Thames Tideway Strategic Study

Objectives Working Group Report

February 2005

Thames Tideway

Volume 1

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Thames Tideway Strategic Study
Objectives Working Group Report

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0. Executive Summary

- The Objectives Group was set up by the Thames Tideway Strategic Study, with terms of reference to establish a series of objectives to meet a broad aspirational aim:

  To reduce the impact of intermittent sewage discharges and further improve water quality in the Thames Tideway to benefit the ecosystem and facilitate use and enjoyment of the river;

- The intermittent sewage discharges are derived from London's sewerage system, which is designed to overflow to the river during times of rainfall; and incorporates 57 combined sewer overflows to the river;

- The overflows occur frequently, 50-60 times per year and result in 20 million tonnes of untreated sewage and run-off to the river each year;

- These discharges can cause environmental damage in three different ways: -

  1. *By reducing dissolved oxygen to a level that will not sustain healthy populations of fish and can result in fish mortality.*

  2. *By introducing large quantities of sewage-derived solids (SDS) to the river, including grease and scum, which create aesthetically offensive conditions both in the river and on the foreshore.*

  3. *By introducing large quantities of pathogenic organisms into the river, which increase the health risk to river users.*

- The Group considered all existing statutory requirements, which might be relevant to the setting of objectives; and concluded that the Urban Waste Water Treatment Directive and the Water Framework Directive were of particular importance;

- The Water Framework Directive was adopted and transposed into UK regulations in 2004. It aims to achieve *good ecological status* or *good ecological potential* for all water bodies by 2015. However, the classification schemes that will be based on biological, hydromorphological, chemical and physico-chemical quality elements have yet to be developed;

- The Urban Waste Water Treatment Directive is the principal legislative instrument for controlling waste water discharges to the Tideway. In the absence of greater certainty regarding the future provisions of the WFD, it was considered to be of critical importance that full account was taken of the requirements of this Directive when deriving objectives for the Tideway. The overarching objective of the Directive is:

"*To protect the environment from the adverse effects of urban waste water*"

This can be divided into five key requirements:

1. The sewerage system must convey waste water to the STWs for treatment;

2. Sewer overflows may occur under conditions of unusually heavy rainfall;

3. Measures shall be taken to limit the pollution from sewer overflows;

4. The STWs must perform sufficiently under all normal local climatic conditions;

5. The sewerage system and the measures taken to limit pollution from the CSOs, must be undertaken in accordance with the best technical knowledge not entailing excessive costs.

- An assessment was carried out to identify which of the 57 combined sewer overflows require action to be taken; and it has been determined that 36 cause an adverse environmental impact, requiring action to limit pollution, whilst 25 require their frequency of operation to be reduced;

- Objectives have been developed to limit pollution, as required by the Directive, taking account of the adverse effects caused by the sewage discharges;

- Standards to protect fish are based on dissolved oxygen levels and have been developed in accordance with the Urban Pollution Manual;

- For those discharges which cause an aesthetic deterioration, standards are applied to reduce the impact of sewage derived solids;

- Combined sewer overflow discharges result in approximately 120 days when health risk is elevated. These need to be substantially reduced to protect river users;

- An objective has also been specified to ensure that potential solutions comply with the requirement of the Directive to use "best available technical knowledge, not entailing excessive cost";

- Potential solutions must also be able to accommodate future changes arising from climatic and other effects.

1. Introduction

1.1 London's Sewerage System

London's sewerage system dates back to before the 19th century and is designed on the "combined" principle, whereby a single set of sewers convey both foul sewage and rainwater run-off to Sewage Treatment Works (STWs) for treatment, prior to discharge to the river. This differs from the more modern "separate" drainage system where there are two sets of sewers, one to convey foul sewage only and the other to collect rainwater for direct discharge to a watercourse. It is normal practice for combined sewerage systems to incorporate overflows in the system, which allows excess flows to discharge directly to a river to prevent flood risk. This is the case with the London sewerage system which, to alleviate flooding, has of necessity been extended over the years and now incorporates 57 of these combined sewage overflows (CSOs) to the Thames Tideway and Lower River Lee.

