# Thames Tideway Tunnel

# Alternatives to the Tunnel : A Strategic Plan


**by**

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## EXECUTIVE SUMMARY

During 2000-2005, in response to the EU Urban Waste Water Treatment Directive (UWWTD), the Thames Tideway Strategic Study (TTSS) was undertaken to assess the environmental impact of intermittent Combined Sewage Outflows ("CSO"s) on the Thames Tideway. In 2005/6, the Steering Group responsible for the Study, comprising Thames Water, OFWAT, The Environment Agency, DEFRA and the Mayor's Office, and chaired by Prof. Chris Binnie, recommended the Tunnel as the only robust solution. The cost of the Tunnel was estimated as £1.7bn, with a benefit accruing of £4-5bn.

In 2009 the decision to designate the Tunnel as an NSIP ("Nationally Significant Infrastructure Project") was taken by Government. Later, in 2012/13, Thames Water, whose finances by this time were highly leveraged, requested Government support to build the Tunnel, resulting in the Water Industry (Financial Assistance) Act 2012.

By end-2013, the costs for building the Tunnel had risen from £1.7-1.8bn to around £4bn before financing costs, with a 6-7 year construction period, and adding £70-80 to TW customers' annual bills for an indefinite period .

Against this background, a number of experts and public figures questioned whether, in today's circumstances, such a costly, high-risk venture is justified and Value for Money. To this end, Prof. Binnie updated the cost-benefit study, using similar methodology to that used previously (ref. his Feb 2014 Report).

**In summary, he concludes that, whereas the Tunnel was seen as a project with an economic benefit of £4-5bn in 2005/6, it has a benefit of only £180mn today. Against this, capital costs have risen from £1.7bn to £4-5bn.**

This turn-around has arisen, not least, due to Thames Water's own £1.5bn. investment program of upgrades at 5 sewage treatment plants (STWs) and the construction of the Lee Tunnel**.** Hence, (a) there are few historic justified public complaints of sewage litter today; (b) in the last 10 years only one fish is recorded as having been killed by CSOs, that would be connected to the Tunnel project; (c) the current works will halve the volume of CSO spills; and (d) using NICE analysis, it would not be worthwhile spending more than £1.5m to satisfy CSO health issues.

Whereas the Tunnel would spill 4 times/year, the European Commission has stated that spills up to 20 times/year could be acceptable, especially considering the minimal environmental impact post-the Lee Tunnel and STW improvements.

**The TTSS and subsequent studies only considered single solutions, e.g. a totally new sewer system. A combination of measures such as: (a) foul/storm sewer separation, e.g. close to the Tideway; (b) correction of the assumed dry-weather flows; (c) real-time control of the sewer network; (d) detention tanks; (e) a series of SuDs schemes; and (f) infiltration of storm water into underlying gravel, where it exists, should meet the environmental criteria set and save several £ billion.**

Against such scenario, this Strategic Plan has been prepared to provide decision-makers and financiers with an alternative strategy to resolving any outstanding CSO issues on the Tideway, so as to provide an economically more sustainable outcome and to eliminate the potential financial burden of the Tunnel for Thames' customers.

## CONTENTS

## Preface

- As a UK licenced water utility under the Water Industry Act (1991), Thames Water (TW) has responsibility for sewage management in the Thames Valley area.

- TW's activities are governed by OFWAT, as regulator, who has to ensure that the services provided by Thames and the tariffs, which Thames can charge customers for such services, represent "Value for Money". Likewise, at the local level, customer interest is protected via Consumer Councils for Water (CCWater).

- In 1991, the EU Urban Waste Water Treatment Directive (UWWTD), supported by UK Regulations, set general standards for collecting systems (sewers) and treatment works. The objective is to protect the environment from the adverse effects of wastewater discharges. To achieve this, spills should only occur because of unusually heavy rainfall events. Compliance with these Regulations falls under the duties imposed by the Water Industry Act (1991).

- The Tideway was supposed to meet these requirements by Year 2000. Hence, the potential infractions against the UK Government from the EU (described below).

- During the period 2000-2005, The Thames Tideway Strategic Study (TTSS) was undertaken to assess the environmental impact of intermittent discharges of storm sewage on the Thames Tideway, to identify areas of improvement, and to propose potential solutions, having regard to costs and benefits.

