

CONSENT STANDARDS FOR STORM SEWAGE OVERFLOWS

Gerard Morris
Environmental Scientist
NRA, Yorkshire Region

1. Introduction

Many rivers in England and Wales are polluted by discharges from storm sewage overflows. Within one catchment in Yorkshire, for example, it has recently been assessed that 21% of the poor quality of the River Aire could be attributable to prematurely operating or inadequate storm sewage overflows. (S.S.O.s)

The effect of the storm sewage can be considerable and cause serious deoxygenation, fish mortalities caused principally by toxicity to ammonia, and offensive littering of the river and banks by sewage solids and plastic material. The disturbing result in 1989 was that there were over 250 serious reported pollution incidents caused by S.S.O. discharges.

In the past engineers have generally based their designs for S.S.O.s on the "Formula A" approach. This procedure having been recommended by the Technical Committee on Storm Sewage Overflows in 1970.¹ However the approach takes no account of the effect on the capacity, sensitivity or potential risk in the receiving water. A point recognised in the 1970 report and which also urged for a study to be undertaken on the effects of intermittent discharges. Little account was taken of this advice until relatively recently.

One of the NRA's main duties is to maintain and improve the quality of all the inland and coastal waters under its control. In the future it will be the NRAs responsibility to ensure that currently unsatisfactory S.S.O.s are abandoned or improved and that standards for new S.S.O.s are based on the need to protect and achieve the water quality objectives and standards.

2. The Inheritance

The NRA has inherited approximately 22,000 S.S.O. Consents which contain a variable selection of control measures. Many of the inconsistencies arose due to the piecemeal implementation of the various Rivers (Prevention of Pollution) Acts 1951, 1961, and Control of Pollution Act 1974 by the predecessor River and Water Authorities. A recent example being the discovery of 7269 unconsented S.S.O. discharges just before privatisation of the water utilities in 1989. In the case of these S.S.O. discharges the NRA was directed by the Secretary of State for the Environment to issue temporary consent until a full determination could be made.

As referred to in the Government's recent White Paper² a major priority of the NRA is to review the terms of the discharge consents for all known storm sewage overflows. To assist the process the NRA has published a document entitled "Discharge Consent and Compliance - A blueprint for the future".³ (The Kinnersley Report). Following public consultation a framework will be established for reviewing existing consents and determining applications for new ones.

Several estimations of the scale of the problem have been made and it appears that c.25-35% of all storm sewage overflows are considered unsatisfactory. However it will not be until a thorough examination of the inheritance has taken place that an accurate assessment can be made.

3. Legislative Basis of Control

All discharges from S.S.O.s into controlled waters require a Consent from the NRA under the Water Act 1989. A controlled water is defined under the Act as any, inland, underground, estuarial or coastal water up to the three mile limit. Under the Act the Secretary of State is required to implement a classification scheme for controlled waters, to set statutory quality objectives for them and a date for their achievement. The NRA will advise the Secretary of State on these matters and once set the achievement of the objectives is both the responsibility of the Secretary of State and the NRA.

In the interim the NRA has inherited a valuable system for the management of inland and estuarial waters of non-statutory objectives based on use related quality.

With regard to discharges to coastal waters guidance on standards is currently being considered by D.O.E. following the recent Ministerial Statements concerning protection of the North Sea and the proposed E.C. Municipal Waste Water Treatment Directive.

Consent Procedure

Applications for Consents under Schedule 12 of the Water Act require detailed information on flows, contaminants, treatment measures and site plans. In addition for an increasing number of cases environmental impact assessments could also be required. With S.S.O.s specifically in mind details on sewerage design, flow characteristics overflow structure and solids retention would also be required.

The NRA from 1 October 1990 is recovering the costs of processing applications for discharge consents. In addition an annual charging scheme for monitoring the discharges is currently being prepared with implementation planned for 1991.

4. River Quality Standards for Intermittent Discharges

Standards are set to maintain or improve the use-related water quality objective. Rivers have many uses from salmon fishery and possible water obstruction to coarse fishery and industrial supply. One of the basic aims being to achieve or maintain good quality river capable of supporting a viable coarse fishery. By definition such a river requires a thriving invertebrate life and be aesthetically free of pollution from solids, plastic material and oil.