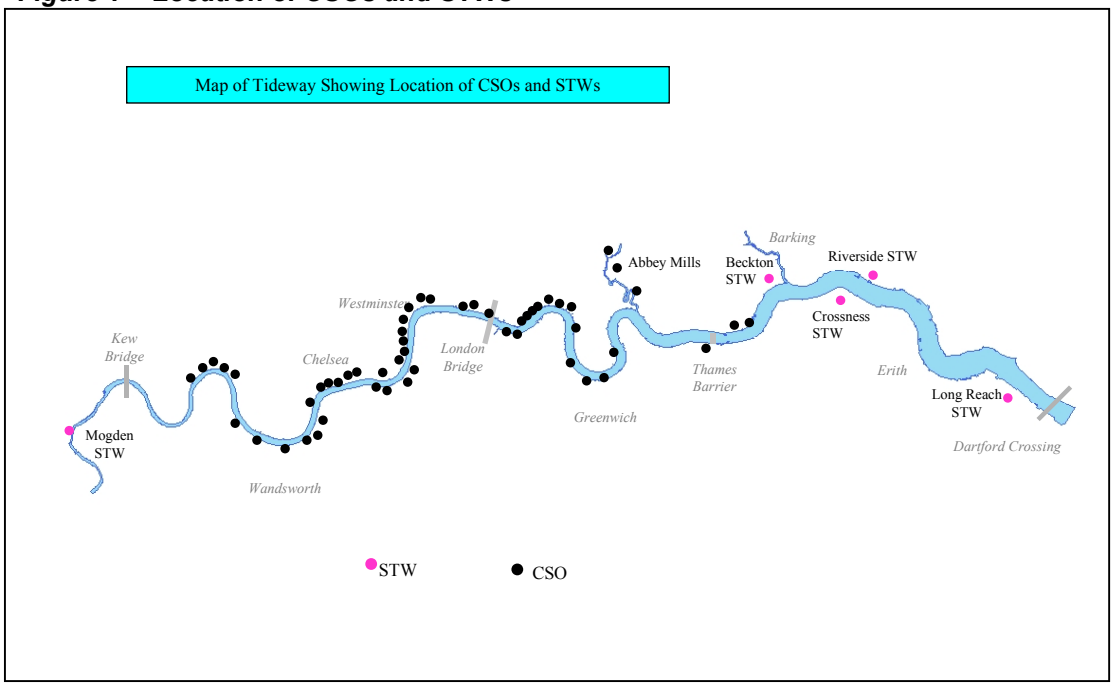
Discharges from the CSOs contain a mixture of sewage and run-off and may be very polluting in nature. They are not screened or treated, hence all the sewage-derived solid matter is discharged direct to the river.

As might be expected, the size and complexity of London's sewage system make it a special case. The original watercourses in London have long since been incorporated into the sewerage system, which means that during periods of rainfall, the massive volume of run–off generated from the large impermeable land area has to be drained to the sewers.

Over the years, societal changes and the rise in impermeable area have increased the frequency of operation of the CSOs and the quantity of storm sewage discharged, to the point where, on average, discharges from the catchment occur 60 times per year and are often caused by only moderate rainfall.

The biggest CSO discharges arise from pumping stations, some of which pump the entire contents of the sewer to the river. In these circumstances, this means that, although the sewage may be diluted to varying degrees by rainwater, everything that is in the sewer is discharged to the river. For the larger rainfall events, total storm sewage volumes in excess of a million cubic metres per event are discharged to the river.

Figure 1 - Location of CSOs and STWs



1.2 The Thames Tideway

The Thames river basin does not generate large river flows and these are further reduced by abstractions in the lower reaches of the freshwater river to be used as a potable supply for London. The estuary does not therefore receive large flows of freshwater to provide dilution and protection from pollution. As a consequence of this, there is a very slow seaward movement and water can take three months to travel through the estuary from Teddington to Southend. This makes the upper and middle reaches of the Tideway particularly vulnerable to pollution, since a polluted body of water will not be quickly flushed through the river and will exert its full effect during its residence time in the estuary. The tidal effect will move water up to 15 kms on each flood and ebb tide, but as little as half a km per day towards the sea. This can create long slicks of polluted water and also allows sewage solid material to be washed onto the foreshore during the ebb tide where it can be very conspicuous.

1.3 The Sewage Treatment Works

Water quality in the Tideway during dry weather is dominated by the discharges from five sewage treatment works operated by Thames Water Utilities, which include the largest works in the country. Although these works operate well under stable dry weather conditions, they have a limited capacity to treat the higher flows which arrive at the works during wet weather, and for historic reasons, this capacity is less than the norm for sewage works discharging to freshwater. The excess flow passes through storm tanks at the works and so receives a lower standard of treatment. These storm tank discharges are generally made at the same time as the CSO discharges and are themselves a significant contribution to polluting load. As the study proceeded, investigations into the performance of these works revealed that additional capacity was required and that improvements in both dry and wet weather performance were required if future objectives, designed to protect fish life in the Tideway, were to be met.

2. The Thames Tideway Strategic Study

The Thames Tideway Strategic Study (TTSS) was set up as a three year project to assess the environmental impact of intermittent discharges of storm sewage on the Thames Tideway, to identify objectives for improvement and to propose potential solutions, having regard to costs and benefits. Under the guidance of the Steering Group (with representatives from Thames Water, Environment Agency, Department of Environment Food and Rural Affairs (Defra), Greater London Authority (GLA), and the Office of Water Services (Ofwat), as an observer, three working groups were set up: Objectives, Solutions and Cost Benefit.