- These sewage discharges are referred to as "combined sewer overflows" (CSOs), and are derived from London's combined sewerage systems, which combine both foul and storm flows into one pipe. Most of these systems were built in the 19$^{th}$ century. The systems, as designed, were not intended to convey and retain large quantities of storm sewage, and the excess generated following large rainfall events, is discharged directly into the Thames via CSOs. These spills can occur up to 50 times a year.

- In 2005/6, the Steering Group responsible for the Study, comprising Thames Water, OFWAT, The Environment Agency ("EA"), DEFRA and the Mayor's Office, and chaired by Prof. Chris Binnie, studied only single measures, utilising the then current technology, and recommended the Tunnel as the only robust solution to the CSO problem.

- The cost of the Tunnel at that time was estimated as £1.7bn, with a benefit accruing of £4-5bn.

- In 2007, with a revised cost estimate of about £2bn, Government instructed TW to proceed with the Tunnel.

- In 2009 the decision to designate the Tunnel as an NSIP ("Nationally Significant Infrastructure Project") was taken by Government.

- In 2011, DEFRA published the updated, - and, in the eyes of some commentators, arguably flawed: see below, - cost-benefit analysis, upon which this decision had been taken.

- In 2012/13, given the high costs and financial risks of building the Tunnel, TW, whose finances by this time were considered "weak", - in yr. 2000, TW's Balance Sheet debt represented 42% of capital, whereas by 2013 debt had risen to 88% of capital, - requested support from HM Government to build the Tunnel. Subsequently, Government passed the Water Industry (Financial Assistance Act) 2012.

- in the interim the Tunnel concept was split into two sections, the downstream part being the Lee Tunnel and the upstream part being the Thames Tideway Tunnel. As a result, to date TW have invested approx. £1.5bn in upgrades at five sewage treatment works (STW), including Beckton and Mogden, and in the Lee Tunnel, which is due for completion in 2014/15. The result will be a much higher effluent quality from all the STWs, and the CSO's annual spill volume will be less than half the level sustained to date.

- By end-2011, the costs for building the Tunnel had risen from £1.7-1.8bn (est. 2008) to around £4bn before financing costs, with a 6-7 year construction period. Financially, these costs and timetable create unique challenges. Overall, one might expect, therefore, the funding package for the Tunnel to reach £5.5 – 6bn.

- Against this background, a number of experts and public figures (incl. the authors of this Paper) have been questioning whether, in today's circumstances, such a costly, high risk venture is justified and Value for Money. Furthermore, what are the alternatives?

- Not only is this important for Government, but it is, too, for investors, lenders and ratings agencies, and, not least, Thames Water customers throughout the Thames Valley, who will have to pay an extra £70-80 per annum on their water bills for an indefinite period. Furthermore, many such customers will have their lives blighted during the 5-7 year period that the Tunnel is being built.

- To this end, Prof. Binnie updated the cost-benefit study, using similar methodology to that used previously. The results are shown in his Feb 2014 Report.

- **In summary, he concludes, with support from other experts, that what was seen as a project to have an economic benefit of £4-5bn in 2005/6 is judged as delivering a benefit of only £180mn today. Against this, the costs have risen from £1.7bn to £4-5bn. Such a swing from net benefit to significant net cost ought not to be dismissed!!**

- Since Sept 2013, the Planning Inspectorate has been undertaking an Examination of the Tunnel proposal, including public meetings, etc. Representations and evidence have been presented to the Inspector by a wide range of independent experts, including Prof. Binnie (mentioned above as Chairman of the original Steering Group, which recommended the Tunnel option in 2005/6).

  Unfortunately, The Planning Inspectorate, under its remit, has not been able in its deliberations to formally question the justification for the decision to proceed with the Tunnel.

- The original cost-benefit analysis was not necessarily wrong! It is just that circumstances under which it was made have changed over the intervening 8 years! The CSO environmental problems have been largely resolved, (see later), technologies have improved, and there are now other, cheaper ways of managing London's sewerage system.

- Adding weight to this outcome is the fact that the underlying public service to be provided by the Tunnel is a monopolistic public service, for which customers will be legally bound to pay. Currently, TW has estimated this to be £70-80 per household per year. Whatever solution to the CSO issue, however, has to be seen as Value for Money to gain public acceptance.

