

Thames Tideway Tunnel



Costs and benefits analysis

with addenda 1, 2, 3, 4, 5, 6, & 7.

by

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Executive Summary

The Thames Tideway tunnel is proposed so the Tideway can meet the Urban Waste Water Treatment Directive and contribute to meeting the Water Framework Directive. The former has a requirement that “*Best Available Technology Not Entailing Excessive Cost*” should be used. The latter has a clause that the cost should not be “*Disproportionate*”.

In December 2006 Thames Water issued the Cost Benefit Working Group report. This was based on a full length tunnel from Hammersmith to Beckton STW costing about £2.1bn. First the costs have increased to about £4.1bn, about double. Secondly the scheme has been split in two, the Lee tunnel and the Thames tunnel. However the 2006 benefit assessment also includes the benefits attributable to the Lee tunnel which will shortly reduce the volume of spills from about 39 Mm³/year to about 18 Mm³/year, a halving. Anyway the benefits would need updating as circumstances have changed since 2006. Thus the 2005 and 2006 Cost Benefit Reports cannot be appropriate for the current Thames tunnel. Sec 104(7) of the Planning Act requires the adverse impact of the proposed development to be assessed., which I take to be a cost benefit assessment. However, as CBA evidence, Thames Water have submitted the outdated and irrelevant 2006 Cost Benefit Working Group Report with its Application. Thus there is no valid CBA submitted to the Inspectorate Panel in support of the Development Consent Application.

The Planning Act 2008 states that the application must be decided in accordance with the relevant national policy statement except if the Secretary of State is satisfied that the adverse impact of the proposed development would outweigh its benefits. It would appear that one illustration of adverse impact is a cost benefit assessment. The government at the EFRA February 2011 hearings said it expected the IPC to take into account the defra, impact assessment. Defra said this was not imminent and one can only assume it is the Defra November 2011 cost benefit assessment.

In Nov 2011 Defra issued a report Cost and Benefits of the Thames Tunnel. This is based on 2006 reports by eftec Stated Preference Survey and by NERA Cost Benefit Analysis. The assessed benefit was £3,935m. I have split this in the proportions found in the 2003 WTP study, 60% to health benefit, £2,400m, 15% to fish, £600m, and 25% to sewage litter, £1,000m. Defra increased the assessed benefits due to inflation, population, and real income growth. The benefit was assessed by Defra to be in the upper half of the range from £2,969m to £5,058m. This compares with the current estimated capital cost of £4.2bn. Thus Defra concluded that the tunnel would be cost beneficial.

There are broadly two sets of issues:

- a) Whether the primary willingness to pay or stated preference survey, as conducted in October/November 2006, gave sufficiently clear and reliable facts to respondents to enable them to make a well-informed assessment when they valued benefits.
- b) Whether DEFRA's updating of the cost benefit analysis based on this primary data in 2011 was based on reasonable assumptions, and whether the authors took adequate account of uncertainties arising from the primary survey.

I am not an economist so the opinions on economic matters need to be considered in that vein and the numbers quoted considered as illustrative of the situation if certain assumptions are made.

Health benefit

The main health risk is illness associated with ingestion of foul water. Levels of pathogens are high at all times because treated sewage effluent discharged into the Tideway is not disinfected. After overflows the presence of pathogens increases substantially, but the difference between dry weather and wet weather risks of developing illness is not understood. Post the Mogden STW upgrade in 2013, spills of untreated sewage into the upper Tideway has reduced considerably and the effluent quality has improved.

The Tideway is not a designated bathing water so does not have to meet the water quality requirements of the bathing Water Directive. The Tideway is a place of high currents and 1,000 ton barges. Recently the PLA has imposed a bylaw that, for safety due navigational reasons, below Putney bathing may only take place with a special licence and such an event would need to be carefully managed with safety boats in attendance.

The Health Protection Authority looked through rowing clubs at reported illness among some 2,000 **rowers** in the Hammersmith area. The incidence of illness in the exposed population, at 18/1,000/year, was remarkably low: gastro- enteric infections in the exposed population was observed at less than one tenth of the incidence in the population as a whole. Post the Mogden STW upgrade the quality of the effluent has improved and spills of untreated sewage into the upper Tideway has reduced considerably

The methodology for appraisal of health interventions, widely used in the health service, places a value on the incidence of illness that an intervention sets out to reduce in terms of Quality Adjusted Life Years. Based on the numbers of people involved, the frequency of illness, the length of illness, the value of time, and the long term discount factor, NERA, the economic consultants, calculate the Net Present Value of the health benefit as £1.5m, considerably less than the £2,400m effectively used by Defra.