Setting standards for continuous discharges has become well established based on the National Water Council (NWC) classification for the various classes. These class standards are based on 95 percentile achievement eg BOD

Class Upper Limit as a 95 Percentile

1B	5 mg/l
2	9 mg/l
3	17 mg/l

The fundamental assumption is the acceptance that for 5% of the time the river may exceed the standard. Since its adoption in the 1970s this approach has proved acceptable despite the fact perhaps that BOD is a surrogate for measuring the effect of organic material on the dissolved oxygen regime of the river. The NRA however in its review³ proposes to consider other measures of organic pollution for the long term and research has been commissioned.

By using the 95% ile river quality standards for BOD, ammonia, dissolved oxygen etc. then consent conditions for continuous discharges can then be relatively easily determined. This methodology does require extensive data collection but the assessment is greatly aided by the use of statistical modelling techniques eg. SIMCAT and TOMCAT.

If this approach were extended to S.S.O.s. then that would imply that discharges could occur 5% of the time eg. 18 days of the year but at an unspecified quality. However, the water quality criteria are intended to protect the long term viability of fish and aquatic life. Although some disturbance may occur during discharge events, risk of fish mortality would be considered unacceptable by the public.

One approach is to use maximum acceptable BOD concentrations as expressed by the 99 percentile:-

	95 Percentile mg/l	MAC (99 Percentile) mg/l
Class 1B	5	10
2	9	15
3	17	20

This method has been used in the NRA Welsh Region for QUALSOC modelling and application of the results does appear encouraging.

However the implication is that unsatisfactory discharges of unspecified quality could occur 3 days per year. The basic question remains would that level of risk of pollution be acceptable and would such statistical standards be suitable for translation into design criteria for sewerage systems.

4.1 Research and Development

In order to investigate these kind of questions a research programme was initiated in the late 80's between several Water Authorities, Water Research Centre (WRC.) Hydraulics Research, D.O.E. and Science and Engineering Research Council (SERC). A River Basin Management Programme was set up to extend work on sewer modelling to include storm sewage quality and such intermittent discharges on river quality. Following privatisation of the water utilities and the establishment of the NRA, work is being steered by a re-constituted Urban Pollution Management Group under the umbrella of the Foundation for Water Research. A considerable amount of research work is currently being carried out by the Water Research Centre specifically to produce standards for intermittent pollution.

Dissolved Oxygen Standards

The early results are encouraging as a recent report⁴ has examined the required levels of dissolved oxygen needed to protect the long term survival of fish and aquatic microinvertebrate communities which have been exposed to oxygen depletion of different magnitudes, duration and frequency. A three dimensional approach has been developed (Figure 1) based on 1 hour and 24 hour criteria, ecotoxicological data for 6 hour exposure and LC50. The short term lethal concentration which kills 50 percent of the fish (LC50). An absolute minimum of 2 mg/l D.O. concentration has been taken for very short events which provides a margin of safety above the minimum survivable concentration of 0.5 - 1 mg/l for rainbow trout.

The criteria are tentative and the next stage is to validate against field derived data at a range of sites together with an assessment of their practical application. In addition, the criteria need to be extended to take account of infrequent events with a return period up to 5 years.

If acceptable the river standard would need to be translated into a condition to be applied to the discharge outlet for sewerage design.

As an example a particular river the NRA could set the following for example:-

Return Period	:	1 Year		
D.O. Instant	:	> 2	mg/l dissolved oxygen	
3 hour duration	:	> 2.5	mg/l	" "
6 hour duration	:	> 3.5	mg/l	" "
24 hour duration	:	> 4	mg/l	" "

Much research work remains to be done particularly on the effects of "first flush", sediment oxygen demand. The next major piece of research is to examine similar responses of fish to pulses of ammonia of varying magnitude, duration and frequency.

Following validation the criteria for dissolved oxygen and ammonia could then be adopted and applied in association with modelling techniques for decision identifying on sewerage improvements needed to achieve the river quality objective.

5. Interim Guidance on Consent Standards

The development of precise standards for intermittent discharges needs to be scientifically valid and practically justifiable. This could take a further two years of research. In the meantime important decisions need to be taken daily as sewerage systems are overhauled and improvement plans are proposed.