The role of the Objectives Group was to review current and likely future legislation and to consider appropriate objectives to be applied to the Tideway. Suitable standards were then to be defined, which would form a basis for the design of potential solutions. The potential solutions were tested for compliance by means of river and sewer modelling techniques and evaluated for compliance with the objectives. This work was carried out by a sub-group of the Objectives Group.

The Objectives working group comprises of representatives from

Thames Water (TW)	Howard Brett (chair), Yvette deGaris, Carl Pelling and Nick Martin
Defra	Mark Cunningham
Environment Agency (EA)	Jon Goddard, Maxine Clement
Corporation of London	Roger Watson

There were also major contributions in terms of the fishery study from Steve Colclough (EA) and Mike Crafer (TW), as well as the principal consultant (Dr Andrew Turnpenny). Paul Dempsey (Water Research Centre) and Elfed Jones (Hydraulics Research, Wallingford) were appointed as consultants for the development and running of the river quality models.

2.1 Terms of Reference

The following terms of reference for the Objectives Group were determined at the Tideway Strategy Steering Group on 25th January 2001 and were split into two complementary objectives.

Primary objective: To establish, individually and collectively, what facets of current operation make the existing CSO discharges unsatisfactory; and hence to recommend objectives to remedy the agreed problem. A range of objectives to be proposed, against which solutions can be developed and costed.

Secondary objective: To evaluate the long-term suitability of the existing quality objectives for the Tideway, and in particular, their consistency with national and international obligations and UK policy.

3. Defining the Objectives - Initial Considerations

The process of defining the objectives has been an iterative process, whereby an increasing knowledge of the operation of London's sewerage system and the corresponding relevance of the Urban Waste Water Treatment Directive (UWWTD) and Guidance, has meant objectives have had to be changed or adapted to make them more appropriate. Account has also been taken of future likely requirements imposed by the Water Framework Directive (WFD).

The Thames Tideway Strategy is working towards a broad aspirational aim:

To reduce the impact of intermittent sewage discharges and to further improve water quality in the Thames Tideway, to benefit the ecosystem and facilitate use and enjoyment of the river.

The Group considered all existing statutory requirements, which might be relevant to the achievement of these objectives; and concluded that the Urban Waste Water Treatment Directive and the Water Framework Directive were of particular importance.

3.1 Water Framework Directive

The Water Framework Directive was adopted in 2000 and transposed into UK regulations in 2004. It aims to achieve *good ecological status* or *good ecological potential* for all water bodies by 2015. However, the classification schemes that will be based on biological, hydromorphological, chemical and physico-chemical quality elements have yet to be developed.

An initial assessment of the pressures and impacts on water bodies has recently been carried out to establish the extent of risk of not achieving the objectives. An assessment of one of the pressures, Organic Enrichment, was based on concentrations of Biochemical Oxygen Demand (BOD) and dissolved oxygen (DO). The assessment demonstrated that there is a high risk that the Tideway will not be able to attain *good ecological status* without improvement.

Water bodies that are designated as heavily modified water bodies (HMWB) will be classified according to their ecological potential rather than status. This may be likely for the Thames Tideway due to the extent of flood defences that have been put in place.

Key dates for implementation of the WFD that are relevant to the Tideway are as follows:

2003 WFD transposed into UK law;
2004 Report key characteristics, environmental impact and economic analysis of water use for each River Basin District (RBD);
2008 Publish River Basin Management Plans (RBMP) for public information and consultation. Establish environmental monitoring programmes, Environmental Quality Standards (EQS) for priority substances, physico-chemical standards and reference conditions;
2009 Publish RBMPs, Designate Heavily Modified Waters (HMWs), Establish Programme of Measures (PoM - environmental, social and economic) to control the pressures that adversely effect water quality;
2012 Establish controls on discharges using PoM;
2015 First date for achievement of environmental objectives.

In the absence of a classification scheme or any WFD reference conditions, the Group has developed a set of objectives that would be required for sustainable fish populations in the Tideway.

3.2 Urban Waste Water Treatment Directive

This is the principal legislative instrument for controlling waste water discharges to the Tideway. In the absence of greater certainty regarding the future provisions of the WFD, it was considered to be of critical importance that full account was taken of the requirements of this Directive when deriving objectives for the Tideway. The overarching objective of the Directive is:

"*To protect the environment from the adverse effects of urban waste water*"

There are five key requirements that are relevant to the Tideway. The requirements and the corresponding extracts from the UWWTD are as follows:

1. **The sewerage system must convey waste water to the STWs for treatment**: *"Urban waste water entering collecting systems shall before discharge be subject to secondary treatment or an equivalent treatment."* (Article4)

2. **Sewer overflows may occur under conditions of unusually heavy rainfall:** *"Given that it is not possible in practice to construct collecting systems and treatment plants in a way such that all waste water can be treated during situations such as unusually heavy rainfall, Member States shall decide on measures to limit pollution from storm water overflows."* (Footnote)

3. **Measures shall be taken to limit the pollution from sewer overflows:** see footnote in 2 above.