Ecological/fish benefit

Fish were taken to represent ecology and the impact of options was assessed in terms of a reduction in the number of fish kills. The show chart said that the baseline condition was 1 to 2 fish kills per year and that with the large tunnel the fish kills would be less than 1 time per year. Major fish kills occurred in 2004 and 2011 but both of these appear to have been caused almost entirely by Mogden STW overflow. To deal with this Mogden STW has been up-rated by 50%. To deal with chronic conditions in the lower Tideway, Beckton STW and Crossness STW are also being upgraded. Further, the Lee tunnel is nearing completion and this will reduce the spill into the Tideway from 39 Mm³/year to about 18Mm³/year. Both the costs and benefits of these works are not allowable to the Tideway tunnel. A supplementary issue presented in the effec survey was impact on salmon migration. Although only 3 salmon migrated in 2013, historically over 300 salmon have migrated, thus water quality would have had limited effect on salmon migration.

I have received the Environment Agency schedule of recorded fish kills in the Tideway. This shows that, ignoring fish kills due to Mogden STW, there were only 3 fish kills in the Tideway

over the last ten years. Thus the situation is already well down the WTP show card of less than 1 fish kill a year. Once the Lee tunnel is operational the fish kill record shows only 1 fish killed from a Tideway CSO spill in ten years. Thus none of the WTP benefit from ecology/fish can be allocated to the Thames tunnel.

In addition there are the existing fixed and mobile bubbler systems as well as the opportunity to implement a more diverse fixed bubbler system as used in the River Seine in Paris.

Litter

Sewage derived litter is only 10% of all litter. The Health Protection Agency state "*Shortly after discharge floating matter disseminates relatively quickly.*" Eftec, consultants to TTSS stated "*Little aesthetics change in the water is to be expected due to Tideway Strategy Options, and this, together with the low correlation between riverside residence and involvement in river-based water sports, suggests that any impact of the Tideway options on property prices is likely to be minor.*" Since then two litter collectors have been provided, reducing the litter impact even further. The requirement of defra to classify a CSO as unsatisfactory is a "*justified historic public complaint*". The EA state "*there are relatively few of these.*" Thus the £1,000bn assessed WTP benefit would appear to be excessive but is retained.

Cost benefit analysis

I have reviewed the base documents and the defra Cost Benefit report. For a number of reasons the primary wtp values are questionable. They are not confirmed by, and are questionable, in relation to more objective valuation methodologies (QALY for health,). Loss of confidence in income growth would also tend to reduce values for benefits which are remote, likely to be invisible or at best marginal for most respondents. At the time of the 2006 survey many respondents will have been confident that incomes would continue to keep pace with inflation. Between 2006 and the revaluation incomes fell significantly in real terms.

The Defra 2011 CBA assessment has been selective in concentrating on those areas where there is an arguable case for up-rating benefits estimates: population growth, income growth, and asset life, while ignoring those uncertainties which support an alternative view that the benefits were significantly overstated in the first place: overvaluation of health benefits well beyond the level and severity of illness that could be affected by the tunnel project, and the known tendency of single issue willingness to pay surveys to over-value.

Other adjustments

Interviewees were given a single choice of what to fund, a measure to reduce the issues on the Tideway, so i have adjusted this for multiple choice based on an analysis of the split with other issues. Defra propose the Thames /Lee tunnel benefit split be done on tonnage transferred. I have corrected the numbers. The defra CBA proposed to increase the appraisal period from 60 to 100 years. There are many uncertainties including the ecological conditions over 100 years in a period of climate change, and future economic conditions. 60 years was selected by NERA and in the defra 2007 RIA, and I have maintained this. I have updated the economic growth factors.

I have doubts about the validity of the benefit base being increased from Thames Water customers to all of England, the lack of allowance for finance for solving other rivers problems, the use of mean rather than median values, and the distance/decay analysis. These would reduce the benefit substantially but I have not adjusted these Defra assumptions.

Analysis outcome

My illustrative analysis shows that, following the methodology used by Defra, and on the basis of the reasons provided, the total NPV benefit would be about £180m. This is about 5% of the cost of the Thames Tunnel. The analysis is summarised in the illustrative table below. Benefits at, or near, this level could mean the cost of the tunnel would be “*excessive cost*” under UWWTD and “*disproportionate cost*” under the WFD.