Therefore general guidelines have been developed to ensure that the aims and responsibilities of the NRA are met. It is the intention of the NRA to produce more detailed guidance following the review and implementation of Kinnersley report.

With regard to storm sewage discharge to coastal waters guidance has yet to be confirmed by the DOE. The main direction of this paper is to present the current situation with regard to inland waters. The N.R.A.'s interim guidelines are as below:-

Storm Sewage Overflows (SSOs) from sewerage systems

Where reasonably practicable for new systems, storm overflows should not be allowed. Before consent is given to a storm overflow from any part of the foul sewerage system, the following guidelines should be considered:

Wherever possible, existing SSOs should:

- not contain significant quantities of trade effluent or 'Listed' substances as described in Circular 7/89 and subsequently in the direction to the NRA under Section 146 of the Water Act 1989 relating to EC Directives on discharges of dangerous substances;
- not cause the receiving watercourse to fail on water quality objectives or affect a Site of Special Scientific Interest.
- receive reasonable dilution so as to prevent nuisance downstream;
- have a means of screening or other method of solids separation installed except in extreme cases where this is not technically feasible because of other requirements relating to the siting of the overflow;
- have prescribed in their consent the flow conditions in the sewer, under which the overflow will come into operation;
- have alarmed telemetry systems when sited in sensitive areas.

With regard to existing overflows, where possible deemed consents should be revoked if:

- there is serious visual pollution - particularly giving rise to public complaint - caused by the overflow;
- the operation of the overflow results in the failure of an water quality objective standard or pollution of a public supply source;
- the local authority notifies the NRA that the operation of the overflow causes a public health hazard;
- an overflow can readily eliminated by sewerage or sewage treatment works modifications or extensions.

Consideration should be given to a reporting/recording system for the operation of SSO's when specified, and for situations where problems of water quality exist.

6. Developments

In addition to the research in developing river quality standards there has been considerable progress made in producing tools for assessing the impact of intermittent discharges. Two methods are currently available QUALSOC, (Welsh Office Storm Overflow Calculation approach) and CARP, (WRC), together with a third, MIKE 11 enhancement, (Danish Hydraulics Institute) which is due for completion in 1991.

QUALSOC. Quality Impacts of Storm Overflows: Consent Procedure.

An extended version of Formula A which uses a mass balance technique to match the overflow setting against a desired river quality concentration for a specific pollutants. QUALSOC is relatively simple to apply with low data requirements.

CARP (WRc) Comparative Acceptable River Pollution.

Overflow load estimates are calculated based on sewerage rehabilitation procedures (SRM 11). Acceptable spill pollutant loads are then calculated for individual reaches by comparing the pattern of load input with a river reach of similar characteristics which requires significant discharges but remains within its water quality objective.

CARP is also simple to apply but requires a considerable amount of hydraulic data. One major problem with CARP however is the difficulty in identifying a range of acceptable reaches with which to compare and validate the method. However a serious deficiency in both the approaches is the inability of QUALSOC and CARP to deal with the "first foul flush" phenomena.

The use of QUALSOC and CARP are recommended as they provide a significant improvement in assessing SSO impact. Following the development of more sophisticated models these simple procedures should still be useful for small schemes or initial appraisal of options during re sewerage planning.

MIKE II - Danish Hydraulics Institute

The need for a dynamic river quality model for intermittent discharges was recognised by the Urban Pollution Management Group. Both NRA and water utility representatives defined the requirements for such a model and an extensive selection procedure identified the MIKE II model to be the best option for development.

Currently the MIKE II model has proved successful in a range of hydraulic and water quality modelling has a high technical specification and produces good quality outputs.

The development, calibration, verification and testing of the model will be carried out on behalf of the F.W.R. for completion in early 1992.

Specific developments required are the abilities to interface with the complementary sewage discharge model MOSQUITO, to utilise an improved sediment transport/pollution interaction and to produce summary event statistics.

The product of this joint contract will be an enhanced version of a dynamic river water quality model which has already found widespread applications in the NRA in addressing urban pollution problems. The enhanced model will be entirely compatible with models of sewer systems discharging to urban rivers, will simulate sediment/pollution interactions in an appropriately sophisticated manner and will provide output directly compatible to existing and proposed standards for water quality.