4. **The STWs must perform sufficiently under all normal local climatic conditions :** *"Urban waste water treatment plants are designed, constructed, operated and maintained to ensure sufficient performance under all normal local climatic conditions"* (Article 10)

5. **The sewerage system and the measures taken to limit pollution from the CSOs, must be undertaken in accordance with the best technical knowledge not entailing excessive costs:** *"The design, construction and maintenance of collecting systems shall be undertaken in accordance with the best technical knowledge not entailing excessive costs, notably regarding:*

- *Volume and characteristics of urban waste water,*
- *Prevention of leaks,*
- *Limitation of pollution of receiving waters due to storm water overflows"* (Annex 1 A).

The UWWTD was adopted in 1991 and transposed into legislation by the Urban Waste Water Treatment (England and Wales) Regulations 1994. A guidance document (The Working Document for Dischargers and Regulators, July 1997) was also produced by the Secretary of State to assist with the interpretation and implementation of the Directive. The implications of the UWWTD for the Thames Tideway have recently been reassessed following detailed work undertaken as part of the study.

The task of the Objectives Group was to develop appropriate objectives to ensure that these specific requirements and the overarching objective of the Directive are met.

4. Performance of London's STWs

The consideration of London's sewage treatment works was not part of the original remit of the TTSS. It became clear, however, during the water quality modelling exercise (as detailed in the report of the Modelling sub-group) that improvements would be necessary at these works to achieve the dissolved oxygen standards required to protect the ecology of the river (see section 6.3.2). The Environment Agency derived suitable standards for the STWs, which will be achieved as soon as feasible.

5. Performance of London's Sewerage System

5.1 Operation of the CSOs

During dry weather, London's sewerage system collects and delivers all the waste water to the STWs, where treatment takes place prior to discharge to the river.
In wet weather, however, the system overflows direct to the river. Table 1 shows the frequency of operation of the CSOs during the summer period for 2000 and 2001; and table 2 gives details of the rainfall conditions for a number of events when the CSOs were operating. It may be concluded from these tables that the occurrence of CSO discharges is not unusual and is not confined to periods of intense or exceptional rainfall. On average, discharges from the sewerage network via the CSOs occur about 50-60 times per year, with yearly totals of about 20 million tonnes being discharged.

Table 1 - Discharges from the CSOs, July-Sep 2000-2001

July		August		September	
2000	2001	2000	2001	2000	2001
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9
10	10	10	10	10	10
11	11	11	11	11	11
12	12	12	12	12	12
13	13	13	13	13	13
14	14	14	14	14	14
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20	20	20	20	20	20
21	21	21	21	21	21
22	22	22	22	22	22
23	23	23	23	23	23
24	24	24	24	24	24
25	25	25	25	25	25
26	26	26	26	26	26
27	27	27	27	27	27
28	28	28	28	28	28
29	29	29	29	29	29
30	30	30	30	30	30
31	31	31	31		

(Source: Data taken from 5 of the largest CSOs – Lots Rd, Hammersmith, Western, Abbey Mills and Greenwich Pumping Stations)

Table 2 showing threshold rainfall that resulted in CSO discharges, total rainfall and the volumes discharged from some of the outfalls, for the summer of 2000

Date	Total Rainfall (mm) prior to Commencement of CSO Discharge	Total Rainfall (mm) of Event	Duration (hrs) of CSO Discharge	Total Volume (m3) Discharged from N. London Pumping Stations
05/07/2000	4.2	4.5	5.5	273,000
09/07/2000	4.7	7.7	6.0	604,000
10/07/2000	5.4	6.8	7.5	533,000
13/07/2000	4.2	5.1	5.0	181,000
02/08/2000	2.1	3.5	3.25	74,000
08/08/2000	6.6	14.8	11.0	1,150,000
19/08/2000	3.3	6.0	2.75	288,000
27/08/2000	4.7	5.1	1.5	98,000
28/08/2000	0.7	2.7	2.0	61,000
01/09/2000	1.7	2.7	2.5	67,000
08/09/2000	0.5	0.5	3.5	76,000
15/09/2000	3.7	38.7	No data	1,807,000
19/09/2000	1.5	8.2	4.5	882,000
24/09/2000	0.5	1.5	3.0	239,000
25/09/2000	2.4	2.5	2.0	173,000
28/09/2000	1.7	1.7	No data	69,000

(Source: Data taken from 4 of the largest CSOs north of the Tideway – Lots Rd, Hammersmith, Western and Abbey Mills Pumping Stations)

5.2 Impact of the CSO Discharges

CSO discharges can cause damage in three different ways: -

1. By reducing dissolved oxygen to a level that will not sustain healthy populations of fish and can result in fish mortality. This is also indicative of serious harm being caused to the overall estuarine ecosystem;

2. By introducing large quantities of sewage-derived solid (SDS) to the river, including grease and scum, which create aesthetically offensive conditions both in the river and on the foreshore;

