

The Thames Barrier project pack 2010



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Who we are and what we do

The Environment Agency is the biggest organisation protecting and improving the environment in England and Wales. We have around 12,000 staff and a budget of almost £900 million each year. We are a public body. Around 60 per cent of our funding comes from Government and most of the rest comes from environmental permits and licence fees we collect from businesses, industry and individuals. For example, companies that take water out of the ground and people who enjoy our rivers and lakes for boating or fishing, all need to be registered with us and pay a licence fee.

We have regional offices across England and Wales working closely with other regional bodies. We also have area offices that work with local authorities and community groups to tackle local environmental issues as they happen. We are independent but we work closely with Government to get the best possible results for the environment.

Our work includes:

- Protecting people from flooding – last year we increased flood protection for around 30,000 properties by building or improving flood defences.
- Working with industry to protect the environment and human health – since 1990 we have reduced the amount of sulphur dioxide released into the air by 75 per cent. This is important because sulphur dioxide can create acid rain and damage people's health.
- Concentrating our effort on higher-risk businesses – such as those that run potentially hazardous operations or whose environmental performance isn't up to scratch.
- Helping business use resources more efficiently – over half of the waste produced by businesses we regulate could potentially be put to other uses, including recycling and producing energy.
- Taking action against those who don't take their environmental responsibilities seriously – every year we bring hundreds of offenders to justice and collect millions of pounds in fines.
- Looking after wildlife – every year we complete around 400 projects to improve the environment for threatened species. For example over the last 25 years there has been a six-fold increase in the number of places otters can be found in England.

- Helping people get the most out of their environment – one of the ways we do this is by selling over a million rod licences a year. All the money we raise from this goes straight back into improving fish populations and the places where people fish.
- Working with farmers – to tackle diffuse pollution we can't see as well as adding to the beauty of the countryside.
- Restoring rivers and lakes – we help to improve the quality of inner city areas and parks.
- Influencing and working with Government, industry and local authorities – we help to make the environment a priority for everyone.

Managing flood risk

Nobody can completely stop flooding, but it is the responsibility of the Environment Agency to reduce the risk flooding poses to people who live and work near rivers and the sea.

Flood warning

We are committed to helping people prepare for, respond to and recover from flooding. As part of this we offer a free flood warning service – Floodline Warnings Direct.

Simple advice on what to do, before, during and after a flood is also available. Sign up for Floodline Warnings Direct by calling 0845 988 1188 or visiting our website www.environment-agency.gov.uk/flood

Flood response

During a flood we:

- advise emergency services and other professional partners what areas are likely to flood and when
- issue flood warnings
- operate and maintain our flood defences, including the Thames Barrier

The Importance of London's River

The River Thames is not, perhaps, one of the most imposing rivers; it has no rapids, no precipitous falls, no geographical eccentricities. But it has character, and there are few others that can compare with it in that respect, or many others.

The Thames happens to be the greatest river in the world, not because of its size, but because of its importance to London. The world's biggest centre of population; to Great Britain, an island nation which depends for its means of living on sea communications, and to the world as a whole because it is London's river without which London would never have made its mark on history, or in international trade and commerce.

The secrets of the Thames are not displayed openly, they must be sought out, or discovered by accident, you can walk down to the river at any point and find something to admire, or to question; but to understand its magic, or at least appreciate its fascination to the full you must embark upon the river, and learn the wonder of its ways.

The banks of the Thames teem with historical places and buildings, all the way downstream from Hampton Court to the Tower of London, and the architectural wonders at Greenwich. All these buildings can be visited and inspected individually from the land; but only from the river itself can you discover how history, art, accident and commerce made London what it has grown into over the centuries.

History and architecture, however, form only part of the fascination of London's river. They lie on its banks, while the ebb and flood of the tide bring living history before your eyes; for this little river is one of the main traffic arteries of Great Britain, it is an international highway; and it is the largest port in the world.

(from "London's River and Guide to the Middle Thames"
W. B. Caisley, 1954)

The Thames

The areas close to the River Thames have always been vulnerable to flooding. Following the human colonisation of the Thames Valley the river has also suffered the ill-effects of pollution.

People have lived in the Thames Valley for over 400,000 years, with the river at the heart of economic growth throughout. The Romans, Vikings and Anglo-Saxons all left their mark, and as London grew in importance, successive generations left a legacy in the form of great palaces, churches, bridges and centres of commercial activity.



There have been reports of floods in London dating back as far as Anglo-Saxon times. In 1236 the river overflowed so much it was reportedly possible to row boats into Westminster Hall. Several hundred years later, in 1663, the diarist Samuel Pepys wrote about 'the greatest tide that ever was remembered in England to have been in this river, all Whitehall having been drowned.'

Pollution of the Thames has been a problem since Medieval times. However, during the Industrial Revolution an increase in the number of factories and a growing population led to dramatic scenes of overflowing

cesspits and problems from industrial waste. More and more waste went directly into the river untreated and by 1849, fish had disappeared from the tidal Thames. At that time, water was still being taken from the Thames for the public to drink. The contaminated water soon caused a cholera outbreak which spread throughout London and killed thousands of people. In 1858 there was a heatwave, and the disgusting smell from the Thames caused uproar in the Houses of Parliament – an event known as 'The Great Stink'. Finally, some action was taken and a new network of sewers proposed by Joseph Bazalgette was made a reality.

History of London and the Thames

The River Thames may take its name from the Sanskrit Tamas meaning 'dark' as its waters are often dark and cloudy; another school of thought is that it is named after the Roman Tam meaning 'wide' and Isis meaning water.

400,000 BC

Archaeological finds show that the Thames Valley was probably first inhabited 400,000 years ago by Neolithic settlers. Farming and fishing were their main occupations.

AD 43

The Romans built the first man-made crossing of the river, a wooden bridge, near the site of today's London Bridge. They also built a fort where the Tower of London now stands. The river at this time was slow moving, wider and had marshy banks.



AD 60

Boudicca, Queen of the Iceni, an East Anglian tribe, began a revolt against Roman rule in London. London was burnt to the ground.

604

The first St. Paul's Cathedral was founded on the site now occupied by the present one. This wooden church was established by King Ethelbert of Kent as home to the first bishop of the East Saxons.

870

Viking longships landed and advanced up the Thames as far as Reading, taking possession of farms and villages by force. This Danish advance was halted by Alfred the Great, King of Wessex.

1016

During his reign, the Danish King Canute built a Royal residence on 'Thorney Island'. The area, now known as Westminster, is the site of the Palace of Westminster which contains the Houses of Parliament and the Big Ben clock tower.

1080

Following the defeat of the English King Harold at the Battle of Hastings in 1066, William the Conqueror began building the Tower of London, to assert his authority and proclaim his physical power and prowess. Some of the building stone was specially imported from William's native Normandy.

1099

One of the earliest records of a flood in London was reported in the Anglo Saxon Chronicle: 'on the Festival of St Martin the sea flood sprang up to such a height and did so much harm as no man remembered that it did before. And this was the first day of the new moon.'

1176

The first stone London Bridge was built just metres away from the original Roman bridge across the Thames. It remained the only one in London until 1750. As the bridge was narrow and busy, travellers found it much easier and quicker to hire boatmen to row them across the river.

1236

John Stow wrote in the Survey of London: 'In the year 1236 the River Thames, overflowing its banks, caused the marshes all about Woolwich to be all at sea wherein boats and other vessels were carried by the stream, so that besides cattles, a great number of inhabitants there were drowned, and in the Palace of Westminster men did row with wherries (rowboats) in the midst of the Hall'.

1245

Henry III began his lifetime work of rebuilding Westminster Abbey in the new Gothic style, intending it as a shrine to the memory of Edward the Confessor, who built the original church on this site.

1397

Richard Whittington – known as Dick Whittington – was appointed Mayor of London.

1477

William Caxton made history when he printed the first book in England on his new printing press near Westminster. The book was an edition of Chaucer's *Canterbury Tales*.

1513

London grew in importance and became a centre of trade and governance under Tudor rule. Henry VIII established the Royal Dockyards at Deptford and Woolwich for building and repairing warships. He chose these sites as they were close to the Tower of London and his palace in Greenwich.

1605

Catholic conspirators including Guy Fawkes planned to blow up the Houses of Parliament when they opened on 5 November 1605. Known as the 'Gunpowder Plot', it was an unsuccessful attempt to kill the Stuart King, James I.

1665

The Great Plague outbreak swept throughout London. It is thought to have been caused by diseased fleas carried on rats. The rats were attracted by city streets filled with rubbish and waste, especially in the poorest areas. Around 75,000-100,000 people died from the pandemic – up to one-fifth of London's population at the time.

1666

The Great Fire of London started in the shop of the king's baker in Pudding Lane. Although only eight lives were lost, over 13,000 buildings, including the old St. Paul's Cathedral, were destroyed.

1683

The most celebrated Frost Fair was held on the frozen River Thames, complete with ox-roasting, music, performing animals and stalls.

