Fact File

THE TIDAL THAMES

GUARDIANS OF THE WATER ENVIRONMENT

NRA
National Rivers Authority
Thames Region

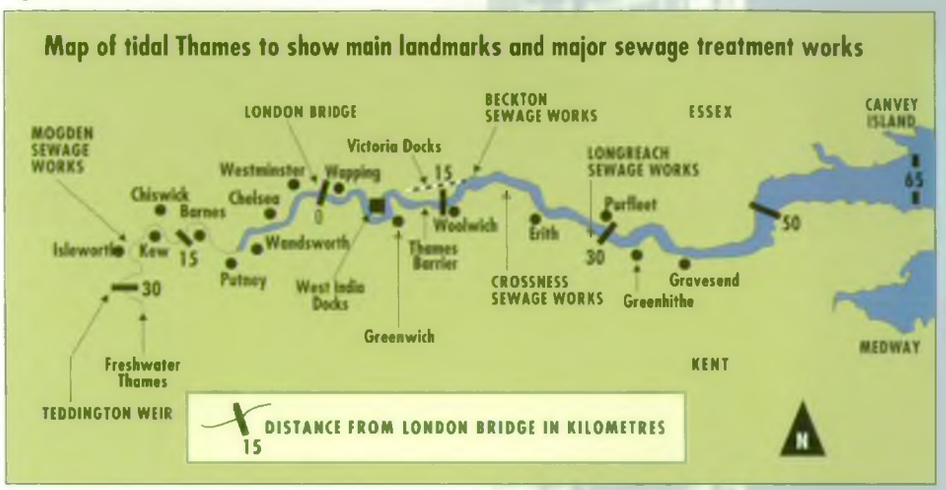
FACT FILE – THE TIDAL THAMES

This is one of a number of Fact Files which cover all the main rivers in the Thames Region of the National Rivers Authority. Due to its size and importance the Thames itself is covered by four fact files, dealing with the Upper Thames, from source to its confluence with the Windrush, the Middle Thames from the Windrush down to the Kennet and the Lower Thames from the Kennet to Teddington. This fact file deals with the Tidal Thames through London.

FACTS IN BRIEF

- The Tidal Thames extends from Teddington in West London to Shoebury just East of Southend, a total length of about 100Km.
- The width of the tideway increases from less than 100m in the upper reaches to more than 7Km at Southend.
- The Thames catchment covers an area of approximately 14,000 square kilometres with a population of over 11 million people.
- Teddington weir is the official tidal limit.
- The freshwater flow at Teddington in winter may exceed 30,000 Ml/day.
- Teddington flows are strongly influenced by abstraction from the freshwater Thames for public drinking water supplies. The Teddington flow is normally maintained at a minimum of 800 Ml/day but this may be reduced to 200 Ml/day in times of drought.
- The Thames is one of the cleanest metropolitan estuaries in the world with over 50 resident species of fish.
- Since 1964 over 110 different species of fish and 1 hybrid have been recorded in the tideway.
- Angling is free and popular where there is good access to the bank and foreshore, below London Bridge.
- The lower estuary is widely regarded as a substantial nursery ground for important commercial species of fish such as sole and bass. There are commercial fisheries for eel, sprat and sole. There is a cockle fishery to the east of Southend.
- The Thames estuary is important for recreation. In London large parks provide riverside views and leisure activities in areas like Richmond, Kew and Battersea. Recreational boating takes place throughout the estuary with contact sports such as windsurfing in the areas close to the sea.

Figure 1



- On the outer estuary the area around Southend is a popular seaside resort with 3 E.C. Designated bathing beaches.
- Despite the world decline in shipping Tilbury is still the busiest port in the UK.
- There are a number of passenger boats operating on the river with the most popular routes being from Westminster downstream to Greenwich and upstream to Kew and Hampton Court.
- In 1993 the total tonnage of cargo handled on the tidal Thames was 53.7 million tonnes.
- The tidal Thames is a very important tourist attraction, being the backdrop to many of London's most popular sites. These include Hampton Court Palace, The Houses of Parliament, Tower Bridge, Tower of London and the Cutty Sark.
- Numerous events are traditionally held on the Tidal Thames including the Oxford and Cambridge boat race and the Great River Race.