- Given the high level of cost and the potential savings that might accrue from alternatives to the Tunnel, a re-think as to the justification for this infrastructure venture and a review of a combination of alternatives have been recommended. To date, that recommendation has fallen upon "deaf ears" in Whitehall.

- OFWAT has declared that the Tunnel is a matter of Government policy, which they are not empowered to challenge. CCWater has questioned the cost-benefit justification of the Tunnel, but to no avail. Whitehall (DEFRA and HM Treasury) are seemingly committed to the Tunnel, notwithstanding that current data casts doubts on the Tunnel's cost-benefit claims.

- Meanwhile, TW has already committed significant time and resource (£200-300mn est.) to developing the Tunnel proposal, and are not for turning back.

- Finally, uncertainty surrounds the nature and extent of any financial support that Government might provide to TW, or a new IP (Infrastructure Provider), and there are arguments to doubt that such support will be allowable under EU State-Aid Regulations, given that there has been no competition for the underlying service that the Tunnel is to provide, i.e. handling CSOs, and the current state of TW's finances.

- Against this scenario, this Paper has been prepared to provide an alternative strategy to resolving any outstanding CSO issues, at much lower cost, lower risk and with a more sustainable outcome.

- Detailed cost estimates, etc. are not attached, as no resources are available to generate such data. However, this Plan, and the associated comments herein, have been assembled by experts, who have an in-depth knowledge of the UK water industry and how it works.

- It is recognised that the ultimate decision on the Tunnel must lie with Government. It is regrettable, however, that to date the TW customers have not been provided with a comprehensive study of how a combination of other measures could meet the requirements and at what cost. Sadly, neither TW, nor the EA, nor Government, have been inclined to entertain or engage with any contrary suggestions in recent times.

Hopefully, this Plan will show that alternatives are, indeed, available and should be explored before it is too late.

## An Alternative Plan

### 1. The Scenario:

Central London has a combined sewer system**,** which in Year 2000 had 57 overflows spilling into the Thames up to 50 times a year, causing aesthetic, environmental and health issues.

The Tideway was required to meet the requirements of the UWWT Directive by 2000, i.e. to protect the environment from adverse impacts of wastewater discharges.

The Thames Tideway Strategy Study (TTSS) Steering Group studied the Tideway from 2000 to 2005. There are no specific numeric standards in the UWWTD, so the TTSS came up with three objectives specifically focussed on the Tideway covering:-

- aesthetics,
- environment and
- health / recreation.

Based on the information available then, the TTSS proposed that, to meet these objectives, five sewage treatment works be upgraded and a storage/conveyance tunnel, now known as "The Tideway Tunnel" (est. cost of £1.7bn), be constructed from Hammersmith to Beckton Sewage Treatment Works ("STW").

### 2. The EU:

In 2005, the European Commission made a case against the United Kingdom in the European Court on the grounds that it considered that the London collecting systems spilled more often than "*unusual conditions*" allow, as set out in Annex 1(A) of the Directive 97/271 (UWWTD), and thereby caused unacceptable environmental impact.

The Court ruled in October 2012 that this, indeed, was the case, and that the UK had not established disproportionate (excessive) cost as an argument against the charge, as it had decided to implement the Tunnel. Thus, the United Kingdom had failed to fulfil its obligations under the Directive.

However, the Court did not rule that the Tunnel, as a remedy, be adopted, merely that an appropriate solution be adopted to meet the UWWTD. It specifically mentioned (ref. p31) alternative solutions, such as increased storage or diverting rainwater before it can enter the collecting systems, could remedy the CSO problem.

The EA seemingly has assumed that about 10 spills a year would be the acceptable limit. During the infraction proceedings, the European Commission proposed, the EU Advocate General accepted, and the Court did not dissent from the proposal, that a CSO spill frequency of up to 20 spills a year on average would be acceptable.

This is in stark contrast to the Tunnel, which would be of such a size as to have only 4 spills a year.

## 3. The Position Today:

Previously the Mogden STW near Twickenham was spilling about 110 times a year, on average, into the smaller Upper Tideway.