1750

Westminster Bridge, the second stone bridge to be built across the Thames was completed. The shops and houses on London Bridge (which had been the only bridge across the river for about 600 years) were also pulled down to ease movement.

1833

In medieval times, salmon from the Thames were a plentiful and cheap food source. However, increasing pollution led to their decline and the last known naturally spawned salmon were caught in the Thames in 1833.

**1851**

The year of the Great Exhibition in London organised by Prince Albert with the support of Queen Victoria. It was conceived to symbolize the industrial, military and economic superiority of Great Britain at the time.

1858

During a particularly hot summer, 'The Great Stink' caused by the disgusting

smell from untreated sewage in the Thames, affected the Houses of Parliament to the extent that they considered relocating. Cholera epidemics linked to the poor quality of water in the Thames, killed 10,738 people between 1853 and 1854.

1864

Sir Joseph Bazalgette, Chief Engineer to the Metropolitan Board of Works was authorised to build a massive sewer system. Bazalgette spent many years building over 2100 km of underground and street sewers to channel London's entire sewage output downstream to pumping stations at Abbey Mills, Deptford and Crossness. Here it could be released into the Thames, untreated, and carried out to sea on the tide. London still relies on this system of sewers today.

1879

Following numerous floods during the 18th and 19th centuries, the Thames River Prevention of Floods Act was passed. This led to higher and stronger flood walls and embankments along the river.

1928

The last time that central London was severely flooded, causing the deaths of 14 people.

1940

The mass bombings of the Docklands during the Second World War on Black Saturday, 7 September, left 430 dead, 1,600 seriously injured and 10,000 homeless.

1953

A tidal surge resulted in disastrous flooding along the Thames Estuary and on the east coast with a loss of over 300 lives. The same surge caused over 1,800 deaths in the Netherlands.



1966

The 1953 flood led to a dramatic rethink of the way in which flood defences were built to protect London. Following a report in 1966 by Sir Herman Bondi, it was decided that the best solution was bank raising together with a flood barrier with moveable gates built across the Thames.

1972

The Thames Barrier and Flood Protection Act led to the construction of the Thames Barrier.

1974

The first salmon for 150 years was caught in the Thames, indicating a significant improvement in water quality.

1982

Eight years after construction began, the Thames Barrier became operational in 1982. It was first used in February 1983. The Queen officially opened the Barrier on 8 May 1984.



1990

The iconic tower at Canary Wharf was completed as part of the transformation of London Docklands from a port area to a major commercial and financial centre.

1999

On New Year's Eve, the Millennium Dome was opened at Greenwich to celebrate the new millennium. It is now a popular music venue.

2005

The famous Southend pier was seriously damaged by fire. Much of the wooden planking was destroyed, but the main iron structure was largely undamaged. At 1.33 miles in length, the pier is thought to be the longest pleasure pier in the world.

2006

A northern bottle-nosed whale, 5 metres in length was seen in the Thames. Huge crowds gathered along the river banks to witness the very unusual event. In a very sad ending, she died as rescuers transported her on a barge towards deeper water in the Thames Estuary.

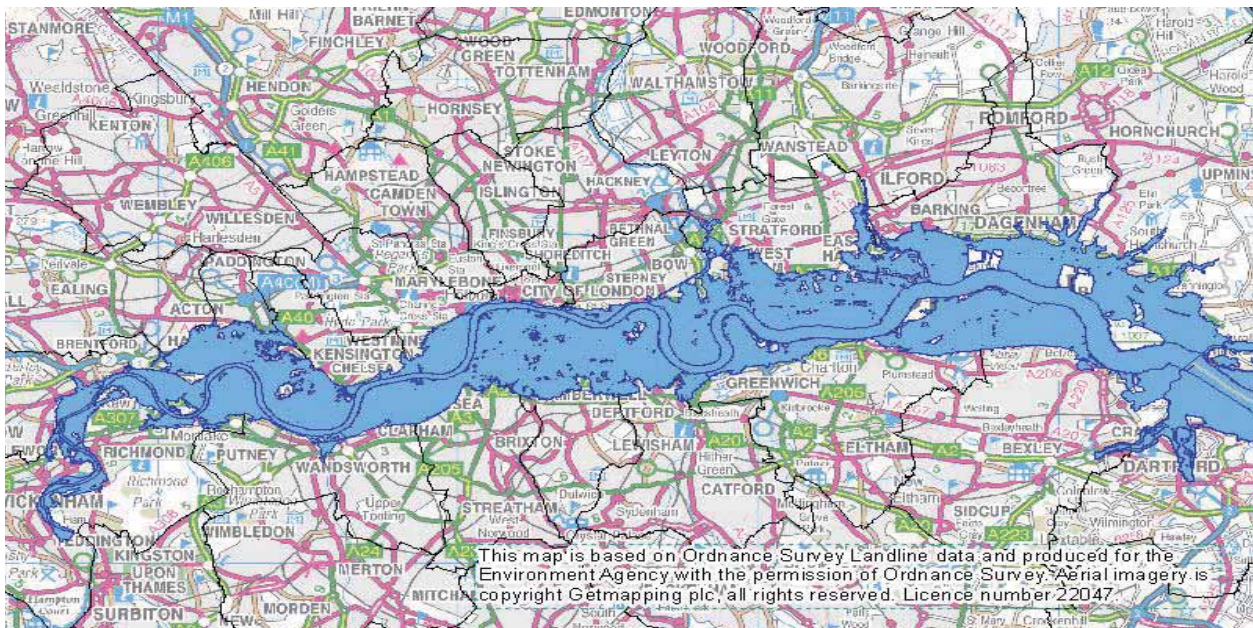
2010

The Environment Agency launches Thames Estuary 2100: London's flood risk management plan for the next 100 years

Flooding on the Thames

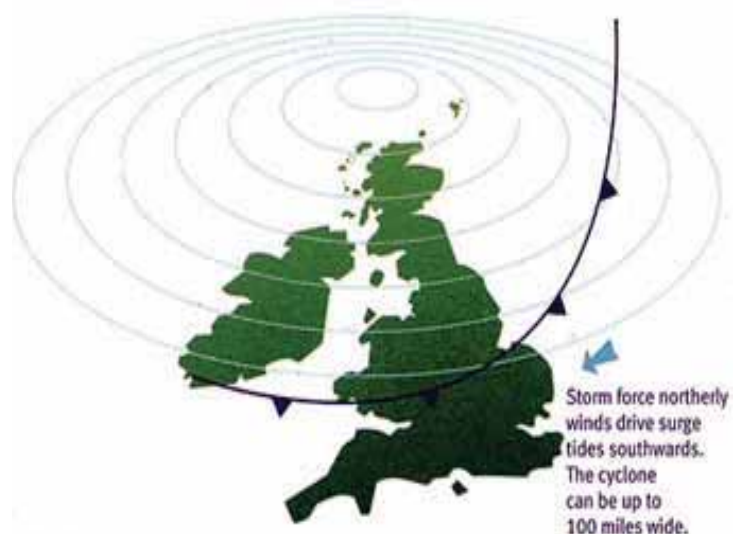
The Thames Estuary is the meeting place of the freshwater River Thames, its many tributaries and the North Sea. The land surrounding the estuary which could flood if a combination of freshwater flow and tidal waters raises the water level is called the 'floodplain'.

This map shows the floodplain for London. This is the area that could flood if there were no defences in place to reduce the risk of this happening.



Everyday, twice a day, freshwater from the source of the Thames is met by the incoming tide from the North Sea. The water levels in the Thames Estuary rise and fall by an average of seven metres every tidal cycle. In addition to the daily tides, the Thames Estuary is vulnerable to an increase in water levels caused by a North Sea surge.

'Surge tides' happen when a band of low pressure or 'depression' moves across the Atlantic towards the British Isles, the sea under it rises above the normal level creating a hump of water. This hump moves with the depression, passing the north of Scotland and moves south into the North Sea. A surge tide happens when this mass of water from the deep ocean reaches the relatively shallow parts of the North Sea just



outside the Thames Estuary. On top of this, strong northerly winds can increase the height of the surge. A surge tide entering the Thames Estuary can increase water levels by over one metre and can be a major flood threat especially if this happens during a 'spring' tide when tide levels are higher than normal. Conditions like these caused the 1953 floods which ultimately led to the Thames Barrier being designed and built.

Did you know?

On Earth, tides are caused by the combined gravitational pull of the moon and the sun acting on the oceans. There are approximately two high tides and two low tides every day. A full tidal cycle takes 24 hours and 50 minutes. When the Earth, moon and sun are all aligned, their combined gravitational pull causes higher than normal tides. This alignment occurs every 14 days and is known as a 'spring' tide.

Protecting people, property and the environment

The Environment Agency are responsible for building and managing flood defences including the Thames Barrier.

The Thames Barrier is part of a system of flood defences which together help manage the risk of flooding in London. The other parts of this system include flood walls and other smaller barriers such as the Barking Barrier and the King George V flood gate.