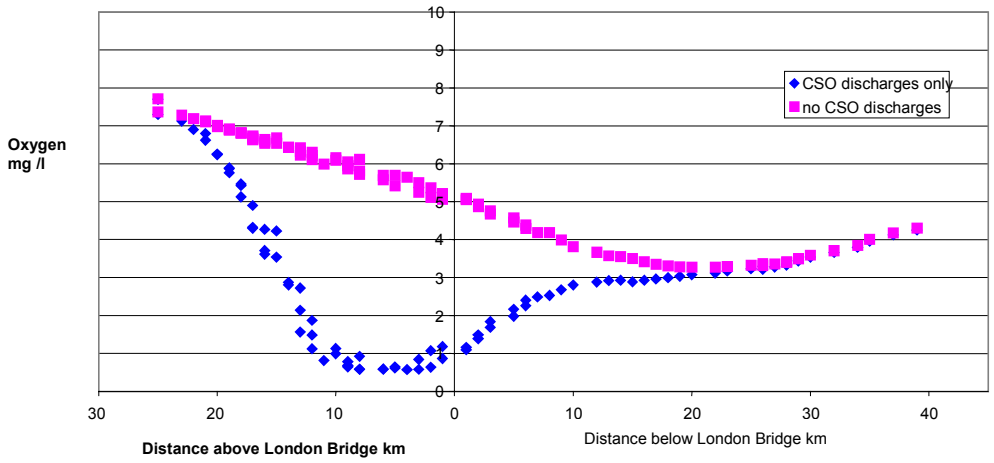
3. By introducing large quantities of pathogenic organisms into the river, which increase the health risk to river users.

Figures 2 & 3 - Overflows in operation and sewage-derived litter

Effect on Dissolved Oxygen

It has been established from results of water quality monitoring on the Tideway, over a long period of time, that the CSOs produce a widespread effect on dissolved oxygen levels, with most parts of the river being affected to varying degrees, according to the pattern of the rainfall. This is supported by recent mathematical modelling of the Tideway, using two models that have been developed as part of this project. Figure 4 shows the modelled DO profile, with and without the CSO discharges, following a severe rainfall event.

Figure 4 - Example of Modelled Event to Show Effect of CSOs on Dissolved Oxygen Two Days after Rainfall Event



Figures 5 & 6 - Effect of very low dissolved oxygen concentrations: fish kill and dead fish fry

Effect on Aesthetic Quality

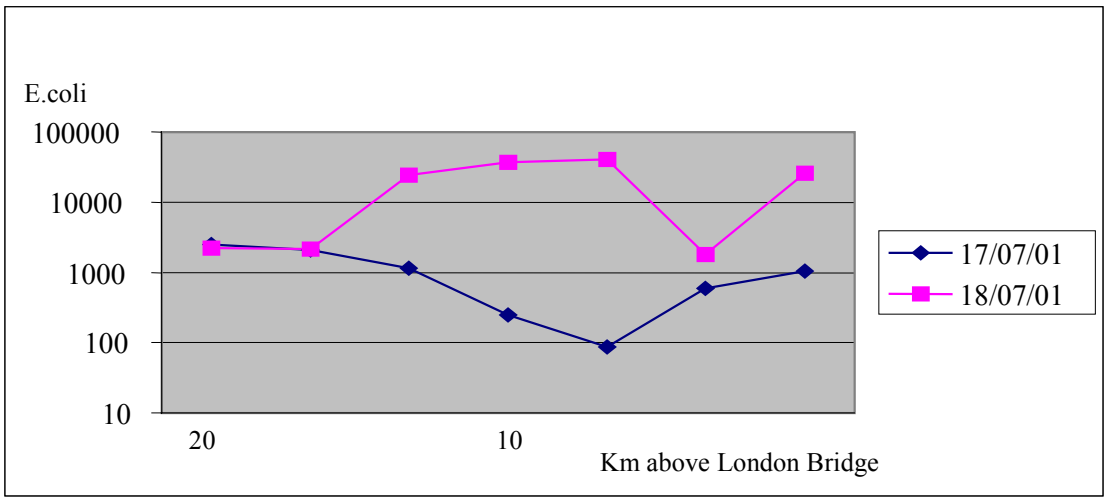
Visual observations have shown that, although there can be some differences in the degree of impact on aesthetic quality caused by individual CSOs, all discharges contain significant quantities of sewage solids. It has been calculated that approximately 10,000 tonnes of sewage derived solids (including paper, condoms, faecal material, sanitary towels and syringes) is discharged from the CSOs into the river every year, where it creates offensive slicks of sewage in the water and large deposits of solid material on the foreshore.

Most parts of the river are now accessible to the public. Tourist and commuter boats operate throughout the Tideway and there are extensive areas of high-cost waterside housing. There are still some areas that are more sensitive than others, however, and these occur particularly in the upper reaches, where there is greater public access and there is less volume of tidal water for mixing and dilution. The areas where there is a history of public complaint are mainly associated with the upper reaches above Vauxhall, the embankment, Greenwich and The Thames Barrier.