Were the litter benefit, classified as “minor” by effec, be not £1,000m but, say, £150m then the total benefits would be negative, being less than the dis-benefits of the construction process.

Response of those paying.

For Thames Valley water users, such as in Oxford and Swindon, the bill increase, of some £70 to £80 per hh per year on average, would be well in excess of the median willingness to pay of £10 to £20/hh/year. At a time of economic uncertainty, for a facility that they may not have benefit from often, this may be of appreciable concern.

Do minimum

The Coalition “will end so called gold plating” require greater transparency to decisions, and the Vision for Ministers is to challenge civil servants to actively explore creativity. The Treasury requires consideration of a do minimum option.

To stop debris discharge from CSOs, booms could be placed around most CSOs. To improve health of recreationists in the docks, the top up water could receive treatment.

The UWWTD requires the CSOs to only spill during unusual rainfall conditions. The sewer system is stated to spill up to 50 times a year. In the Infraction proceedings the EC proposed up to 20 spills a year. To reduce spill frequency to that one could: Revise the dry weather flows due to falling per capita demand, reduce the flow into the sewers by further demand management measures, reduce storm flows by diverting to other catchments, remove sewer restrictions, provide real time control, provide some detention tanks, where economical separate the combined sewer system, implement SuDs and BGI, implement infiltration.

Some of these single measures have been studied as individual solutions to London and found to be too expensive. SuDs was studied at Putney in 2009 and rejected as spilling more than 10/year. However subsequent analysis showed it could meet the EC 20/year.

The RBPG states “*The WFD requirement is to make judgements about the **most cost effective combination of measures**, so it is important that the Environment Agency considers the inter-relationship between measures.*” My emboldening. Thus the Agency has an obligation to study the **most cost effective combination of measures**.

An independent study is proposed to identify how a combination of measures might reduce the spill frequency of the London CSOs sufficiently at an economical cost.

Item	2003/5	2006/7	2011	Comment	Adjustment
	CBA	CBA	CBA		
Base amount			£3,935m		£3,935m
Health	60%	combined	combined	QALY not WTP	To £1.5m
Fish	15%		combined		To 0
Litter/aesthetics	25%		combined	Property benefit minor	Keep £1,000m
Jurisdiction	Admin	A+B	A+B	Benefit Jurisdiction doubt	none
Single/multiple	single	single	single	Multiple in FBP	-60%
Other rivers				No allowance. ? half	none
Mean/median			mean	Median about half	none
Protest votes	included	included	excluded	15% increase	none
Distance decay	No	Yes	Yes	Results look odd	none
Monetary values	no	No	No	15% constant nominal	none
Thms/Lee split	NO	No	TT 60%	Adjust tonnage	-52%
Benefit of Lee T	No	No	No	Lee tunnel needed for Thms T	none
Appraisal period	60 years	60 years	100years	60 years	No increase
			+14%		£192m
Reduced hh flood			no	Entec Table 4.3	+£7m
Disbenefits	no	no	no	Half upper of £85m	-£42
Base amount					£157m
GDP deflator 06-11			+10.6%	Fall of 6.5%	
2011			2,969m		£157m
Population rise	No	No	+14%	Ldn % applied to benefit area	+14%
amount			3,391m		£180m
Real income growth	NO	No	+33%	2006-2011 -6.5% not 10% GDP includes population.	zero
Spill volume			Not included		Not included
Amount			4,502m		£180m
Quoted range			2,969-5,058	. ?£4,502. ?maths.	
Mid-point benefit			4,013m		

This illustrative table takes the base the amount found by the effec WTP study, £3,935m, splits it according to the ratio found in the 2003 wtp,. The three dated columns are how particular factors were taken account of in the three cost benefit analyses. The right hand column is my assessment, and the column on its left the reason for the change. GDP includes population change. GDP has been negative and the future is uncertain so I have accepted the population change and ignored GDP changes. For details see the relevant sections of the report.

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1 Introduction

The objective of the Thames Tideway Tunnel is to meet the Urban Waste Water Treatment Directive (UWWTD). This has the overarching objective “*To protect the environment from the adverse effects of urban waste water.*” At the start of the millennium, combined sewer overflows (CSO) into the Thames Tideway occurred up to about 50 times a year resulting in adverse conditions and some of them breaching the requirement in the directive to only spill during unusual rainfall. The Directive requires Best Available Technology Not Entailing Excessive Cost.