We can forecast potentially dangerous weather conditions up to 36 hours in advance. We then make the decision to close the Thames Barrier and the other barriers in the system based on the predicted height of the incoming tide. We get this information from the Met Office, tide gauges and from computer analysis we carry out at the Barrier.



This is Barking barrier

The Barrier is usually closed after the tide has gone out and incoming water levels are low. As soon as we decide to close the Barrier we contact the Port of London Authority as they control navigation on the River Thames. They inform ships that a closure is about to start and we then make sure that the Barrier's navigation lights are red. The Barrier stays closed during the high tide, we reopen when the water levels downstream and upstream are the same.

Thames Barrier facts

How did we manage flooding before the Thames Barrier?

Historically the solution to flooding was to build higher and stronger river walls and embankments. This form of flood defence became popular following the Thames Flood Act of 1879 and remained an accepted method until the early 1970s. As a solution to flood risk, raising walls had many advantages. Walls are permanent, easy to maintain and not likely to fail through human error. On the other hand, building walls higher and higher would eventually block the River Thames from view.

Why did we build the Thames Barrier?

In 1953, the east coast of England and the Thames Estuary felt the full force of a disastrous flood. Over 300 people lost their lives. If the flood had got all the way to the highly populated, low lying areas of central London the results would have been even more horrific. The flood, the loss of life, and the prospect of the damage it could have caused led to a dramatic rethink in the way we built flood defences to protect London.

What were the stages in the decision to build the Barrier?

1. It was recognised, after detailed research, that flood protection for the tidal parts of the River Thames needed to be improved.
2. Following the 1966 report by Sir Herman Bondi it was decided that the best solution was bank raising together with a flood Barrier with movable gates built across the river.
3. Legislation in the Thames Barrier Flood Prevention Act 1972 gave us powers to carry out that solution.
4. Interim bank raising began in April 1971 and was completed in December 1972 improving defences until the final works were completed.
5. The then Essex River Authority and the Lee Conservancy Catchment Board also carried out similar improvements to complete this standard of protection from the Thames down river of London.

Who designed the Barrier?

Charles Draper, who got the idea of 'rising sector gates' from a gas tap.

Who built the Barrier?

The former Greater London Council (GLC) Department of Public Health Engineering co-ordinated the Barrier project. The engineering company Rendal Palmer and Tritton designed the Barrier and supervised the building works. The main civil engineering contractor for the Barrier river works was the Costain, Tarmac, Hollandsche Beton Maatschappij Joint Venture. The contractor for the steel gates and operating machinery was the Davy

Cleveland Barrier Consortium. The shore works contractor was Sindall Construction Ltd and the main services contractor Balfour Kilpatrick Ltd. The GLC Department of Public Health Engineering also designed and supervised downstream and upstream bank raising works.

How long did the Barrier take to build?

Eight years. Construction started in 1974 and was completed in October 1982. It was first used in February 1983, and formally opened by Queen Elizabeth II on 8 May 1984.

How was it possible to pour concrete into the water during construction?

'Cofferdams' (watertight steel boxes, formed using steel piles) were sunk into the river bed, and the river bed material was excavated. 'Tremie' pipes were used to feed the concrete into the excavated space, under the river water. Concrete can set under water, as oxygen from the air is not required. The Romans used this method. Once the concrete had set and formed a watertight seal, the water was pumped out and work on the piers could begin.

Who paid for the Thames Barrier?

Building the Barrier and associated works was a massive project. The final cost came to over £535 million (valued at £1.4 billion at 2007 prices). There was no private funding, and the cost was met through central government funding (75 per cent), with the remainder provided by local government.

How much does it cost to operate the Thames Barrier and associated defences?

They cost around £8 million a year to maintain and operate. In addition we also spend approximately £10 million on capital improvements to the defences (2008/2009 expenditure levels).

How long does it take to close the gates?

An individual gate can be closed in 10 to 15 minutes but to close the whole Barrier for a flood defence closure usually takes 1½ hours. This provides enough time to check the equipment and stops the potential of a reflective wave. The gates are closed in pairs from the outside into the centre. The ideal situation is for the gates to be closed just after low tide.

What powers the machinery in the Barrier?

There are 11,000 volt power supplies across the Barrier. Three back-up generators are available if the mains supply fails. When closing the Barrier our total energy demand is in the region of 1.1 megawatts. The main method of moving the gates is by using one of two pairs of yellow 'rocking beams', which are moved using hydraulic oil pressure.

Why do the gates not get jammed with built up silt?

The silt is allowed to drain out at regular intervals. This is called a 'desilt'. The gates rest in concrete sills under the riverbed when not in use, the largest of these sills weigh 10,000 tonnes. There is a gap between each sill and gate (approximately 10cm) to allow the natural tidal flow to keep the sills clean. The gap is narrower at each edge of the gate, preventing large debris getting into the slot.

How big are the gates?

The four largest rising sector gates span across 61.5 metres, and weigh 3,700 tonnes each, and the two smaller rising sector gates span 31 metres. The straight back of each gate measures 20 metres, 4 metres of which are below the riverbed.

Why are the pier roofs the shape they are, what are they made of and what do they contain?

The pier roofs look like two ends of a boat tilted to 90 degrees. This shape is ideal for the machinery they house and is also aerodynamic reducing wind disturbance – this is important for navigation purposes. The piers consist of wooden structures covered by stainless steel plates, which are maintenance free.

How deep is the river normally at low and high tides?

The river by the Barrier is on average approximately 7 metres in depth at low tide and 15 metres at high tide, however this changes seasonally.

How long is the river Thames?

The non-tidal stretch of the Thames runs from the source to Teddington (West London) and measures 150 miles. The tidal section, which runs through the Barrier from Teddington to Southend, measures 62 miles. The total length of the Thames is therefore approximately 212 miles.

How many counties does the Thames pass through?

Nine - Essex, Kent, Middlesex, Surrey, Berkshire, Buckinghamshire, Oxfordshire, Wiltshire and Gloucestershire (from mouth to source).

At what speed does the river flow?

A maximum speed of 3 mph or 2.75 knots in either direction.

At what time of year is the Barrier more likely to be closed?

September to April is considered to be the flood season so during this period there is an increased likelihood of Barrier closures.

How often has the Barrier been used for flood defence purposes?

The Thames Barrier has been closed 119 times (up to March 2010) to protect London from flooding. The Barrier is also closed at least once a month for testing and maintenance purposes. Details of Thames Barrier closures can be found online at:

<http://www.environment-agency.gov.uk/homeandleisure/floods/38359.aspx>

Could the Thames Barrier be used to generate electricity?

No. The tidal range isn't great enough and the structures would need to be redesigned as locks. The cost to generate the electricity would be more than provided by the national grid network. Having a lock across the Thames would also impact on the natural river environment.

Has there been a rise in sea-level in the tidal part of the River Thames since the Thames Barrier was completed? If there has been, is this due to global warming?

Looking back into the nineteenth century a gradual increase can be seen in the River Thames tidal high water levels. Average tidal levels in the Thames have continued to rise in recent years. It is predicted that further rises will occur due to climate change, which is due to the melting ice caps and expansion of the sea. There are other factors such as isostatic rebound which is the tilting of the land (north east of the UK rising and south east falling) after being compressed by glaciers during the last ice age.

How fast is the sea-level rising and how much is it rising by?

The Department for Environment, Food and Rural Affairs (Defra) has published guidance relating to the allowances that should be made for sea level rise based on the best available scientific research into the matter. In the South East of the UK we should allow 4mm per year until 2025.

The table below shows the allowance we should make for sea level rise beyond 2025. These figures take into account isostatic rebound, melting of the ice caps and the expanding ocean due to global warming.

Years	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Net Sea Level Rise (mm/yr) in SE	4.0	8.5	12.0	15.0

(Source: Defra 2006)

At present is the Thames Barrier and other flood defences able to cope with sea level rise?

Yes the Thames Barrier and other flood defences are able to cope. There has not been any tidal flooding along the Thames Estuary since the Barrier was built in 1982.

Is the Thames Barrier's life expectancy due to increasing sea-level, storm intensities over the North Sea or another reason?

The Thames Barrier is a mechanical structure built in a salt water environment. In time it will degrade, regardless of sea level rise or climate change. Any increase in sea level or storminess will affect the standard of protection that the Barrier and other associated defences can provide and so will eventually necessitate their improvement or replacement.

At present, what level of protection does the Thames Barrier provide?

The Thames Barrier and associated defences were originally designed to protect London from a 1 in 1000 combined tidal/fluvial event up until the year 2030. This means that the tidal defences protect against a flooding event that has a 0.1% annual probability of occurring up to the year 2030. This includes allowance for sea level rise of 8mm per year until 2030. Sea level rise is, in fact, less than 8mm per year, so at present the standard of protection is much higher than originally expected.

Does the closing of the Barrier cause the height of the water at high tide between the Barrier and the Thames mouth to be higher than if the Barrier was left open?