Effect on Health Risk

The principal recreational areas in the Tideway are contained in the upper reaches, above Vauxhall. Figure 7 shows the elevated levels of sewage-derived bacteria following the operation of the CSOs; and this clearly indicates an increased health risk to those exposed by virtue of leisure or work activities on the river. The plug of polluted water will move up and down with the tide by up to 15 kms. This means that discharges that occur in non-recreational areas may eventually reach areas in the Upper Tideway that support a great deal of water-based recreation. Water quality surveys have also demonstrated that even small discharges in this part of the river contribute to the risk and can cause localised problems.

Figure 7- E.coli pre/post rainfall event of 18/07/01



Figures 8 – 11: Recreational use of the Tideway

5.3 Existing Measures to Limit Pollution from CSO Discharges

For many years, Thames Water has taken steps to limit some of the polluting effects from the CSO discharges, by providing compensatory oxygenation to attempt to prevent dissolved oxygen levels falling to the point where fish mortalities could occur. This has been helpful and has been supported by the Environment Agency as a useful intermediate measure to limit some of the harmful effects caused by some of the CSOs, whilst a longer term sustainable solution is sought.

As a result of observations carried out during this study, it has become apparent that the polluting effects of the discharges extend far beyond the adverse effects on DO levels and there are no existing measures in place to limit the aesthetic and microbiological pollution derived from the CSO discharges.

6. Development of Objectives for London's Sewerage System

6.1 Assessment of CSO Discharges

The history of the frequency of operation of the CSOs and the adverse environmental effect that the discharges produce raised questions regarding the sufficiency of measures to meet the requirements of the UWWTD.

In order to gain a more comprehensive picture of the operation and impact of the CSOs, a detailed assessment was made of each of the 57 outfalls. This assessment utilised information relating to historical records, visual observations and modelling data. The detailed results of the study are provided in Appendix C, but the main conclusions are:

- Of the 57 CSOs, 36 cause significant adverse environmental impact;
- Of these, 28 discharge more frequently than 12 times per year, and 20 discharge more frequently than 36 times per year.

From this additional information, it became apparent that the principal means to achieve the environmental objectives would be to reduce the frequency of operation of the CSOs and to take more effective measures to limit pollution. A benefit of this approach would be to remove any doubts about meeting the requirements of the UWWTD.

6.2 Reduction in Frequency of Operation

The Directive acknowledges that, during situations such as unusually heavy rainfall, it might not be possible to treat all waste water and that storm overflows may occur. No definition is given in either the Directive or the Guidance as to what might be considered as unusually heavy rainfall. The occurrence of frequent, prolonged and intense rainfall in the London area is not unusual. There are, however, several rainfall events per year that are of sufficient intensity or duration to be considered as unusual. Therefore, it seems reasonable to consider "unusual" as something that might occur several times per year, but not several times per month.

Given the existing high frequency of discharges from many of the CSOs, it is necessary to reduce the frequency with which discharges occur.

6.3 Limitation of Pollution from the CSOs

The directive requires Member States to decide on measures to limit pollution derived from CSOs; and the UK provides details of what these measures might be in the Guidance document.

The Directive is not entirely prescriptive in making suggestions as to the selection of suitable measures to limit pollution. Similarly, the Guidance allows for flexibility to be used according to local conditions. Mention is made in the Directive and Guidance that measures to limit pollution might be based on:

- dilution rates;
- the capacity of the system in relation to dry weather flow;
- a certain number of overflows per year.

These measures are closely inter-related and the end result of each measure will be to reduce the volume discharged (and hence the frequency of discharge) from the CSOs and therefore to reduce the environmental impact. This is, however, a rather imprecise and indirect method of achieving an environmental objective. This could be better achieved by the

use of models to identify the required environmental standards and specify the discharge conditions necessary to meet those standards.

Appendix 8 (i) of the Guidance proposes the use of a formula for calculating minimum acceptable forward flow at overflow points in the sewerage system. This formula (referred to as Formula A) takes account of the contributing population, dry weather flow and trade effluent flow in the sewer. Although this formula is widely used as a design parameter for CSO operation, it was never intended for use in a large complex network such as London. It is of interest to note, however, that London's system fails to meet the broad principles of Formula A by a wide margin; and that to comply with the formula, would require the enlargement of every one of the 10 intercepting sewers, as well as many of the trunk sewers. This would clearly not be the most cost-effective method of dealing with the CSO problem.

Where the use of Formula A is inappropriate, section 5.5.2 of Appendix 8 (ii) of the Guidance allows for flexibility on a case by case basis. Since the principal objective of the Directive is to prevent adverse environmental impact from the discharge of waste water, it would be compatible with these aims, if the measures taken to limit pollution were to be defined in terms of an acceptable level of impact from the CSO discharges. Standards were therefore derived to cover the three areas of environmental and social impact caused by these discharges.