The upgraded Mogden STW, completed in March 2013, has spilled 20 times over 10 months, - say, a spill frequency of about 20 spills a year, - with no adverse impact on fish, as confirmed by the EA.

Thus, the EA already appears to have approved a spill frequency of about 20 spills a year into the Tideway, in line with EC requirements.

Hence, overall TW's current upgrades to the Tideway sewage treatment works, plus the Lee Tunnel:-

- will shortly reduce the volume of spill from the current level of about 39 Mm3/year to about 18 Mm3/year;
- reduce the number of modelled dissolved oxygen failures from 24 in 10 years to less than 3 in ten years; and
- will much reduce the spills from Mogden STW, which was primarily responsible for the fish kills in 2004 and 2011 in the Kew/Chiswick area.

Described below are the various environmental issues to be overcome and the ways that these could be achieved. Further details of these alternatives are given in Prof. Binnie's Report, "Thames Tideway: Measures to protect the river environment from the adverse effects of waste water discharges", 31st March 2014.

## 4. Issues to be overcome:

### A: Aesthetics:

*Objective:*

The TTSS aesthetic objective was to limit the pollution caused to the point where it ceases to have a significant adverse impact. The EA classified 36 CSOs as unsatisfactory. However this assessment is subjective and has no aesthetics data to support it.

*Analysis:*

The DEFRA criterion for classifying CSOs as "unsatisfactory" is: "*historic justified public complaints*".

The EA reported that there were "*few formal complaints"* from the public about aesthetics. Now, in 2013, two litter collectors are working on the River, Mogden STW overflow discharges have much reduced, and the Lee Tunnel will more than halve the volume of the remaining CSO discharges.

Thus, post-Lee Tunnel completion, i.e. by 2014/15, it would appear that the aesthetics objectives may well be met by existing TW facilities and measures.

*Implementation:*

Under an Alternative Plan to the Tunnel, discharge of sewage debris into the River could be reduced yet further by installing booms around most of the CSO outlets covering some ¾ of the spill volume. The retained debris can thereby be collected. The existing litter collectors and new oil skimmers could be used in the River to collect debris, which escapes, or where booms cannot be fitted.

**B: Environment / Ecology**

*Objective:*

The TTSS ecological objective is to have a sustainable fish population. Fish are considered the most sensitive ecological species and dissolved oxygen (DO) standards have been set, based on fish trials.

The current improvements being undertaken by TW to the sewage treatment works and the Lee Tunnel go a long way towards reaching the DO standards.

*Analysis:*

The EA has provided a schedule of recorded fish kills in the Tideway, in the last 10 years. Compared with the 24, as used in the original modelling, there were only 3 fish-kills in the last 10 years. This discrepancy between the model and record casts great doubt on the reliability of the standards and modelling employed by TW and the EA.

Of great importance, from the perspective of Tideway CSOs that could be connected to the Tunnel, there has been only one recorded fish-kill, and that was of only one fish!. Thus, post-Lee Tunnel completion, it would appear that the objective of a sustainable fish population will be met.

*Implementation:*

The existing mobile bubbler boats would still be available to raise the dissolved oxygen conditions in the Tideway, should that be necessary.

**C: Health / Recreation:**

*Objective:*

The Upper Tideway is widely used by rowers for recreation, generally in the area of Hammersmith. The TTSS recreation objective was to substantially reduce the number of elevated health risk days.

*Analysis:*

The Tideway is not designated as bathing water, and is not subject to the Bathing Water Directive. For navigation reasons, the PLA (Port of London Authority) has recently banned bathing in the Tideway, except with a special licence.

The HPA (Health Protection Agency) carried out an analysis of the illness of rowers in the Upper Tideway. This showed that rowers were ten times less likely to get gastric problems than the general public.

Standard Quality Adjusted Life Year (QALY) analysis, as used by NICE, shows that it would only be worthwhile spending a maximum of £1.5 million to deal with the gastric problems of the rowers.

*Implementation:*

Recent investment at Mogden STW, in particular, has much improved water quality in the Mogden/Hammersmith stretch of the Tideway, which many rowers use. Furthermore, a warning system has been provided to warn rowers in the Upper Tideway, if and when CSO spills occur into that reach.