With the Barrier closed downstream water levels do rise. The height difference could range from approximately 0.1 to 0.4 of a metre in North Woolwich and dissipates as it heads towards the estuary. By Southend there will be no noticeable difference.

The defence levels downstream of the Barrier are about 2 metres higher than those upstream. This helps cope with the slightly higher water levels there are when the Barrier is closed.

It has been reported that the Thames Barrier is coming to the end of its life, is this true?

No. The Thames Barrier is not even halfway through its design life. It was completed in 1982 and was designed to protect London from flooding until 2030 and beyond. The standard of protection it provides will gradually decline over time after 2030. We are examining the Thames Barrier for its potential design life under climate change. Early indications are that subject to appropriate modification, the Thames Barrier will be capable of providing continued protection to London against rising sea levels until at least 2070.

The Future of the Thames Barrier

Background

The Thames Estuary 2100 project (TE2100) was established in 2002 with the aim of developing a tidal flood risk management plan for London and the Thames estuary through to the end of the century. The project, led by the Environment Agency, covers the tidal Thames from Teddington in West London, through to Sheerness and Shoeburyness at the estuary mouth in Kent and Essex. The key driver for the project was that tidal flood risk is increasing in the Thames estuary due to:

- Climate change and sea level rise
- Ageing of the current flood defence infrastructure
- More people living and working in the defended floodplain

Because of the uncertainty in the climate change impacts on water levels in the future, the Plan has been designed to be adaptable. This means that, if sea levels are found to be rising faster than currently predicted, the plan will indicate what changes will be required to the plan and when they will need to be implemented.

Key finding of the Plan

The key finding of the work has shown that the current flood defences – already of a higher standard than elsewhere in the country - provide a much greater degree of protection to predicted water levels than previously understood.

This means that the Thames Barrier, with continued maintenance and planned improvements, and with later modification, could continue to provide protection to London and the estuary through to the end of the century. However, economic assessment and analysis into the risk of Thames Barrier failure suggests it may prove safer and more cost-beneficial to construct a new barrier further downstream at Long Reach before the end of the century (to become operational ~2070). Upgrading the current system of associated tidal defences will be required from around 2035.

Summary of Plan outline

The key elements of the Plan are covered within three time periods. They are:

First 25 Years (2010 – 2035):

- Continue to maintain the current flood defence system including planned improvements
- ensure effective floodplain management (emergency and spatial planning) is in place across the estuary

- safeguard areas that will be required for future changes to the flood defences
- monitor change indicators including sea level rise and climate change (to continue through to end of century) and review plan as required
- commence work to create new habitat through realignment of defences

Second 35 Years (2035 – 2070):

- replace and upgrade the current network of defences upstream and downstream of the Thames Barrier
- continue habitat creation schemes
- make final decision on building new Barrier at Long Reach or other end of the century option (based upon monitored climate change and sea level rise and any modification to climate change predictions), and start the planning for that.
- continue monitoring sea level rise and climate change

Final 30 Years (2070 – 2100):

- Implement agreed end of century option (see 2035-2070) which current appraisal indicates as the construction of a new Thames Barrier at Long Reach to be operational by ~ 2070
- Further raising and adaptation of defences, where required, to keep new Barrier closures to within operational constraints

Further findings of the project

Climate Change – based upon the latest science (in a joint collaboration with the Met Office Hadley Centre) included in the forthcoming UKCP 2009 Marine Section:

- sea level rise in the Thames over the next century due to thermal expansion of the oceans could be between 20cm and 88cm; this is in line with current Defra guidance.
- there is still much uncertainty over the contribution of polar ice melt to increasing sea level rise. At the extreme it may further raise maximum sea levels up to +2m (including thermal expansion) by the end of the century - although this is thought highly unlikely.
- climate change is less likely to increase storm surge height and frequency in the North Sea than previously thought

- the worst case (highly unlikely) maximum sea level prediction has been revised down to +2.7 metres above current levels by the end of century.
- Under current Defra guidance or even under this worst climate change scenario we will not require an outer estuary barrage (tide excluding) in the estuary

Consultation

Throughout the plan development many key strategic stakeholders across the estuary have been consulted and updated on progress. The consultation process also gave less strategic stakeholders, such as the many estuary user groups, the opportunity to input to the Plan's development.

The final consultation ran for four months in 2009. We held 15 local workshops, 50 meetings with key organisations, and received over 125 written responses. We are using these to review and refine the TE2100 Plan before its submission to Defra.



Thames Barrier closures

Please visit this webpage to get a summary of all Thames Barrier closures:

<http://www.environment-agency.gov.uk/homeandleisure/floods/38359.aspx>



Thames Barrier closures for flood defence

1993

11 January and 25 January

Several days of heavy rain over the Thames Valley had led to high river flows which, in combination with the highest spring tides of the month and moderate tidal surges, would have led to appreciable flooding in the upper estuary, had the Barrier not been closed.

21 February

Although by this date the river flow had reduced to about the seasonal norm, a fairly large surge on the run up to spring tides again made it prudent to close the Barrier.

Evening 13 October - Morning 14 October - Evening 14 October

The Thames Barrier was raised on the above dates, to assist in the prevention of possible flooding due to high fresh water flows in the North bank Thames tributaries (especially the Lea, Brent and Crane). There were no tidal problems, but the theory is that, as the high tide effectively stems the flow of water in the tributaries, closing the Barrier 2 hours before high water to take the top of the tide could allow water in the tributaries to run off more quickly. It will take a considerable amount of analysis to assess whether this in fact produced a significant effect. During the week beginning 10 October, the tide levels were rising with the arrival of the spring tides, the highest predicted tide being Sunday, 17 October - Annual Closure Day.

Morning of 16 October there was a Tidal Surge Closure

This was due to a moderate tide and surge, combined with high freshwater flow, putting the upper estuary at risk.

Morning of 15 November there was a Tidal Surge Closure

Tidal Defences were closed for the early morning (00.02 Southend) tide, the tide level at Southend being the highest seen since the construction of the Thames Barrier. In fact, due to quirks of tide and weather, upriver levels below the Barrier were only moderate.

13/14 December

The Meteorological Office model forecast a problem well ahead of (18 hours before) the surge tide. In the event the tidal surge worsened shortly before high water at Southend, which was the highest tide level since the Thames Barrier was completed. In contrast with 15 November, this high level continued upriver, producing the highest recorded level at the Thames Barrier since it was completed (5.2 ODN) (metres Ordnance Data Newlyn), only slightly below the 1953 level. This high local level resulted partly from closure of the Barrier gates, but was still 2 metres below the Barrier's capability.

1994

Night of 27-28 January

At 23.57 the Meteorological Office issued a forecast that the afternoon tide, due at 13.10, would be 0.91 metres above prediction, the closure level for the Barrier. At 04.23 the forecast was amended to 0.79 metres above prediction, the Barrier closure arrangements were put into action as a precautionary measure. At 09.30 it was decided to close and the gates were moved progressively in a staged sequence to fully closed at 11.37. The tide peaked some 30 minutes early and reached 0.84 metres above prediction. The level at the Barrier was 4.34 ODN.

1995

Morning of 2 January

The Thames Barrier was closed against the early morning (01.48) tide. The Meteorological Office forecast for that tide at Southend was 3.89 ODN which would have been one of the highest tides since the Barrier was commissioned. A forecast level of 3.75 ODN was required to initiate a closure of the Barrier. In the event, the tide at Southend only reached 3.61 ODN. The Barrier team was prepared to close the Barrier against the following afternoon tide (14.13) because the initial forecast was above barrier closure level. However, during the morning the Meteorological Office reduced the forecast and it was decided not to close on the second tide. The level reached 3.66 ODN at Southend.

February

Following the wettest January in the South East for 50 years the volume of freshwater flowing into the tidal Thames at Teddington Weir was running at 114 cubic metres per second (cumec), 6000 million gallons per day (mgd). The 30 year average flow for February is 45.6 cumec (2400 mgd).

Midday 1 February

At 11.50 on 1 February the Meteorological Office issued a forecast that the afternoon Spring tide, due at 13.36, would be 0.33 metres above prediction, 0.13 metres above the action level for the Barrier. At 12.15 the Barrier closure arrangements were put into action as a measure to avoid flooding in areas upstream of the Barrier. The tide peaked some 35 minutes early and reached 0.52 metres above prediction. The level at the Barrier was 4.93 ODN, which produced a difference in water level either side of the gates of 1.77 metres. The operation was completed by 15.30. However, the forecast for the next tide due at 01.46 on 2 February was 3.30 metres again, equalling the Barrier action level. Staff were sent home at 16.30 with the expectation that they would be called back to work for a closure on the next tide.

Night of 1-2 February

The closure team were called out to reach the Barrier for 22.00 for a closure planned at 24.00. Closure started at 23.45 and was completed by 00.47 on 2 February. The tide peaked some 20 minutes early and reached 0.49 metres above prediction. The level at the Barrier was 4.46 ODN, which produced a difference in water level either side of the gates of 1.37 metres. The operation was completed by 04.10. The forecast for the next tide due at 14.17 on 2 February was 3.13 metres, well below the Barrier action level.

