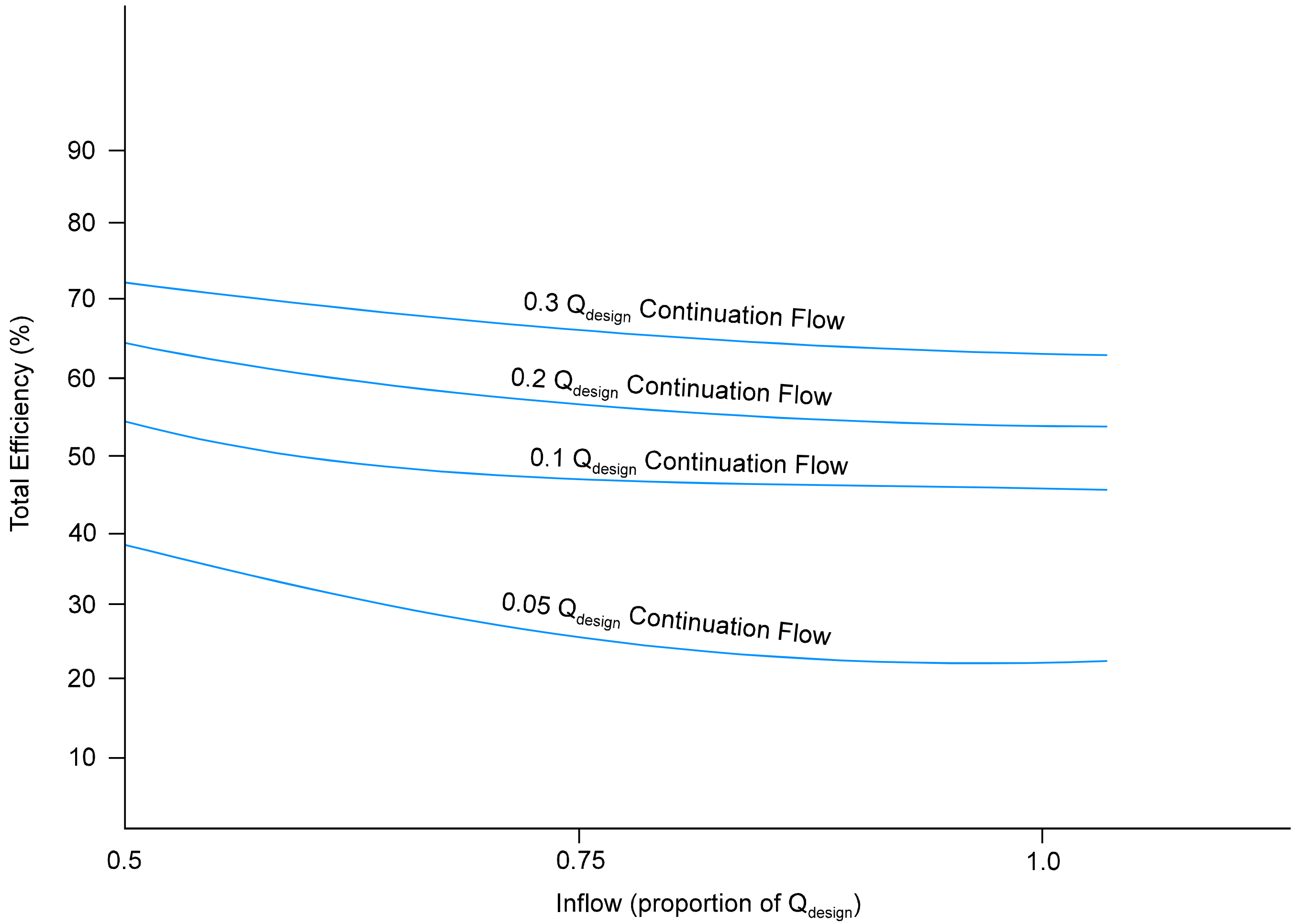

Figure C.1 6 mm solids separation

A High Side Weir chamber fitted with a 6 mm mesh screen was used for the testing. The screen was kept clear of accumulated solids for the duration of the test by manual cleaning to ensure that a true representation of screen performance was achieved.

The structure was subject to a matrix of tests of varying inflow rates (up to and including the peak design inflow of the structure) and continuation flow rates which were considered to be representative of a wide range of operational conditions.

By virtue of the nature of the test facility, all of the tests were undertaken using essentially dry weather sewage from the combined sewer system and, hence, it was not possible to simulate a ‘first flush’ of gross solids as might be experienced at a CSO under storm conditions. Instead the solids content of the incoming sewage was measured prior to and following every test. When the solids content was found to be above or below defined limits, or to have varied markedly over the duration of the test, the test was aborted and repeated at a later date.