The Tidal Thames

THE NATIONAL RIVERS AUTHORITY (NRA)

Established on 1st September 1989 the NRA is an independent public body charged with safeguarding and improving the natural water environment. It is responsible for flood defence, regulating the quality of rivers and groundwaters, balancing the needs of various water users, protecting and improving fish stocks and promoting water-based recreation of all kinds. The NRA is committed to improving wildlife habitats and conserving the natural environment in all it undertakes.

FLOOD DEFENCE

One of the most important responsibilities of the NRA is the control of flooding and in the lower part of the Tidal Thames the main threat is from the sea. Defences include raised river embankments, flood gates at strategic points such as the Barking Barrier and by far the largest structure, the Thames Barrier. The Thames Barrier, which was completed in October 1982, spans the 520 metre wide Woolwich reach and consists of 10 separate movable steel gates, each pivoting and supported between concrete piers and abutments which house the operating machinery. During the first ten years of operation, the Barrier was closed eleven times to protect London.

The Thames Barrier

WATER QUALITY

Pollution control staff obtain water quality information from nine automatic monitoring stations sited strategically between Kew and Purfleet, see figure 2.

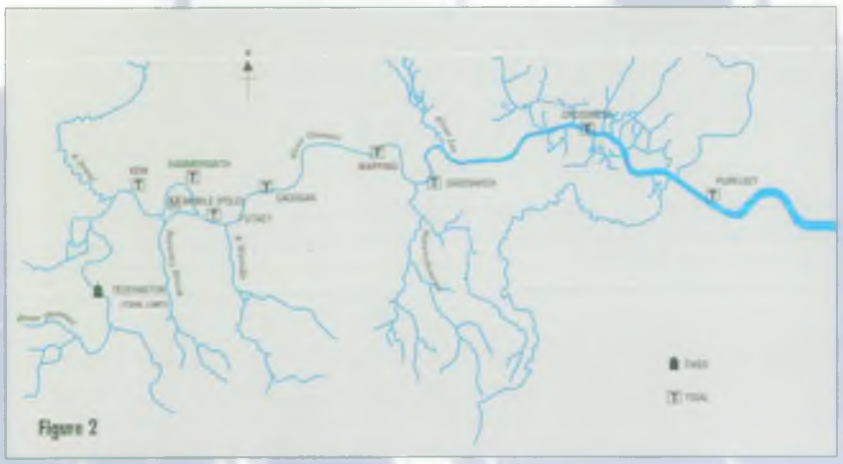


Figure 2

Data on dissolved oxygen, temperature and conductivity is collected continuously via a telemetry system by computers at the authority's offices in Crossness and Reading. This information can be displayed on a screen. In addition, manual sampling is undertaken using a survey launch. About 20 sites along the tideway are sampled weekly in the Summer and fortnightly in the Winter for a broad range of determinands. In addition 6 key sites are sampled monthly for heavy metals, organic pollutants and other persistent chemicals.

Sediment samples are also taken at several sites throughout the estuary annually.

During the bathing season, from May to September the NRA regularly samples the bathing water at the 3 bathing beaches in accordance with the European Community Bathing Water Directive. Bathing water quality sample results can be obtained from Southend-on-Sea Borough Council or the NRA. The NRA also monitors recreational waters on the coast which have been identified as bathing areas but are not formally identified under the Bathing Water Directive.

Beach sampling

FLORA AND FAUNA

NRA Biology, Fisheries and Conservation staff work closely together on the tidal Thames, particularly in the area of habitat protection and enhancement, where responsibilities both compliment and overlap with each other.