## D Conclusions

Thus, when the Lee Tunnel is completed in 2014/15, the existing works and measures taken should meet the three TTSS objectives set to meet the UWWTD objective to protect the Thames Tideway from adverse CSO effects.

Hence, the Tideway Tunnel, if or when built, would have very little, if any, impact and, therefore, be of limited utility as a long-term infrastructure asset.

## 5. Additional Measures:

### A: Operational Improvements:

If deemed appropriate, the installation over the next two to three years of:

- booms around most of the higher spilling CSOs;
- in-river aeration;
- oil skimmers; and
- treatment of the top-up water to the docks, where dinghy sailing occurs

could improve conditions further at a cost of about £20mn.

### B: Correcting Sewer Dry-weather Flows:

TW assumed in its London Sewer Model analysis that sewer flows would increase with increasing population and at constant per capita demand. The increase from the base date for the calculations, 2006, to 2035, was approx. 270 Ml/d. However the TW WRMP (Water Resources Management Plan) shows that water supplied is projected to decrease, - not increase, - by some 100Ml/d over this period, i.e. a reduction of nearly 20% on the sewer, dry-weather flow assumed by TW.

This might be expected to reduce the CSO spill frequency, not increase it as assumed by TW. Hence, prima facie, there appears to be some unexplained inconsistencies in TW's modelling on this topic; this must be corrected.

### C: SuDS (Sustainable Urban Drainage Systems)

The implementation of widespread SuDs and BGI (Blue-Green Infrastructure) would also increasingly reduce storm flows from entering the sewers.

At the time of the TTSS, 2003-5, there was limited information about SuDS, and there was very limited experience of how well such schemes worked. Thus, the TTSS was unable to recommend them as a viable solution to meet a European Directive.

A pilot study of SuDS was carried out in the Putney area in 2009 and the report showed that spills would be 10/year or more. Hence, SuDS for Putney was rejected at the time.

At a later date, TW's sewer model was corrected and the existing spill frequencies for two of the CSOs reduced from 59 to 26 and 29 to 19, but the Putney analysis and report were not revised. Furthermore, it now is projected that, with a 50% SuDS scheme in Putney, the spill frequency would be below the EC 20 spills a year, ie within the EC limit.

(*For more information on this see Chris Binnie Report, "Measures to protect the river environment from the adverse effects of waste water discharges", 31st March 2014.)*

Further, although there are significant areas of terrace gravel in the Putney area, the study team was instructed by TW that "*infiltration* was deemed not viable*". With infiltration, the spill frequency would be lower still.

*[* = water permeating the soil to the Water Table, and therefrom distributed naturally].*

The EA assessment of SuDS report states that the scope for the introduction of infiltration schemes into the London sewer catchment area is limited. The Bloomberg Report, based on BGS (British Geological Soc.) data, states that 67% of the area could be developed for infiltration, subject to some technical adjustments and bespoke measures.

Hammersmith and Fulham Borough is claimed by the EA to only have 2% suitable for SuDS, but a large area around Fulham's Farm Lane, as shown by BGS, has high permeability, albeit suffers from a groundwater level less than 3m below the surface.

Nevertheless, SuDS can be successfully implemented with less than 3m of terrace gravel. Geotechnical investigation at Farm Lane has shown no water table within 3m of the surface from December 2010 to August 2011.

Thus, there would seem likely to be reasonable expectation that infiltration, albeit with special measures in some areas, would be possible within about 2/3rd of the sewerage area covered by the Tunnel.

The TW 2010 Sewer Model for London was run on the basis of 50% of the area as impermeable and no infiltration. Not surprisingly, this showed CSOs generally exceeding the assumed 10 spills a year limit. The Model should be re-run with more up-to-date and relevant inputs and judged on the EC proposed limit.

**D: Sewer Separation**

Whereas total separation of the London sewer system into a foul system and a storm water system would be uneconomic and very disruptive, there appears to be significant scope for local separation of the sewers, particularly of developments along the Thames and other local rivers.

There are also many areas in London, where there are already separate foul and storm drainage systems. For instance, at West Putney a storm water drain discharges into the combined sewer system whereas it could be diverted to the Beverly Brook about 70m away. This method of reducing spill frequency was not considered as part of the Putney Study. Such action should be considered across London.