The solids load of both the continuation flow and the spill flow was measured for each test. The method was to pass the complete flow stream through 6 mm mesh Copasacs for the duration of each test. Hence, all solids of greater than 6 mm in two dimensions in each flow stream were captured. At the end of each test the sacks were allowed to drain for 30 minutes before being weighed. Any solids remaining in the chamber were collected and added to the continuation flow sack to allow the event efficiency to be computed. A more detailed description of both the Wigan rig and the testing programme undertaken to derive the standards can be found in the project report (Environment Agency, 1997 see see UPM2 References, Section 1.9).

In summary, the numerical descriptions presented in Figure C.1 have been derived on the basis of practical testing using real sewage for the types of structures in common use by the industry. As such, the descriptions constitute a realistic indicator of the solids retention performance that can be expected of these structures under the specified design and flow conditions. Hence, it is considered that these descriptions provide a reasonable and realistic basis for comparing the performance of alternative and novel forms of technology which are aimed at providing protection of the amenity use standards.

C.4 Testing protocol for novel devices

The numerical descriptions provide a sound basis to allow objective comparison of performance for different types of CSO technology. However, for the comparison to be fair, the alternative devices must be tested in a comparable manner to that by which the recommended structures were evaluated. Hence, there is a need to define a standardised testing protocol which can be applied at any suitable testing site (not only the CSO Test Facility at Wigan) and on any new or novel device. This section describes such a protocol.

C.4.1 CSO design

The device to be tested should have a known peak design inflow rate which is compatible with the flow delivery capability of the test facility. The continuation flow rate should be fixed and representative of the flow split (ratio of continuation flow to peak design inflow) to be used in the field application. Alternatively, the continuation flow can be variable to allow a comprehensive range of tests to be undertaken to prove the technology for widespread application.

C.4.2 Test facility

The chosen testing facility must be able to meet the following conditions:

a) The sewage feed should be delivered to the test rig without excessive distortion to the flow patterns; i.e. no bends, drop shafts, etc. immediately upstream of the test rig.

b) An adequate supply of “suitable sewage” should be available. “Suitable sewage” means predominantly domestic sewage which has not been subject to excessive pumping which would macerate the gross solids content.

c) Accurate control must be able to be exercised over the inflow rate, so that the specified test conditions can be adhered to.

d) The continuation flow should be either fixed or capable of being varied between tests (see Section C.4.1).

e) Accurate flow measurement of both the inflow and the continuation flow streams must be possible.

f) There must be facility to capture gross solids in both the continuation and spill flow streams. The solids should be captured in 6 mm mesh Copasacs to ensure the results are comparable to the baseline tests.

C.4.3 Test procedure

The testing procedure should be carried out as follows:

a) Define the matrix of tests to be undertaken. As a minimum, this should include at least three inflow rates up to and including the peak design inflow for the device under test. The continuation flow should be representative of the proposed installation or, if the testing is for widespread application of the device at multiple sites, should encompass a range of continuation flow rates as indicated on Figures C.1 to C.3.

b) An influent strength test should be carried out before every test. In this test, flow is passed through the rig at a known rate and solids are captured from the entire inflow. At the end of a known period of time (typically 20 minutes), the mesh sacks are withdrawn from the flow, allowed to drain for a further period (30 minutes is recommended) before being weighed. The solids concentration of the inflow can then be computed. If the concentration is between allowable limits (35 to 120 g/m^3 is recommended) the test can proceed, otherwise it should be aborted.

c) Run the test. The recommended form of test is a steady state flow test where flow is passed through the rig at the prescribed rate and flow split (see (g)) until steady state conditions are achieved. The solids collection sacks are then placed in the continuation flow and spill flow streams (ensuring that all flow passes through the sacks) and left there for a known period of time (20 minutes is recommended). During the lead-in period and for the duration of the test itself, the device under test should be operated in the manner recommended by the manufacturer, i.e. any cleaning mechanism or arrangement should be operational, but no other maintenance should be undertaken. At the end of the period, the sacks are removed from the flow, allowed to drain for a period of 30 minutes and weighed. The total efficiency of the device for that particular test can then be computed by the relationship:

$$\text{Total Efficiency (\%)} = \frac{\text{Total solids load retained}}{\text{Total inflow solids load}}$$

d) Repeat the influent strength test to ensure that the solids concentration has not moved out of the acceptable range or fluctuated excessively during the test period.

e) Steps (b), (c) and (d) should be repeated for other inflow and continuation flow rates, as determined in Step (a).

When the matrix of tests is complete, the performance of the test device can be compared to the performance descriptions in Figures C.1 to C.3. The device can be considered to achieve comparable performance to the conventional technology for a particular set of conditions if it’s

Total Efficiency is equal to or higher than that illustrated in the relevant Figure. If the device has been tested for a full matrix of flow conditions and exceeds the numerical description for a particular standard in all circumstances, then it is likely that the device will deliver performance in the field that will be comparable or better than conventional technology. If only a partial set of tests has been undertaken, or the device's performance curve falls below that of the relevant performance description under certain conditions, then the likelihood of compliance should be considered to be similarly qualified.