Within London the River Thames changes from a freshwater river to an estuary of international importance. The plants and animals that inhabit the river reflect this change, resulting in a wide variety of species and habitats to be found in this continuous corridor, making the tidal Thames a unique habitat resource within the centre of London.

Biology

Biologists regularly sample the animal and plant communities of the river to assess the effect of pollutants on the environment. The diversity and number of invertebrate animals (worms, snails, shrimps, etc) in the river reflects the overall water quality and habitat variety of the tidal Thames. Work is being done to help us understand more fully how the study of these small animals can show the effects of both development and pollution on the river.

The invertebrate distribution of the Thames estuary closely reflects the changes in salinity and the habitat diversity of the estuary. More than 350 freshwater, estuarine and marine macrofaunal species have been recorded over recent years. In the upper Thames estuary typical freshwater species such as insect larvae and molluscs occur with decreasing diversity downstream attributed to a reduction in habitat diversity and increasing saline penetration. In the mid Thames estuary worms are dominant with a downstream sequence of species associated with salinity. Typical estuarine species such as the crustacean *Corophium volutator* and the polychaete worm *Nereis diversicolor* are also present, particularly on the inter-tidal mud banks. The outer estuary is an area of brackish water to full seawater salinity and supports the greatest variety of invertebrates with polychaete worms, crustaceans, molluscs, sea anemones and sea urchins being the most common.

Fisheries

The estuary plays a crucial part in the life-cycle of many fish and acts as an important nursery area for many marine and estuarine species, such as plaice, bass, sole, mullet, flounder and smelt, by providing a rich food source and protection from predators.

Sorting sample fish from the Tidal Thames

Fisheries and Biology staff conduct surveys of the fish in the tidal river in order to assess the health, diversity and number of fish. These produce information on contaminants within the fish tissues, the prevalence of disease and of the general community structure. This information contributes to the monitoring of water quality and habitat and provides vital information upon which decisions on the maintenance, development and improvement of the fishery are based. A biannual survey is conducted at six key sites in May and September along with fortnightly surveys of the cooling water intakes at Tilbury Power Station.

The principal species of fish in the upper river from Teddington to Battersea are those found in the freshwater Thames, with dace and roach dominant. Of the more marine species, sole, whiting and sprat are common in the river below Dartford. Many estuarine species show marked seasonal pattems in their movements. In the early spring smelt travel up river to Wandsworth to spawn on gravels. These are followed by large numbers of flounder fry which ascend right up to Teddington. Then come elvers or young eels. Later in the summer, waves of bass fry move up as far as Chelsea, along with juvenile and adult thin lipped grey mullet.

The smelt is a fastidious species, generally in decline throughout Western Europe. The contrasting strong recent recovery of the species in the Thames gives this population an important conservation status and a role in quality monitoring.

Conservation

The fauna within the channel has expanded with improvements in water quality, with species such as mute swans, great crested grebes, cormorants and kingfishers all found on the river, with cormorants and shelduck roosting on the numerous jetties downstream. The numerous islands also provide refuges for many of these species, as well as containing areas of important wet woodland.

Inter-tidal mudflats along the lower reaches provide valuable feeding areas for a variety of bird species such as oystercatcher, dunlin and redshank, while the shingle beaches upstream are utilised by species such as carrion crow, black-headed gull, heron and coot.

Areas of natural bank contain a variety of habitats important for birds, fish and invertebrates such as reedbeds and relic saltmarsh. Much of the river has been embanked and although not as valuable, can still contain some unusual plant species such as petillary-of-the-wall and hemlock water dropwort. Further downstream the grass flood embankments provide a valuable habitat for butterflies, crickets and more unusual plants.

There are a variety of important adjacent habitats which are dependent on the Thames. These include grazing marshland at Rainham, relic watermeadows at Richmond and areas of open water at Thamesmead. NRA staff are also carrying out a programme of habitat enhancements, including the establishment of marginal reed beds.