Midday 2 February

By 10.00 on 2 February the Meteorological Office forecast for the afternoon Spring tide was increased to 0.25 metres above prediction. Freshwater flow

was forecast to peak at 136 cumec (7200 mgd), again above the action level for the Barrier. At 10.00 the Barrier closure arrangements were put into action for the third successive tide closure planned at 12.00. Closure started at 12.50 and was completed by 13.19, the tide peaked some 14 minutes early and reached 0.10 metres above prediction. The level at the Barrier was 4.50 ODN, which produced a difference in water level either side of the gates of 1.97 metres.

Midday 23 December

The Thames Barrier was closed against the 13.17 afternoon tide. The Meteorological Office forecast was for a tide level at Southend of 3.72 ODN with a river flow of 237 cumec (4500 mgd). The forecast level at which a closure routine is started is 3.7 ODN. The tide actually achieved a level of 3.79 ODN. The Barrier was closed at about 1½ hours after low tide and remained closed for a little over 6½ hours.

1996

Morning and Afternoon of 19 February and Afternoon of 20 February

The Thames Barrier was closed 3 times on successive tides - at 09.00 and 22.00 on 19 February and 12.00 on 20 February. This was mainly due to the gale force north easterly winds experienced over the eastern side of the UK and the North Sea, which increased the level of the tide from its natural level by up to 1.9 metres at times. The river flow measured at Teddington Weir was between 70 and 80 cumec (between 1400 and 1600 mgd) which is not a great deal for a "winter" time flow but does slightly reduce the Barrier closure action level at Southend which for these closure was 3.5 metres. On each occasion the Barrier was raised between 1 and 2 hours after low water and re-opened some 5½ hours later.

As an aside, on the second of this series of closures, Southend experienced its highest tide since 1978 (3.96 metres).

29 October

The Thames Barrier was closed at 10.30 due to a strong northerly gale force 9 wind which followed after Hurricane Lily. This increased the level of the tide at Southend by up to 1.4 metres above the predicted (natural) level. The Barrier remained closed until 16.30. The river flow was about 26 cumec (500 mgd) which is very low for this time of year. The level recorded at Southend (3.98 metres) was the highest experienced since January 1978 and at times the level at the Barrier was 2.2 metres above that predicted.

1997

12 November

On Monday 27 October at 06.50, the dredger MV Sand Kite carrying 5000 tonnes of sand and gravel collided with the Thames Barrier. The vessel discharged most of her cargo and sank between piers 4 and 5 of the Barrier rendering the gate in that span inoperable (Gate F). The vessel was successfully refloated and towed off the Barrier on Saturday 1 November. Extensive operations were then programmed to remove all the remaining sand and gravel which still remained on and around the gate. These operations included a full tide closure of the Barrier on 12 November to remove the sand and gravel from the gate cill.

1998

28 February

The Thames Barrier was closed at 11.00 as a result of high spring tides coupled with a surge which increased the tide level at Southend by 0.5 metres to 3.84 metres. The weather was of a typical nature to cause a closure, with an intense Atlantic depression passing north of Scotland and causing northerly winds over the North Sea. The Barrier remained closed until 16.50. The fluvial river flow measured at Teddington was 500 mgd which is very low for winter.

8 October

The Barrier was closed for the second time in 1998 at 11.00 on the highest spring tide of the month, increased by a surge of 0.35 metres. Although river flow was still about 1,000 mgd October 1998 became the wettest October for over 100 years.

6 November

The river flow had increased to 4,000 mgd due to the heavy October rain, and this combined with a high spring tide and 0.24 metre surge necessitated the thirty-third Flood Defence Closure. Interestingly this defence closure was the first carried out by a woman, Mrs Sarah Lavery a qualified Civil Engineer and one of only four people allowed to close the Barrier.

1999

3 December

The Thames Barrier was closed hydraulically at 22.00. A vigorous depression tracked rapidly across the British Isles and located in the North Sea giving very strong northerly winds. Although the forecasts indicated that no action was required with this tide, firstly Yellow Flood Warnings were issued only to be upgraded to Amber. Subsequently it was apparent that with

the tide running well above forecast, at one time, only a few hours before high water, the surge was 1.39 metres against a forecast of 0.6 metres, it would be prudent to close the Barrier.

The maximum level reached at Southend was 3.43 metres with a surge at high water of 0.96 metres with a maximum surge of 1.39 metres. The main gates were reopened at 23.15 hours.

Afternoon of 25 December, Morning and Afternoon of 26 December, Morning and Afternoon of 27 December

The Thames Barrier was closed five times on successive tides – at 14.00 on 25 December, at 02.30 and 15.00 on 26 December and at 03.30 and 16.00 on 27 December. The full moon at the beginning of the Winter Solstice on 22 December was at its closest point to the Earth for one hundred and thirty three years, and Spring tides on Christmas Day and Boxing Day were predicted to be high.

Due to continuous heavy rain over most of the UK, the river flow over Teddington Weir into the tidal Thames increased from just over 1000 mgd (50 cumec) on 21 December to nearly 7000 mgd (370 cumec) by 27 December, the highest river flow for four years.

A very deep depression (948 millibars) swept across the UK causing gale force westerly to south westerly winds. Heavy rain caused widespread flooding throughout the UK and particularly in Wales and the South West prior to Christmas, and high Spring tides in the Channel caused flooding along the Sussex and Kent coast where up to two hundred people had to be evacuated.

The combination of high Spring tides, high river flow and tidal surge due to low pressure and strong winds brought about conditions that required the Barrier closures. Disruption to London was minimal as a result.

2000

14 November

The continued high river flows due to the recent heavy rainfall, combined with a surge element on the high spring tides has resulted in the issuing of flood warnings for the Teddington to Putney area and a Floodwatch from Putney to the Thames Barrier on several tides during the week commencing 12 November.

Forecast levels for the 01.34 tide on 14 November exceeded the warning threshold and therefore required closure of the Thames Barrier, Barking Barrier and Royal Dock Floodgates to prevent the surge tide from causing

flooding in London. Following the closure the river flow over Teddington slowly decreased due to the improvement in the weather, and the spring tides peaked before naturally reducing.

12 to 16 December

A combination of extremely high fluvial river flows, high spring tides and a deep depression off the North of Scotland resulted in the Thames Barrier and it's associated gates closing for nine out of ten tides for this period. For the first time in it's history the Thames Barrier closed for seven consecutive tides, with the highest river flow being recorded at 9,000 mgd, 475 cumecs. As a result of the emergency closures the planned test closure for 14 December was cancelled.

2001

10 and 11 January

The Thames Barrier and it's associated gates closed over two consecutive tides (01.08 and 13.32 high water at Southend) for the night of 10 and the day of 11 January 2001.

The need for closures arose as a result of the peak period of high spring tides combining with an extremely high tidal surge of 0.54 metres for 10 January and 0.55 metres for 11 January. These two factors, when assessed with a river fluvial flow of 5,000 mgd (263 cumecs) entering the river over Teddington Weir into the tidal Thames, met the conditions required to close the Thames Barrier. With river flows slowly decreasing over 11 January, naturally reducing spring tides and a reduction in tidal surge, further emergency closures of the Thames Barrier were not required. As two emergency closures had taken place the planned test closure for 12 January was cancelled.

These two emergency closures marked the 50th and 51st time the Thames Barrier and it's associated gates have closed to defend London from the risk of flooding.

8 to 12 February

The Thames Barrier and it's associated gates closed for seven out of the nine tides between 8 to 12 February.

This period of closures saw peaks of all three factors which contribute to closure conditions:

- River flows as a result of earlier rain - 8,200 mgd (430 cumecs)
- Naturally high spring tides for the month
- Tidal surge of 0.75 metres.

Although the river flow was still high - 6,000 mgd (315 cumecs) by 13 February, the spring tides level and surge element had reduced sufficiently to not require further closures. As the emergency closures had taken place the planned test closure for 12 February was cancelled.

10, 11, 12 and 13 March

The Thames Barrier and it's associated gates were closed for four tides over the spring tide period 10 to 13 March.

Exceptionally high astronomical tides combined with modest Thames flows, less than 4000mgd, and modest North Sea surges, less than 0.4metres, required closures of the Thames Barrier on alternate tides, each during the daytime. The intervening non closure night tides were covered by the issue of a Flood Warning for the Tidal Thames from Putney to Teddington and the issue of a Flood Watch for Thames Barrier to Putney. The Flood Warning/Flood Watch were downgraded to All Clear on 14 March.

As the emergency closures had taken place the planned test closure for 13 March was cancelled.

10 April

The Thames Barrier and it's associated gates were closed for the single high tide on 10 April. The need for the closure arose as a result of the monthly peak high spring tide combining with a tidal surge of 0.26 metres. The river flow for this time was 5300mgd (280 cumecs).

As the emergency closure had taken place the planned test closure for 10 April was cancelled.