- to reduce the aesthetic pollution due to sewage-derived litter;
- to protect the ecology of the Tideway;
- to protect the health of river users.

6.3.1 Limitation of Aesthetic Impact from Sewage Derived Solids

An estimated 10,000 tonnes of screenable sewage derived solids is discharged by the CSOs to the Tideway each year.

The assessment of the impact of the CSO discharges showed that 35 caused significant aesthetic pollution and the Guidance states that unsatisfactory CSOs should receive screening prior to discharge in order to limit the pollution caused.

Objective: To reduce the frequency of operation and limit pollution from those discharges which cause significant aesthetic pollution, to the point where they cease to have a significant adverse impact

6.3.2 Limitation of Ecological Damage

In the absence of WFD standards, or other recognised criteria, the TTSS group developed a series of DO standards that are compatible with the achievement of a sustainable fish population in the Tideway.

The standards were developed from considerable amounts of data collected from a network of Automatic Quality Monitoring Stations (AQMS) along the Tideway that continuously record water quality information such as DO. These were derived in accordance with the recommended methodology of the Urban Pollution Management Manual, for addressing intermittent discharges, with DO concentrations defined in terms of a return period and duration.

These standards are more realistic than single percentile-based standards commonly used in setting river quality objectives and are shown below.

Table 3 DO Standards for the Tideway

Dissolved Oxygen (mg/l)	Return Period (years)	Duration (tides)
4	**1**	**29**
3	**3**	**3**
2	**5**	**1**
1.5	**10**	**1**
Note: The objectives apply to any continuous length of river ≥ 3 km. Duration means that the DO must not fall below the limit for more than the stated number of tides. A tide is a single ebb or flood. Compliance will be assessed using the network of AQMS stations.		

Suitability of these standards was confirmed by research into the dissolved oxygen requirements of a range of fish species found in the Tideway (Fawley Aquatic Research 2002/3 – Appendix A). The 4mg/l standard is set to protect fish from sub-lethal effects of hypoxia that may effect feeding, reproduction and migration.

Objective: To limit ecological damage by complying with the DO standards specified in table 3

6.3.3 Limitation of Adverse Effects on Health Risk

The section of the Tideway considered by the TTSS is not a designated water under the EC Bathing Water Directive, yet 3000-5000 people practice water-based recreation on the Tideway each week (EA reports – Appendices D and E), and it is important that due consideration is given to the protection of all river users including those working in this environment.

In the absence of any statutory standards, the following are proposed as a suitable surrogate for the protection of river users e.g. rowers, canoeists.

Table 4 Microbiological Standards

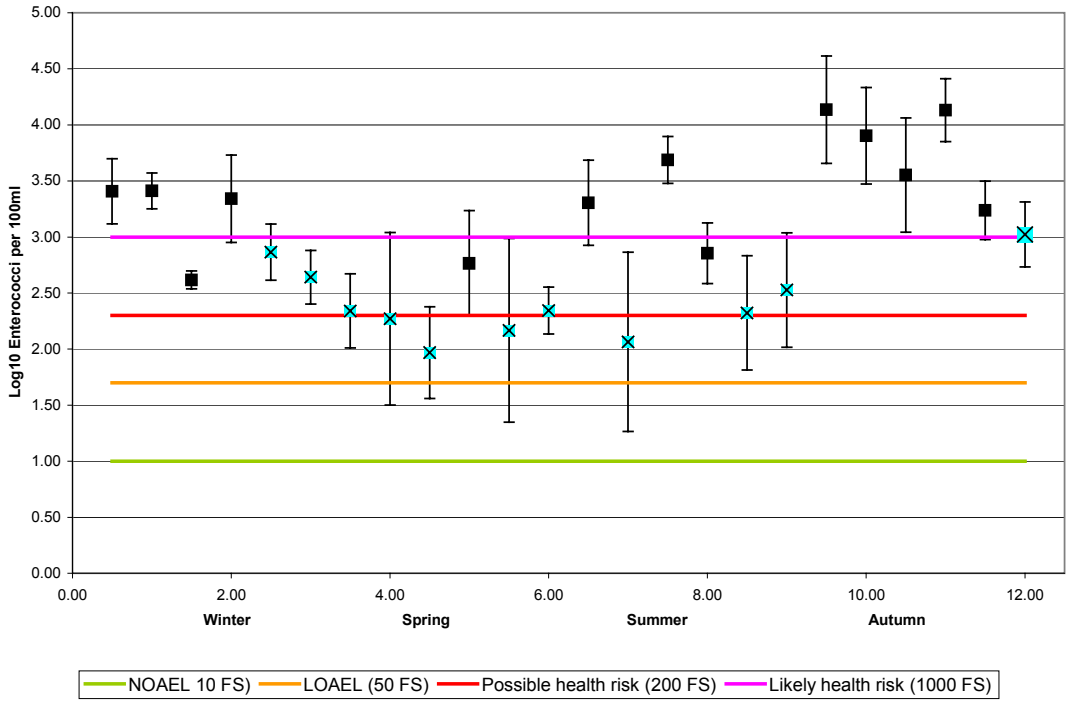
Microbiological Parameter	*Excellent Quality (Guide)*	*Good Quality (Obligatory)*
Intestinal Enterococci (I.E.) in cfu/100ml	***100***	***200***
E. coli (E.C.) in cfu/100ml *Where cfu = colony forming units*	***250***	***500***

These standards have been used to assess the current status of bacteriological quality of the Tideway and determine the number of elevated health risk days that result from the CSO discharges.