Development Pressures

Effective water quality management will help to protect and further encourage the major ecological resource which has developed in the Thames in recent decades. However, development pressures can threaten the resource by habitat degradation. Many riverside developments seek to involve some encroachment onto the foreshore, which provides rich and diverse habitats for fish, birds, invertebrates and plants. As statutory consultees in planning control, the NRA will seek to protect and enhance the ecological resource. Major encroachments will tend to be resisted on flood defence and environmental grounds. With minor issues, there may be some scope for mitigation to offset any loss of foreshore.

Tidal creeks which exist at the mouths of the tributary streams provide unique habitats for flora and fauna and act as important refuge areas for fish life. Today, many of these creeks exist against a background of industrial decay. Often the public perception is that these creeks contain nothing of value to protect. Many developers view the economic regeneration of these areas as necessarily involving the installation of a barrage at the creek mouth. Experience has shown that this can have undesirable environmental consequences and may not achieve the goal of assisting regeneration. A more sensitive approach can realise regeneration hand in hand with protection and enhancement of these increasingly rare features.

DISCHARGES

All discharges are regularly monitored. These include some of the largest sewage treatment works in Europe at Mogden, Beckton and Crossness, which serve the population of London. We also monitor two paper mills at Northfleet and Dartford, a board mill at Purfleet and a sugar refinery at Silvertown.

Monitoring of the two oil refineries at Stanford Le Hope and water used for cooling purposes at Thameside power stations comes under Her Majesty's Inspectorate of Pollution (HMIP).

Beckton sewage treatment works outfall

The following are the main consented discharges into the Tidal Thames:-

DISCHARGE	AVERAGE FLOW (CUBIC METERS/DAY)	TYPE OF EFFLUENT
River Thames		
Mogden STW	420,000	SewageEffuent
Kew STW	46,000	Sewage Effluent
Shell Centre	9,000	Cooling Water
British Telecom	23,000	Cooling Water
Tate and Lyle	41,000	Trade
Beckton STW	1,000,000	Sewage Effluent
Crossness STW	550,000	Sewage Effluent
Purfleet Board Mills	6,000	Trade
Long Reach STW	190,000	Sewage Effluent
Van Den Berghs	30,000	Cooling Water
Cory Hall Aggregates	7,200	Trade
Scott Ltd	12,600	Trade
Tilbury STW	10,700	Sewage Effluent
Gravesend STW	4,200	Sewage Effluent
Canvey Island STW	5,300	Sewage Effluent
Southend STW	36,500	Sewage Effluent
Ingrebourne		
Riverside STW	110,000	Sewage Effluent
Dartford Creek		
AR-JO Wiggins Carbonless Papers Ltd	10,000	Trade
Mucking Creek		
Standford Le Hope STW	4,400	Sewage Effluent
Pitsea Creek		
Basildon STW	9,500	Sewage Effluent
Benfleet Creek		
Benfleet STW	6,100	Sewage Effluent
HMIP CONTROLLED DISCHARGES TO THE THAMES		
Shell UK Ltd		
4 discharges	310,500	Trade, Cooling + Surface Water
Mobil Oil Co.		
6 Discharges	216,000	Trade, Cooling + Surface Water
Littlebrook Power Station	5,042,710 *(Max Volume)*	Cooling Water
Tilbury Power Station	2,727,561	Cooling Water
Greenwich Power Station	2,273	Cooling Water
Lots Road Power Station	285,747	Cooling Water

Sewage Treatment Work STW flows are dry weather flows.

WATER QUALITY OBJECTIVES

Water quality objectives have been set for the tideway and are outlined below. The tideway is split into three reaches to take into account the transition from the freshwater to the marine environment. Each reach has a different salinity range and supports different biological communities. All three reaches must be of suitable quality to allow the passage of migratory fish, including salmon.

The upstream reach, from Teddington to Battersea must maintain a freshwater coarse fishery; the middle reach from Battersea to Mucking, must support an estuarine fish population and a commercial eel fishery and the third reach from Mucking to the sea must maintain a marine fishery and EEC Designated Bathing Beaches.