7. Conclusions

The N.R.A. has a duty to set standards for storm sewage overflows based upon the specified water quality objectives. This will require the effects of intermittent discharges to be quantified and modelled where necessary in order that the degree of protection for river life can be assessed.

The river water quality standards will be based on well founded research field evaluation and operational testing.

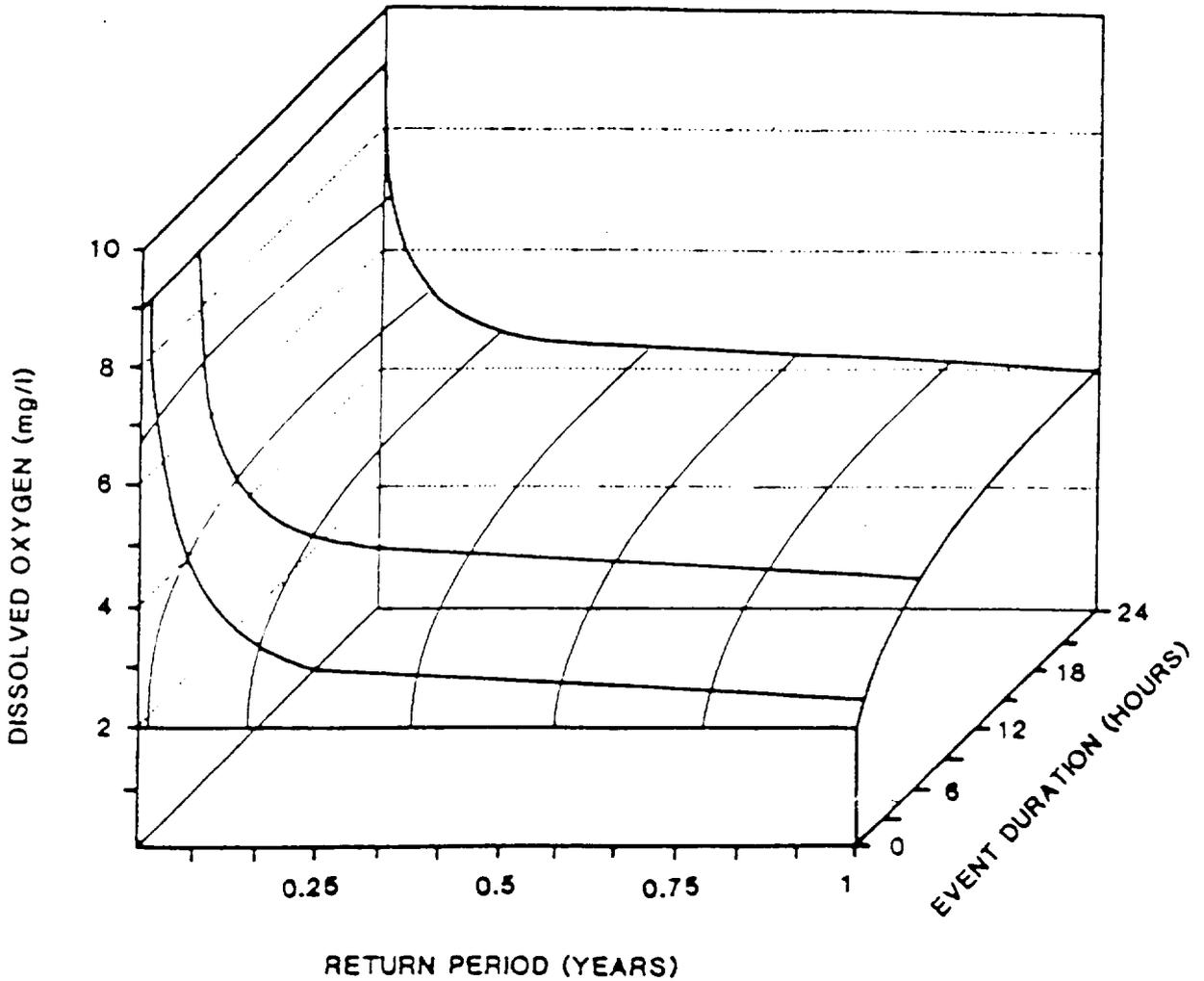
Although the primary importance is to set standards for organic material and ammonia, should there be a need other pollutants would be considered such as bacteria, toxic material, colour, detergents etc. In addition the more visible contamination caused by litter and gross sewage solids needs specific design standards and storm sewerage treatment devices. The questions of screen sizes, settlement tanks, etc. have not been considered in this paper but they are being urgently reviewed by the NRA.