The standards bear some similarity to standards proposed by the World Health Organisation (WHO). The 200 cfu /100ml IE standard is the equivalent to the '*Possible Health Risk*' threshold proposed by WHO.

Two-weekly surveys were carried out between 1999 and 2002 to determine the impact of CSO spills on pathogen levels in the Tideway. Figure 10 shows data from surveys carried out in 2002 plotted against WHO standards. Data marked as blue squares are samples that were taken during dry periods when there were no discharges up to 2 days prior to sampling. These points fall below the '*Possible Health Risk'* threshold. This is despite the large volumes of treated sewage effluent discharging from the sewage treatment works. The black squares represent sampling occasions during wet weather, and indicate that potential health risks for people who are immersed and/or swallow polluted water is elevated as a result of CSO discharges (EA Report – Appendix B).

Figure 12 Enterococci concentrations in Tideway during 2002



Where FS is 95%ile faecal streptococci (equivalent to enterococci on y-axis) per 100ml of sample.

The surveys also demonstrated that pathogen levels remain at high risk to human health for approximately 2 days after a discharge. With weekly discharges from CSOs, this equates to approximately 120 days of 'elevated health risk' per year as a result of CSO discharges. The London Port Health Authority, which is responsible for matters concerning public health in the Tideway, has stated that "the present situation regarding the CSO discharges represents a potentially serious threat to public health."

Objective: To help protect river users by substantially reducing the number of 'elevated health risk' days following CSO discharges.

6.4 Implications of BTKNEEC

Annex 1 of the UWWTD states that ***'The design, construction and maintenance of collecting systems shall be undertaken in accordance with the best technical knowledge not entailing excessive costs (BTKNEEC), notably regarding:***

- ***Volume and characteristics of waste water,***
- ***Prevention of leaks,***
- ***Limitation of pollution of receiving waters due to storm water overflows'***

This provision is seeking to ensure that the best possible technical knowledge is used to prevent environmental damage being caused from waste water discharges, up to the point where an increase in the level of technology leads to an excessive cost compared to the lower level of technology. When considering alternative schemes, account must therefore be taken of the need to evaluate costs in the context of the technical knowledge being applied
This provision obviously only applies when there are a number of schemes to be evaluated against each other or when there is an option of enhancing a particular scheme by the use of better technology. The term "excessive cost" needs therefore to be applied as a comparison and does not provide an option to discount a scheme solely on the grounds of "high cost". It

does, however, impose an obligation to consider the costs and levels of technology associated with different options and to make an appropriate assessment using the BTKNEEC principles.

Objective: To comply fully with the requirements of BTKNEEC.

6.5 Climate Change

In order for the CSO solution to achieve compliance with all objectives throughout its intended life span, consideration has to be given to the various changes that will occur with time that might affect the ability of a solution to perform adequately. The nature of CSO discharges could alter significantly according to a range of changes, including socio-economic, demographic and climatic, which could impact on the design specifications required of the solution to meet these future changes.

The furthest ahead that sufficiently reliable climate scenarios is available is 2080, so this was set as an objective to ensure that any solution would perform adequately under these predicted conditions.

Objective: To ensure that a solution has sufficient flexibility to accommodate future changes brought about by climate and other effects.

7. Summary of Objectives

The proposed objectives can be summarised as:

- To reduce the frequency of operation of those discharges that cause significant aesthetic pollution or to limit the pollution caused, to the point where they cease to have a significant adverse impact.

To limit ecological damage by complying with the DO standards specified in table 3, which were developed from historic water quality data, supported by fish studies and based on UPM standards.

- To help protect river users by substantially reducing the number of 'elevated health risk' days following CSO discharges.

- To comply fully with the requirements of BTKNEEC.

- To ensure that a solution has sufficient flexibility to accommodate future changes brought about by climate and other effects.

Appendix

Appendix A: Experimental Studies on the Oxygen Requirements of Fish; Fawley Aquatics 2002/3

Appendix B: Impact of the CSO Discharges on Microbiological Water Quality of the Thames Tideway

Appendix C: An assessment of the frequency of operation and environmental impact of the Tideway CSOs

Appendix D: Water based Recreation in London Docklands

Appendix E: Recreational Use of the Thames Estuary