The tidal creeks are equally important and their objectives are compatible with the adjoining tideway.

From these objectives a series of chemical and biological standards are derived (see figure 3) and compliance with these standards should ensure that the objectives are achieved. Compliance for the upper and most of the middle estuary is assessed using data from the Automatic Quality Monitoring Stations, while the seaward section of the river is assessed using samples obtained using a boat.

POLLUTION AND CLEAN UP OF THE TIDEWAY

The Thames suffered from severe pollution for many years. It was a thriving salmon river once with records showing up to 3000 fish per year being sold in London fish markets as late as 1800. Until recently the last salmon recorded upstream of London Bridge was caught in 1833.

London's population increased dramatically during the 19th Century from 1.25 million in 1820 to 4.75 million in 1880. Britain's industrial output also expanded rapidly dealing with about a third of total world trade at its peak. London dealt with a large proportion of this.

In the early part of the 19th Century most of the waste from London's population was discharged into cesspools, the contents of which were periodically removed and used as fertiliser on agricultural land. The industrial revolution was well under way and an increasing number of factories, slaughter houses, tanneries and other industries appeared on the banks of the Thames and its tributaries. This and the steadily growing population led to an increase in pollution from industrial wastes and overflowing cesspools. Gas works were a particular problem due to the toxic nature of their by-products. Two key factors spelt the final destruction of the Thames, the introduction of the water closet which dramatically increased the volume of water-borne waste and the abolition of cesspools by an Act of Parliament in 1843. This meant that all the waste from London's population was discharged untreated into the Thames. Water was still being abstracted from the Thames through London for public consumption and waterborne diseases like cholera were rife. In 1849, 14,000 people died of cholera. By then the fish had disappeared and the London reaches of the river were in a dreadful state.

The story of the clean up begins in the mid 19th Century. In the summer of 1856 a heat wave occurred and the appalling smell from the river caused so much discomfort to Members of the Houses of Parliament that in an effort to counteract the smell sheets soaked in disinfectant were hung over the windows. This prompted Parliament into action. In 1857 the Thames Conservancy Act founded the Thames Conservancy with pollution prevention powers from Staines to the North Sea. Its powers did not extend to the control of sewage disposal. This was dealt with by a system of intercepting sewers, designed by Sir Joseph Bazalgette, completed in 1874. Running either side of the river they carried most of London's sewage eastward to two large disposal works, where the sewage was discharged to the Thames on the ebb tide from large storage tanks.

In central London the state of the river greatly improved. However, down river in the vicinity of the outfalls the river was in an unsatisfactory state and big mud banks were building up. In 1878 the Thames pleasure steamer Princess Alice sank after a collision in the vicinity of the Beckton outfall and an enquiry into the great loss of life concluded that the deaths had been accelerated by the putrid state of the water. A Royal Commission set up in 1882 resulted in new treatment