With the privatisation of the water utilities and the establishment of the NRA the differentiation of responsibilities of the operation and regulating of the sewage system is now clearly separated. The NRA will set and ensure the S.S.O. standards will be met to achieve the river quality objective and the Water Service Companies have a requirement to comply with these consent standards by adopting appropriate design methodology and good management of the sewerage system.

References

1. Technical Committee on Storm Overflows and the Disposal of Storm Sewage Final Report", H.M.S.O., 1970.
2. "This Common Inheritance - Britain's Environmental Strategy", HMSO 1990.
3. "Discharge consent and compliance policy : a blue print for the future". NRA Water Quality Series No. 1. 1990.
4. "Proposed Water Quality Criteria for the protection of aquatic life from intermittent pollution : Dissolved Oxygen WRC Medmenham 1990. PRS 2498-M.
5. "Interim River Water Quality Planning Procedures for Controlling Intermittent pollution from storm sewage overflows", WRC Engineering, 1988.

FIGURE 8. WATER QUALITY CRITERIA FOR THE PROTECTION OF AQUATIC LIFE DURING INTERMITTENT OXYGEN DEPLETION EVENTS: 3-DIMENSIONAL MODEL



"Proposed Water Quality Criteria for the protection of aquatic life from intermittent pollution : Dissolved Oxygen WRC Medmenham 1990. PRS 2498-M.

Paper 2 : Overflow Performance (K Thomas, NRA)

Mr Jenkins (Hertsmere) : Do you agree there is a need for a totally integrated approach i.e. coastal/riverine, taking into account long sea outfalls?

Answer: Long sea outfalls are not usually prone to intermittent discharges as are rivers from storm sewage overflows, and their fairly constant discharges are reasonably understood.

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R Salinger (Such and Salinger Partnership) : Do you feel there is a need for consents for highway drainage outfalls which can be very polluting?

Answer: Yes - studies have been undertaken which prove there is a bacterial load.

.....
J Payne (Hydraulic Research Ltd) : Will there be any stipulation on the time of day when DWF is measured e.g. You can take a measurement at 4.00 am in order to achieve your consent.

Answer: A daily average DWF would be stipulated.

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J Riley (Scarborough B.C.) : What is the NRA's view on closing of overflows?

Answer: I personally have no knowledge of a specific policy.

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M Osborne (Hydraulics Research Ltd) : If a previously unknown overflow is discovered during WALLRUS verification, what will be the procedure to register that overflow? Will it have a deemed consent?

Answer: Everything has to be put into the melting pot and a programme worked out for improving existing overflows. It is recognised that this will take time. Full consultation and mutual understanding is required between the Water plc engineers and the NRA. Deemed consents only apply to known overflows.

.....
J Voges : Are consent conditions imposed or likely to be imposed that would require the correction of problems from overflows eg the collection of gross solids from banks?

Answer: At the moment the NRA would request the drainage authority to clear up the effects of pollution from an overflow, but consent conditions requiring a clear up are starting to appear.

F Jackson (Mott MacDonald) : What is the situation regarding consents for existing SSO's?

Answer: There are about 800 pre-existing SSO's in the Yorkshire region which are deemed consented without condition. Over the next 2 years these will be reviewed and conditions applied to achieve the status quo. After that there will be work towards improvement.

C Jeffries (Dundee Institute of Technology) : The sample condition clauses displayed in the paper say nothing about storage facilities. If these are required who would be taking responsibility for their design?

Answer: A condition requiring storage could be included in the consent. Early discussions on proposals are very important so that conditions are agreed before an application is made. Initially approximate conditions may be suggested from a menu of options. Design may be suggested from a menu of options. Design responsibility would remain with the applicant.

G Catterson (IHS) : What timescale do you envisage occurring between an initial consultation and agreement on the criteria for consent?

Answer: About 2 months between making the first contact and making the application.