**E: Active System Control ("ASC")**

The Tideway sewer system is complex with many inter-connections between sewers, storm relief sewers and interceptors. The inter-connections are fixed weirs, whose levels were set many years, if not a century, ago. Much has changed in London since then, and the weir levels may no longer be appropriate.

Very few rainstorms are uniform over the whole of the sewer system, so there is often spare capacity where the rain has been less. For instance, the rainstorm of 3rd August 2004 was heavy over the Mogden catchment, significant over West London, but negligible over much of Central and East London.

The idea behind active system control (ASC) is to have weirs, whose level can be varied, thus making maximum use of the spare sewer capacity. This can be done using radar to predict rainfall, and hence sewer flows, and moveable weirs.

Bloomberg states that, in Quebec, Canada, real time control/active system control has reduced spill frequency from 45 spills a year to 26 spills a year.

The EA now requires active system control to be considered for all new schemes. However this has not been done for the full London sewerage system to see where such a method could be applied economically.

**F: Detention Tanks:**

Space for large detention tanks in London is limited. However the detention tanks at Acton have reduced the spill frequency there to 17 spills a year. Planning Permission has recently been given by Southwark Council for detention tanks in Belair and Dulwich Parks. There are likely to be further such opportunities, particularly where RTC/ASC are in use.

**G: Other Measures**

In addition, flow in the sewer interceptors could be reduced by various methods, including reducing the amount of water entering the sewers by connecting part of the sewerage system to another STW, e.g. Mogden or Hogsmill, or to the soon-to-be-completed Lee Tunnel, or diverting storm water to the Thames –Lee water transfer tunnel crossing West London.

Remaining CSO spills from the sewers into the Tideway could be reduced further, by:-

- removing restrictions in the sewer system,
- increasing pumping capacity at the Pumping stations,

**H Combination of Measures**

One requirement of the EU's WFD (Water Framework Directive) is to make judgements about the most cost-effective combination of measures. Whilst a number of studies have been undertaken by TW as to how well individual measures would work and how much they might cost, there appears to be no study about how a combination of measures would work for London, how the most economical solution could be selected in each area, and how much that would cost.

The Commission has since stressed in its Policy Communication the importance of Green Infrastructure. It would be open for the UK Government to discuss such an approach for London with the Commission.

## 6. Summary

A program of a combination of measures, including SuDS schemes, for the area of London which otherwise might be covered by the Tunnel, needs to be developed by TW in co-ordination with Government and London Boroughs to provide a more practical and affordable remedy to any persistent CSO problem that might exist. There is every indication that the EU would find such a Plan acceptable too. Almost certainly the cost of such a combination of measures would be much cheaper than the Tunnel.

Chris Binnie

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**About the author and supporters**

**Prof Chris Binnie**

Chris is an independent, water engineering consultant. He chaired the TTSSG from 2000-2005 so knows the studies that have been done to support the tunnel. He is a Past President of the Chartered Institution of Water and Environmental Management, a fellow of the Royal Academy of Engineering, was director for water consultancy at Atkins, one of the largest engineering consultancies in Europe, for 15 years and is now a Visiting Professor at Exeter University.

**Sir Ian Byatt**

Ian was Director-General of Water Services (OFWAT) from privatisation in 1989 to 2000 & Chairman of the Water Industry Commission for Scotland from 2005 to 2011. He was previously (from 1978 to 1989) Deputy Chief Economic Advisor to the Treasury, concentrating on micro-economic issues, including the performance of Nationalised Industries..

**Lord Berkeley**

Lord Berkeley is a Member of the House of Lords and Life Peer. He is a civil engineer, a Harbour Commissioner at the Port of Fowey in Cornwall and Chairman of the Rail Freight Group, having been Chairman of the European Rail Freight Association (2009-10). He lives in London and Cornwall.

**Martin Blaiklock**

Martin has over 35 years experience of structuring, developing, evaluating and implementing the funding of private and public sector infrastructure projects.

Uniquely, he has worked for extended periods in:

(a) an investment bank [Kleinwort Benson
(b) a commercial bank [HSBC]; and
(c) a development bank [EBRD, as Director of Power & Energy Utilities].

For the last 16 years he has operated as an independent consultant and as a trainer in Project Finance & PPP for governments and banks in over 40 countries.