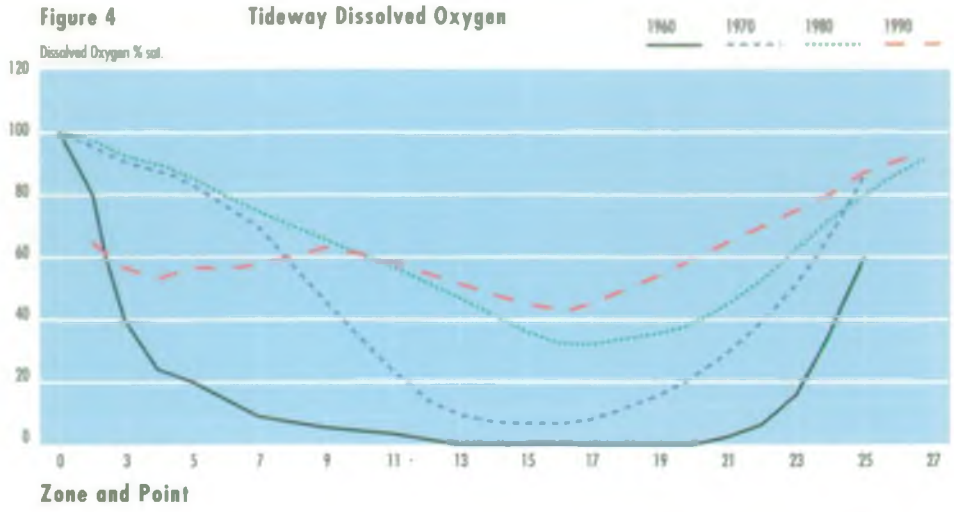
CHEMICAL STANDARDS		BIOLOGICAL STANDARDS
IN ANY QUARTER - D.O. 40% FOR 80% TIME, D.O. 10% FOR 95% TIME, MINIMUM D.O. 5% SAT. MAXIMUM TEMPERATURE 28°C. COMPLIANCE WITH EC DANGEROUS SUBSTANCES DIRECTIVE, DAUGHTER DIRECTIVES & RED LIST STANDARDS.	TEDDINGTON TO BATTERSEA	SELF SUPPORTING DACE FISHERY AS INDICATED BY PRESENCE OF FISH OF THE YEAR. BMWP SCORE GREATER THAN 25.
IN ANY QUARTER - D.O. 30% FOR 80% TIME, D.O. 10% FOR 95% TIME, MINIMUM D.O. 5% SAT. MAXIMUM TEMPERATURE 28°C. COMPLIANCE WITH EC DANGEROUS SUBSTANCES DIRECTIVE, DAUGHTER DIRECTIVES & RED LIST STANDARDS.	BATTERSEA TO MUCKING	MINIMUM OF 8 SPECIES OF FISH TO BE IDENTIFIED DURING POWER STATION INTAKE SURVEYS. DATA FROM COMMERCIAL EEL RETURNS TO BE EXAMINED AS A POTENTIAL FUTURE STANDARD.
IN ANY QUARTER - D.O. 60% FOR 80% TIME, D.O. 10% FOR 95% TIME, MINIMUM D.O. 5% SAT. MAXIMUM TEMPERATURE 28 °C. COMPLIANCE WITH EC DANGEROUS SUBSTANCES DIRECTIVE, DAUGHTER DIRECTIVES, BATHING BEACH AND BATHING WATERS DIRECTIVES & RED LIST STANDARDS.	MUCKING TO SEAWARD LIMIT	SUITABLE STANDARDS TO INCLUDE MEASURE OF COMMERCIAL FISH CATCHES AND PROTECTION OF MARINE NURSERY GROUNDS TO BE EVOLVED.

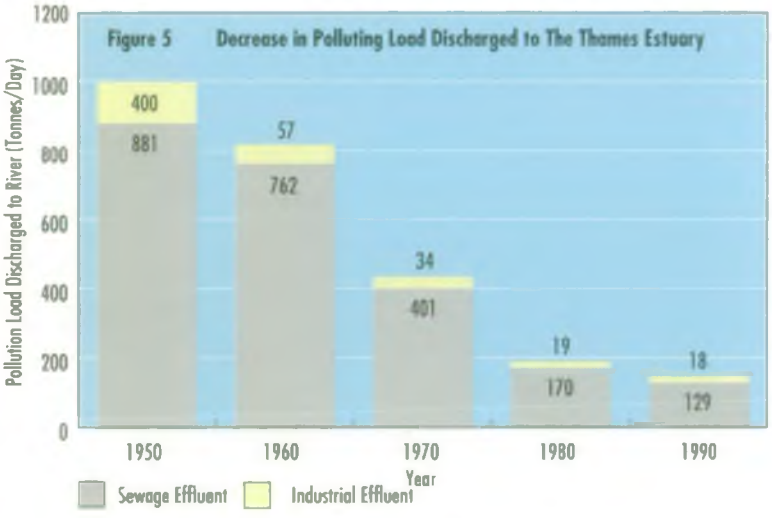
Figure 3

methods being employed at Beckton and Crossness, involving the settling out of solid matter from the sewage effluent and its disposal at sea.