17 September

The Thames Barrier and it's associated gates were closed for the single high tide on 17 September. The river flow at this time was 320mgd (16 cumecs) which is extremely low and as such provided a minimal effect on the closure criterion. The need for the closure arose as a result of the monthly peak high spring tide combining with a tidal surge of 0.43 metres.

2002

31 January

The Thames Barrier and it's associated gates closed for a single tide on 31 January.

The river flow prior to the tide was 4000mgd (210 cumecs). This volume of river flow combined with a high spring tide predicted at 3.2 metres and a surge of 0.27 metres determined the need for the closure.

1 March

The Thames Barrier and its associated gates closed for a single tide on 1 March.

The river flow prior to the tide was 4020mgd (210 cumecs). This volume of river flow combined with a high spring tide predicted at 3.33 metres and a surge of 0.29 metres determined the need for the closure.

27 April

The Thames Barrier and its associated gates were closed for a single high tide on 27 April. Although the river flow at this time was 625mgd (33 cumecs), the need for the closure arose as a result of the high spring tide forecast at 3.22 metres at Southend, combining with a tidal surge of 0.77 metres to exceed the Thames Barrier closure criteria. The lack of recent rainfall determined that fluvial flow was not a contributory factor for this closure.

7 November

The Thames Barrier and its associated gates were closed for a single high tide on 7 November during a period of spring tides and increased fluvial flow in the tidal Thames.

Weak model performance with a higher than forecast tidal surge had produced a level of 3.60 metres at Southend for the previous tide, which was 0.36 metres above forecast. The Met Office had issued an alert at 3.63 metres for this tide. Surge levels were behaving erratically but indications suggested that a similar surge to the previous day might occur and if so the Thames Barrier closure level would be exceeded.

Although the closure took place, the surge dissipated during the closure period.

2003

1 to 8 January

The Thames Barrier was closed 14 times on successive tides – at 23:31 on the 1st, at 11:52 on the 2nd, at 00:19 and 12:41 on the 3rd, at 01:04 and 13:29 on the 4th, at 01:46 and 14:14 on the 5th, at 02:27 and 14:56 on the 6th, at 03:06 and 15:39 on the 7th and at 03:44 and 16:21 on the 8th January. This is

double the previous record of seven consecutive closures during the floods of October 2000.

High river levels on the Thames flowing into West London meeting high spring tides coming up the Estuary into East London meant there was a real risk of flooding from the Thames in the City.

Rainfall across the Thames Region since 1st November had been more than double the seasonal average. From 21st to 31st December, 86mm of rain fell in the region - more than the average for the whole month. This heavy rainfall pushed river levels on the Thames to their highest since 1947, and the third highest in 120 years.

At their peak, river levels flowing over Teddington Weir were three times greater than average winter levels with over 9,000 million gallons of water a day flowing through the weir – the equivalent in volume of 220,000 Olympic swimming pools of water flowing through Teddington a day.

High flows moving downstream combined with tidal flows over 3 feet (1 metre) higher than a regular high tide, meant river levels in London rose 4 feet (1.2 metres) above what would normally have been expected.

Had the Barrier not closed to hold back the high tide there was a risk of the Thames overtopping riverbanks, flooding riverside properties and causing havoc for London's transport network.

In Greater London, riverside properties lying on tributaries of the Thames were also protected from flooding by the Barrier closures. Holding back the tide creates a 'reservoir' on the Thames behind the gates, into which the rain-swollen tributaries can flow.

21 to 23 January

The Thames Barrier was closed 5 times on successive tides – at 14:38 on the 21st, at 02:52 and 15:20 on the 22nd, and at 03:32 and 16:05 on the 23rd January. Further rainfall on a rain swollen catchment led to a repeat of flows 7,000 mgd. The Thames Barrier was closed under similar circumstances to those during the period 1st to 8th January.

2004

22 February

A flood defence closure took place on the afternoon tide on 22nd February. The decision to close came about as a result of a high tide plus surge forecast of 3.65m for Sheerness. The tide at Sheerness was actually

recorded at 3.86m and Southend at 3.95m, the third highest level since the Thames Barrier was commissioned. A level of 5.02m was recorded at the Thames Barrier, this level is the highest level recorded with the Thames Barrier in operation.

12 November

A flood defence closure took place on the evening tide on 12/13 November. A low pressure system moving across Scotland resulted in an additional surge of 1 metre on the already high monthly spring tide. The Thames Barrier closed at 2100 hours and reopened on early Saturday morning at 0330 hours.

2005

13 and 14 February

A flood defence closure took place on the afternoon tide on 13 February which was a result of a high spring tide predicted to reach 2.85m at Southend at 15:49 hours. Although there was only a small fluvial flow the surge preceding this tide was running at 0.7m. The second closure on the consecutive tide arrived at Southend on 14 February at 03:56 hours. The preceding surge was running at 1.7m but reduced to an actual 0.14m at the high point of the tide. Both closures were completed successfully with no reports of flooding.

8 April

A flood defence closure took place on the afternoon tide on 8 April which was a result of a high spring tide predicted to reach 3.08m at Southend at 13:22 hours. Although there was only a small fluvial flow the surge for this tide was 0.45m.

16 and 17 December

A Flood Warning was issued for the Putney Bridge to Teddington Weir area and a Flood Watch for Thames Barrier to Putney Bridge on Friday 16 December. This was a period of high spring tides and for the tide in question the forecast surge, an element which occurs in addition to every tide, was running at approximately 0.8m. As the tide approached the Thames estuary the surge began to rise an additional 0.3m and achieved a final level of 1.2m in addition to the astronomic tide level. The tide peaked at Tower Bridge at 4.73m. The forecast tide on 16 December did not achieve Thames Barrier closure level and although the late increase in surge contributed to a higher actual tide level, the tide was still below Thames Barrier closure level. Minor flooding was reported to a few properties where the seals to a few riparian owned floodgates leaked. Roadway flooding associated with normal spring tides was also experienced at Richmond where the towpaths and roadways

are on the riverward side of the flood defences. The warnings issued clearly stated these known areas although some vehicles were caught out. Surge activity associated with the strong northerly winds in the North Sea continued over the weekend and increased in magnitude, which resulted in two consecutive closures of the Thames Barrier on Saturday 17 December.

2006

28 February

The Thames Barrier and Associated Gates were closed for flood defence purposes from 10:30 hours, for (approximately) 6 hours on 28 February. This was due to northerly winds and a low-pressure system in the North Sea which added a surge element to already high spring tides. Due to the flood defence closure, the test closure planned for 2 March was cancelled.

2007

18, 21 and 22 January

The Spring Tide period, 18 to 22 January coincided with a period of very high, generally westerly winds over the North Sea and prolonged rainfall over the Thames catchment. This resulted in a period of high flows, approximately 250 cumecs, in the River Thames, the highest over a prolonged period since January 2003.

A depression, centred to the North of Scotland at midnight, 19 January tracked rapidly east. The prevailing weather conditions resulted in considerable surge activity in the southern North Sea with the forecast surge at Southend to oscillating between -1.0 and +1.0 metres. Forecasts indicated that three tides would be particularly high and, taking note of the high fluvial flow, the Thames Barrier was closed on these tides to prevent flooding in Central London.

The tides in question were, time of high water, Southend, midnight 18, 1.30pm 21 and 2.30pm on 22 January. The highest of these tides was the tide on 22 January. At Southend this tide was recorded at 4.04m giving a surge at high water of 1.03m. Although not the largest surge of this set of Closures, which was recorded at 1.25m on the first of the three closures, it resulted in a 4.04m tide which is the highest Southend tide since the Thames Barrier came into operation. In comparison, the 1953 tide was 4.60m.

3 March

This closure was undertaken against a background of considerable uncertainty over tidal forecasting. A depression tracked across Kent from the south West giving a “back door” type surge, ie a surge coming up the English

Channel. The depression then remained static over the southern North Sea / Thames Estuary also giving rise to elevated sea levels. The Storm Tide Forecasting Service issued Tidal Alerts highlighting the uncertainty caused by the weather pattern. Although the predicted tide was modest, the upstream flow was high and in considering all of the facts including the considerable degree of uncertainty over the forecasting, the Thames Barrier was closed.

18 to 20 March

Over the weekend of 17/18 March there was a deep depression centred over the North Sea off the coast of Scotland. This continued to dominate until 19 March when it moved eastwards giving strong northerly winds down the east coast. These winds were forecast to continue on 20 March and to reduce slightly on 21 March until a high pressure system slowly moved in on 22 March. This weather system has resulted in significant surge activity which at times has been recorded at 1.5m above the astronomical levels at different points on the tide.

The weather system coincided with the naturally occurring high spring tides for the month which resulted in four consecutive closures of the Thames Barrier and associated tidal defences. There was a brief respite with no closure being required on the 20 March early morning tide.