The improvement was only temporary. After the First World War (1914 - 1918) the quality of the Tideway began to decline as London's population and industrialisation continued to increase. During the Second World War (1939 - 1945) bomb damage to sewers and sewage treatment works throughout London led to further pollution problems which were made worse due to the widespread use of non-biodegradable detergents. By the 1950's, the combined effect of sewage effluent, industrial discharges, thermal pollution from power stations and gas works and non-biodegradable detergents, produced a river that was virtually dead. Water quality was so poor from 1920 - 1964 that fish were absent from Fulham to Tilbury.

Figure 4 **Tideway Dissolved Oxygen**





In 1949 the Thames Survey Committee, set up by the Water Pollution Research Board at the request of the Port of London Authority, began an investigation into siltation and pollution of the Thames. Then in 1951 Professor A J S Pippard chaired a government commissioned study of the polluted estuary. As a result of these investigations pollution of the Tideway was more fully understood. The Thames Survey Committee identified the need for an improvement of the main sewage works and the Pippard study concluded that the water quality of the Thames should be improved to enable migratory fish to pass through. It recommended a minimum dissolved oxygen concentration of 10% which was achieved in 1966.

In 1964 a greatly enlarged new works was opened at Crossness, and similar work at Beckton was completed in 1974. Improvements to the sewage works, the diversion of some industrial discharges away from the river and the introduction of biodegradable detergents gradually brought about a cleaner river and the return of salmon to the Thames in 1974. See Figures 4 and 5.

In 1979 the Thames Salmon Rehabilitation Scheme commenced. This involved the introduction of young fish into the freshwater river and the construction of passes at weirs throughout the lower Thames to allow returning salmon to reach spawning grounds. Returning adults are trapped and recorded at Molsey Weir before proceeding upstream. In 1993 there was a record return of 338 salmon.

TIDEWAY MANAGEMENT TODAY

The presence of abundant fish populations in the previously polluted reaches of the river has highlighted the need for careful management of river water quality, particularly over the summer months. The main factors influencing water quality during this time are freshwater flows at Teddington weir, sewage works effluent quality, water temperature and storm sewage inputs. So following privatisation of the water industry in 1989 a formal operating agreement between Thames Water Utilities and the NRA was negotiated.

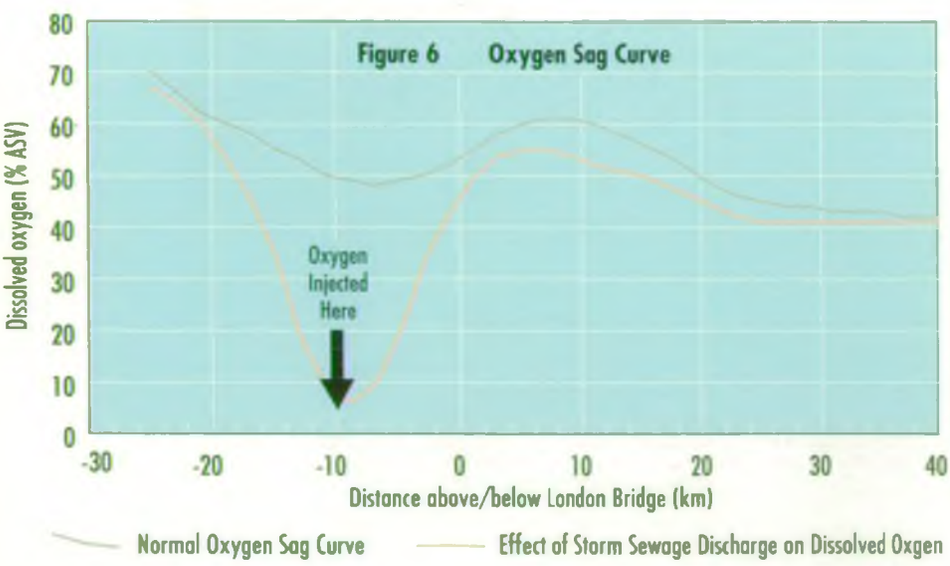
The most significant factor in managing water quality is now the massive additional organic loads from storm sewage overflows during the summer. London's sewerage system is based on a network designed in the mid 19th Century and its hydraulic capacity is inadequate to cope with the flows generated by heavy rainfall. Therefore, at times of high rainfall, the tidal Thames receives a large polluting load from more than 20 storm sewage outfalls situated between Chiswick and Beckton. There is also an additional polluting load discharged from the sewage works and fresh water tributaries. The organic material in these discharges is oxidised by bacteria in the river. When the freshwater flows are low and provide little dilution, the oxygen is rapidly removed. This results in the development of an acute oxygen "sag" in the reach of the river where the storm sewage was discharged.

(See figure 6). In the most severe circumstances, generally after summer storms, the oxygen concentration may fall to near zero, which results in fish deaths.

The cost of improving London's sewage system to eliminate the storm sewage problem would be hundreds of millions of pounds. This, and the considerable engineering problems involved, meant that alternative measures had to be sought.

The direct injection of oxygen was the only practicable method of ensuring that oxygen was supplied at the right time and at the right location. A prototype mobile oxygen injection vessel was launched in 1980, using the hull of a Thames Barge. This vessel, known as "Thames Bubbler", utilised equipment and technology supplied by British Oxygen Company to extract oxygen from the air and inject it into river water. This prototype had an output of 10 tonnes of oxygen per day and had to be towed into position by tugs. Operational experience soon established the need for a purpose built vessel with greater oxygen output and manoeuvrability. As a result the new Thames Bubbler (on front of fact file), with overall dimensions of 50.5 metres by 10 metres, a gross tonnage of 592 tonnes and costing £3.5 million came into operation in 1989. Owned by Thames Water Utilities, this vessel has an output of 30 tonnes of oxygen per day and average operating costs of £0.25 million/year.

In addition to the use of the Bubbler, the operating agreement imposes improved effluent quality standards for the major sewage treatment works between 1st May and 31st October to reduce the effective oxygen load on the Tideway. It also allows for the suspension of abstraction by Thames Water Utilities in order to increase freshwater flows over Teddington weir to counter the effect of storm sewage.



The first indication of a storm sewage problem is the development of a sag on the dissolved oxygen plot produced by automatic water quality monitoring stations. The development and movement of this sag can be closely monitored using the computer software. The Thames Bubbler can be deployed at a few hours notice if it seems likely that oxygen concentrations will fall to critical levels. Once the Thames Bubbler is operating, its deployment is controlled by a NRA scientific officer using information from the pollution operation room and on-board dissolved oxygen sensors. Oxygen is injected at the lowest point of the sag and it's movement with the tides is closely followed to ensure oxygen is injected where it is most required.

In 1989 the Bubbler was deployed on 34 days, in addition to storm events, due to the failure of major STW's to decrease their organic loads sufficiently during the summer. In 1993 it was deployed only once, partly due to the fact that 1993 had a drier and cooler summer. Since the Bubbler came into operation in 1989 no large scale fish mortalities have occurred on the Tideway.

During dry periods in the Summer when the river is particularly vulnerable, the Thames Bubbler may be deployed as a pre-emptive measure if heavy rainfall is anticipated. In this context, a duty officer will supplement river quality information with rainfall warnings from the London Weather Centre and rain radar information from the National Rivers Authority. The rain radar system also gives access to information from a wide network of rain gauges throughout the Thames Region which enables rainfall in sensitive parts of the catchment to be monitored. When gauged rainfall in any catchment totals 20mm or if 10mm of rain is recorded in 1 hour the flood control group operates a 24 hour notification system.

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Produced by The Design Quorum, Beaconsfield 01494 670700 Job No. 7247.
TH/6/95/ZK/AOML