The tide forecast for 14.30 hours at Woolwich on the afternoon of 20 March saw again the need for a closure. The tide was forecast to be 3.92m at Sheerness slightly short of the 4.04m tide recorded last month which was the highest level since the barrier became operational in 1983. The weather effect (surge) is 0.7m on this tide.

Tides continued to be closely monitored with the forecast for the 01:35 hours tide on 21 March falling between Barrier action and closure level. A decision on this tide was taken following the next modelling run at 16:00 hours on 20 March.

We celebrated our 100th closure on Sunday 18 March at the start of this period.

8 and 9 November

Due to the deep depression and strong northerly winds the surge at Sheerness was forecast to take 12 hours to build from negative residuals at 20:00 hours on 8 November to a peak of 3.03m at 08:00 hours on 9 November before reducing down again over a 4 hour period to 0.8m. The surge peak was forecast to exceed that experienced in 1953 but come in 1m below in actual total water level.

The forecasts for Sheerness were above Barrier action level and Division 5 Alerts were issued for both tides. This means that if the tide had been allowed to travel into central London it would have been within 450mm of the top of the defences, which meets the Thames Barrier operating threshold. Due to the moderate confidence in the forecast given by the Met Office and the increasing profile of the surge the Thames Barrier and associated floodgates were closed on both consecutive tides.

The Thames Barrier and associated flood gates were closed twice between 22:00 hours on 8 November and 03:00 hours on 9 November and the following tide between 08:35 hours and 14:45 hours on 9 November.

The closures were completed without any operational incidents. The resultant surge out turned 0.64m lower than forecast and gave an actual level of 2.39m at Sheerness. Due to the slightly reduced surge the actual tide levels were both above Barrier action level but below closure level. Although there were very high surge levels in the North Sea the resultant tide levels were 3.73m and 3.58m for the two tides.

As a result of the surge tide there were no people or property damaged as it was contained within the flood defence system in the estuary.

For Sheerness the surge peak coincided two hours after low water, but even if it had coincided with high water by operating the Barriers and floodgates it would still have been contained within the present flood defences.

25 November

Due to a depression moving across Scotland, strong northerly winds produced a positive surge down the east coast. The forecast surge was above Barrier Action level and due to a small forecast error on the previous tide the decision was taken to close the Thames Barrier and associated gates. The resultant tide level was above Barrier closure level. There were no reported flooding incidents.

2008

24 January

With high fluvial flows in the River Thames and some uncertainty over the tidal surge forecast, the Thames Barrier was closed later in the tidal cycle to control the tidal effect upstream of Teddington Weir. The actual tide proved to be higher than forecast and the Thames Barrier closure was effective in reducing high river levels in the Richmond area.

21 March

Closure took place as a result of the 12:30 hours tide at Sheerness. The closure was required because strong Northerly winds combined with a high fluvial flow and a spring tide at Sheerness which met Barrier closure criterion. As a result the Thames Barrier and Associated Gates were closed to prevent the risk of flooding upstream of the Thames Barrier.

22 March

Closure took place as a result of the 13:08 hours tide at Sheerness. The closure was required because of strong northerly winds, gusting up to 50mph at the Thames Barrier, combining with a high fluvial flow and a spring tide forecast for Sheerness. The combined effect was to exceed the Thames Barrier action level and because of the deteriorating weather conditions in the North Sea which were producing the snowy conditions over the Easter weekend the Thames Barrier and Associated Gates were closed to prevent upstream flooding.

2009

10 February

The tide at Sheerness, time of high water 13:07 hours, was forecast above Thames Barrier Closure Level. This was the result of a combination of Spring Tide, very high fluvial flow in the River Thames and North Sea storm surge. The Associated Floodgates, downstream of the Thames Barrier were also closed. Flows in the River Roding/Barking Creek were also particularly high with levels at Barking Barrier being closely monitored to ensure no possibility of "tide lock" on the River Roding. At 13:03 hours the tide peaked at Sheerness reaching a level of 3.84m AOD; 0.66m above prediction. The tide at Thames Barrier reached a height of 4.99m AOD.

11 February

The Thames Barrier was closed for two consecutive tides on 11 February. Times of high water, Sheerness, 13:51 hours and 02:03 hours (12 February). Spring tides and continuing high fluvial flows, exceeding 350 cumecs, necessitated the closure of the Thames Barrier to ensure critical levels were not exceeded upstream. Barking Barrier and Associated downstream floodgates gates were not closed.

12 February

The Thames Barrier was closed for a single tide on 12 February. Time of high water, Sheerness, 14:32 hours. As on 11 February, Spring tides and continuing high fluvial flows, exceeding 350 cumecs, necessitated the closure of the Thames Barrier to ensure critical levels were not exceeded upstream. Barking Barrier and Associated downstream floodgates gates were not closed.

13 February

The Thames Barrier was closed for a single tide on 13 February. Time of high water, Sheerness, 15:11 hours. As on 11 February, Spring tides and continuing high fluvial flows, 350 cumecs, necessitated the closure of the Thames Barrier to ensure critical levels were not exceeded upstream. Barking Barrier and Associated downstream floodgates gates were not closed.

2010

28 February

The low pressure system which dominated on 27 and 28 February led to significant rainfall on an already saturated catchment and led to 33 flood watches being issued across the region although thankfully did not cause any property flooding.

The first two closures on 28 February at 0930 and 2200 hrs were as a result of the surge created by the low pressure coinciding with the start of the high spring tides for the month.

The closures were due to high upstream flows and a forecast on a spring tide, with some additional surge of just under Barrier Closure level. Barking Barrier and associated gates were closed. The River Crane tidal gates were inoperable due to the very high river flow.

1 March

Following the closures on 28 February, a further two closures took place on 1 March at 1030 and 2300hrs but were this time a result of fluvial conditions. The low pressure moved off and high pressure which generated better weather began to dominate which give relatively small surges. The surge reduction was replaced by higher flows as the weekend rainfall found its way into the river system.

The closures took place due to high upstream flows coinciding with spring tides, with some additional surge of just under Barrier Closure level. Barking Barrier and the associated gates were closed but the River Crane tidal gates did not operate due to the very high river flow.

2 March

The last of the five consecutive closures took place on 2 March at 1130hrs and was a result of fluvial conditions.

The heavy rainfall over the weekend meant there were large flows coming down the Thames as the land drained and coincided with the normally high spring tides. The combination of these and some surge activity in the North Sea meant that the Thames Barrier was required to close.

Fish found in the tidal Thames

The Thames once supported important and valuable fisheries. Smelt were plentiful at Billingsgate – up to 40 boats worked every day between Wandsworth and Hammersmith taking up to 50,000 of this fish. Shads, salmon, flounder, eel and whitebait were also important. Over a million lamperns were sold annually to Dutch fishermen for bait. The remains of Bronze Age and Saxon fish traps along the Thames illustrate the river's long fishing history.

Growing pollution and habitat loss combined to destroy fisheries in the early 19th century. By 1960, a mammoth scheme was started to extend London's major sewage treatment works and improve river water quality. The Greater London Council and Thames Water Authority carried through the 20-year project, which today would cost £200 million.

Today, the Thames clean-up campaign is internationally recognised as a success. The estuary now supports over 120 species of fish, is an important marine nursery ground and plays a major part in supporting North Sea stocks. There are recreational fisheries for a range of species, a commercial eel fishery below Tower Bridge and a fishery for sole below Mucking.

Some of the Freshwater fish species found in the Thames

Bream

The bream is found in shoals in slow-flowing backwaters of the upper estuary. It may grow to 75 centimetres and weigh as much as six kilograms. The name dates back to the 12th century. Some researchers suggest it derives from an old German word meaning 'to glitter', possibly as a reference to the fish's gleaming silver flanks.



Carp

The carp is a large, powerful fish and a favourite with anglers. It can often be spotted basking on the surface during the summer. Thames carp may be descendants of fish cultivated centuries ago by monks. The carp is not that common in the tidal Thames, but very large specimens are caught occasionally.

Dace

The dace is a lively fish. Large shoals often dart around in the upper waters. This is the most common freshwater fish in the Thames estuary and is

normally found down to the city reaches. Dace spawn near Wandsworth in March and April. Adult dace rarely weigh more than 300 grams.

Perch

A striking fish, the perch is common in the upper reaches to Putney. After a heavy rainfall, it may be found as far down river as Dartford.



Pike

The pike is the most voracious fish-eating carnivore of all the British freshwater species. Specimens of more than 20 kilograms have been recorded. The pike is common in the clear freshwater reaches above Richmond.

Roach

The roach is a shoaling species that reaches down to Battersea. They usually grow to a length of about 25 centimetres and a weight of up to one kilogram. The spawning season for roach is May or early June. Like the perch, they may be found a considerable distance down river during periods of heavy rainfall.

Some of the Euryhaline fish species found in the Thames

(Euryhaline fish can live in both fresh and salt water)

Bass

The bass is a coastal and estuarine fish. Between June and October, large numbers of fry enter salt water and often move right up to the edge of freshwater. Bass like warm water and so are much more common off the south coasts of Britain than the north. The name bass is thought to come from 'barse', an old English word meaning 'bristly' or 'spiny'. This is a common fish in the Thames as the river is a major bass nursery up to Chiswick. Bass weighing up to four kilograms are regularly caught by anglers as far upstream as Thamesmead.

Eel

The common eel differs from most other migratory fish in that it leaves the river to spawn. Eels breed in the Sargasso Sea at a point halfway between Bermuda and the Leeward Islands. Larvae spend three years drifting in the Gulf Stream. Young eels migrate through the Thames estuary in April and May to mature upstream in rivers, lakes and ponds. Mature eels, with a metallic sheen and now called silver eels, leave the inner Thames in late autumn.

Flounder

The flounder is a flatfish that grows to about 50 centimetres and breeds in the lower reaches of the estuary. Young flounder migrate right through the estuary into freshwater reaches in May and June. Heavy autumn rain provides the stimulus for the flounder, now the size of a postage stamp, to move back to the lower reaches below Dartford. Fish older than two years do not migrate so far up the river. Flounder is probably the most abundant fish in the estuary from Tilbury to Teddington in the summer months. It is the only flatfish in the river above Woolwich.

Salmon

The exciting discovery in 1974 of an adult salmon, the first for 150 years, suggested that the Thames might once again be clean enough to support its passage. Thames Water subsequently instigated a Salmon Rehabilitation Scheme. Migrating juveniles and returning adults are now commonly reported.

Smelt

The smelt is a cousin of the salmon so it also moves towards fresh water to spawn. It grows rapidly to about 20 centimetres and matures when two years old. Smelt have large mouths and teeth that give the fish an aggressive appearance. Smelt also have a characteristic cucumber smell. Like the salmon, the smelt needs good water quality to thrive. An increase in the smelt population is one of our best indications of improved river quality, so it is encouraging to see that smelt are now abundant in the Thames. Pre-spawning shoals congregate below Gravesend during the late winter months. In March, the shoals swim up to spawn near Wandsworth. Fry are then distributed throughout the estuary in the summer months.

Three-spined Stickleback

In the breeding season, the throat of the male stickleback turns brilliant orange/red. The fish rarely grows to more than six centimetres and has three dorsal spines in front of the dorsal fin. The skin has no scales but



there are vertical bony plates on the sides of the body. Sticklebacks are found mainly in fresh water but they are also common in salt water.

Trout

The brown trout is a member of the salmon family and, providing the water is clean, is adaptable to a wide range of conditions. Trout may grow to a length of over 100 centimetres. Brown and sea trout are now found in the Thames estuary fairly regularly. A female sea trout kelt found in the River Colne in

January 1981 was the first positive indication of a migratory salmonid spawning in the Thames catchment this century.

Twaite Shad

Twaite shad used to spawn at Greenwich. Adult and juvenile fish are now common again in the estuary below Mucking. The re-establishment of a spawning population would have important implications under the European Union's Habitats Directive, since this is now a very rare fish.

Some of the Marine fish species found in the Thames

Dab

The dab is a flatfish inhabiting sandy bays and offshore banks. Abundant all around Britain, the dab rarely exceeds 30 centimetres in length. Most dab caught in the Thames are much smaller than this, and are immature. The lateral line is strongly curved above the pectoral fin,



and this feature may help to distinguish the dab from the flounder, with which it is often confused. The dab is common in the river below Grays.

Sand Goby

The sand goby grows to about 10 centimetres and is found in salt water all around Britain. The eggs are laid in empty bivalve shells and guarded by the male. During autumn, the sand goby is abundant in the estuary up to Battersea. It can sometimes be found as far up as Chiswick during dry summers when salt water moves further up the estuary than normal.

Herring

There are two main groups of herring around Britain that differ in distribution, lifespan, number and size of eggs laid, spawning times, growth rate and size. Young herrings live off planktonic crustacea and shoal in large estuaries. After six months in coastal waters they take to the open sea and do not join shoals of large herrings until they are aged three to five years. Young herrings are common in the river below Woolwich in the autumn and winter. Together with juvenile sprat, herring were once sold as 'whitebait' in the taverns of Greenwich and Blackwall.

Sprat

The sprat rarely grows larger than 15 centimetres. Their diet is entirely planktonic and huge shoals can often be found in coastal waters. Sprats are common in the Thames up to Greenwich during most months of the year, but their numbers peak in the autumn and early winter.

Tub Gurnard

The name gurnard is said to be derived from the French word 'grogner', meaning 'to grunt', as gurnards are known to make a deep sound when they are caught. The British rod-caught record for this large species is 5.195 kilograms. Found up to Erith, the tub gurnard is the most common gurnard in the Thames. It is coloured red, with brilliant blue-edged pectoral fins.



Thick-lipped Mullet

Essentially a marine fish migrating inshore in summer, the thick-lipped mullet feeds by sucking soil and extracting small particles of plants and animals from it. Their stomachs can contain over 85-per-cent indigestible matter, and their intestines are five times the length of their body. The fish grows to a maximum of 50 centimetres. The thick-lipped mullet can be a common fish in the Thames up to Woolwich during the summer.

Greater Pipefish

The greater pipefish is one of the most common pipefish and grows to 46 centimetres. It lives among seaweed and eel-grass and, like the other members of this species, feeds on tiny crustacean that it stalks with great deliberation. This fish is quite common in the salty reaches of the river.

Sole

Sole is believed to feed almost entirely by night and lie half buried in the sand during the day. It can grow up to 60 centimetres in length. Sole differ from other flatfish by having tongueshaped bodies. Most fish taken in the inner Thames are juveniles, but further out at the mouth of the estuary large fish weighing a kilogram are encountered. The sole is a common fish in the lower estuary, and is found in large numbers throughout the year. Young fish come up as far as Greenwich during late summer.

Sea Lamprey

The sea lamprey is a primitive jawless fish that lives in the sea as a parasite on fish such as cod. It returns to spawn and then die in freshwater streams in early summer. This fish requires good water quality in order to spawn; it is a good indication of how much the Thames has improved that sea lamprey have begun to spawn in the upper estuary near Barnes in the last few years.

Common Birds found on the Thames

Cormorant

A large and conspicuous waterbird, the cormorant has an almost primitive appearance with its long neck making it appear almost reptilian. It is often seen standing with its wings held out to dry. Regarded by some as black, sinister and greedy, cormorants are supreme fishers which can bring them into conflict with anglers and they have been persecuted in the past. The UK holds internationally important wintering numbers.



Grey Heron

The largest European heron. It can stand with neck stretched out, looking for food, or hunch down with its neck bent over its chest. In flight it holds its neck retracted and has large rounded wings. It is usually solitary although several birds may feed fairly close together. It stalks its food, often standing motionless for some considerable time. It usually feeds close to the bank or shore, but may wade out into shallow water.



Herring Gull

Herring gulls are large, noisy gulls found throughout the year around our coasts and inland around rubbish tips, fields, large reservoirs and lakes, especially during winter. Adults have light grey backs, white under parts, and black wing tips with white 'mirrors'. Their legs are pink, with webbed feet and they have heavy, slightly hooked bills marked with a red spot. Young birds are mottled brown. They have



suffered moderate declines over the past 25 years. Over half of their UK breeding population is confined to fewer than ten sites.



Great crested grebe

A delightfully elegant waterbird with ornate head plumes which led to its being hunted for its feathers, almost leading to its extermination from

the UK. They dive to feed and also to escape, preferring this to flying. On land they are clumsy because their feet are placed so far back on their bodies. They have an elaborate courtship display in which they rise out of the water and shake their heads. Very young grebes often ride on their parents' backs.

Mute swan

The mute swan is a very large white waterbird. It has a long S-shaped neck, and an orange bill with black at the base of it. Flies with its neck extended and regular slow wingbeats. The population in the UK has increased recently, perhaps due to better protection of this species. The problem of lead poisoning on lowland rivers has also largely been solved by a ban on the sale of lead fishing weights. Some birds stay in their territories all year, while others move short distances and form winter flocks.



Oystercatcher

The oystercatcher is a large, stocky, black and white wading bird. It has a long, orange-red bill and reddish-pink legs. In flight, it shows a wide white wing-stripe, a black tail, and a white rump that extends as a 'V' between the wings. Because it eats cockles, the population is vulnerable if cockle beds are overexploited.

Breeds on almost all UK coasts; over the last 50 years, more birds have started breeding inland. Most UK birds spend the winter on the coast; where they are joined on the east coast by birds from Norway.

Mallard

The mallard is a large and heavy looking duck. It has a long body and a long and broad bill. The male has a dark green head, a yellow bill, is mainly purple-brown on the breast and grey on the body. The female is mainly brown with an orange bill. It breeds in all parts of the UK in summer and winter, wherever there are suitable wetland habitats, although it is scarcer in upland areas. Mallards in the UK may be resident breeders or migrants - many of the birds that breed in Iceland and northern Europe spend the winter here.



Pictures and descriptions courtesy of www.rspb.org.uk

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