Chris Binnie

I was the Independent Chairman of the Thames Tideway Strategy Steering (TTSS) group from 2000-2005. I continue to be independent, my time input in preparing this report is not funded by any party or lobby group, and I live outside the Thames catchment so I would not benefit from any change in Thames Water charges. I am not an economist so the opinions on economic matters need to be considered in that vein and the numbers quoted considered as illustrative of the situation if certain assumptions are made.

TTSS

At the time of the TTSS study we were steered that the limit of unusual rainfall adopted elsewhere was, from memory, about 6 to 8 spills a year on average. At that time there was limited experience elsewhere on many of the measures that could be adopted and how successful they might be. Thus, the only option where we could be certain that it would meet the Directive with certainty was the tunnel. At that time, 2005, it was estimated to cost £1.7bn.

Recent experience

Since then there is much more experience of a number of the other alternatives of reducing spill frequency and in addition the EC has indicated that up to 20 spills a year might be acceptable. This in itself much enhances the potential of other measures in combination meeting the required spill frequency.

In December 2006 Thames Water issued the TTT Cost Benefit Working Group report. This was based on a full length tunnel from Hammersmith to Beckton STW costing about £2.1bn.

Ofwat view of the cost benefit of the full length tunnel

In 31st January 2007 Ofwat wrote to Ian Pearson MP, Minister for Climate Change, Food and Rural Affairs, and published on their web site the following. “*The quality of the Thames Tideway has been much improved in recent years. Much more will be achieved by the substantial programme extending from now until around 2014. In addition, a programme to strengthen Thames Water’s ability to minimise environmental and aesthetic problems arising from the discharge of combined sewer outflows has been commissioned. This consists of boats to skim the surface to remove litter to supplement the existing re-oxygenation boats. The first such skimmer boat is due to enter service in March.*” And did.

“*All the work done to consider yet further improvements to the Tideway demonstrates that it would not achieve value for money. Indeed, the evidence strongly suggests that the benefits*

would be very limited from the proposed sewer interceptor, whether in terms of health improvement, nuisance reduction, or environmental improvements. Any such improvements would not in any way be proportionate to the very high cost-well over £2 billion for each of the variants of Option 1”

“none of the options investigated has been shown to represent value for money...all options have been calculated as having negative NPVs when benefits accruing to Thames customers are used.” Despite these concerns, in March 2007 the Minister instructed Thames Water to develop the tunnel scheme.

Planning Act

104(3) of the Planning Act 2008, as amended, states “*The Secretary of State must decide the application in accordance with the relevant national policy statement except to the extent that one or more of subsections (4) to (8).*”

104(7) states “*This subsection applies if the Secretary of State is satisfied that the adverse impact of the proposed development would outweigh its benefits.*”

I am advised that adverse impact includes the costs of construction of the scheme. If so then the Panel, in advising the Secretary of State, presumably has to consider the cost benefit analysis of the scheme. If this is adverse then the Development Consent Order can be refused, notwithstanding the status of the Tideway tunnel as a national infrastructure project.

EFRA Committee hearing on the draft National Wastewater Infrastructure policy statement.

The EFRA Committee hearing was held on 16th February 2011 with the Minister Mr Richard Benyon supported by the Defra deputy director Mr John Bourne.

Q205 EFRA “...should the culture of cost-benefit analysis be hard wired into the NPS...?”

Richard Benyon “*The IPC will look very carefully, wont they , at the economic case...? I think they will look at it particularly in the context of looking at alternatives.*”

Q206 John Bourne “*Would we expect the IPC to take into account the kinds of things the Minister has mentioned about customer bills and the work that others including ourselves have done on impact assessment and value for money. Yes*”

Thus it appears clear that the government expect the Planning process, ie the Panel, to look at the cost benefit assessment.

Q207 EFRA “*Obviously, you will provide us with the updated impact assessment before we conclude.*”

Q208 John Bourne “*It is not imminent, but it will be ready before the IPC look at any planning application.*”

This would appear to refer to the Defra Cost Benefit assessment which was eventually published in November 2011. Thus government expected the panel to consider that.

Q209 Richard Benyon “Yes, *the IPC will look at issues relating to this scheme and alternatives...*” Thus government also expected the Panel to look at alternatives

Planning Application

Thames Water have submitted the 2005 and 2006 Cost Benefit Working Party reports to the Panel, documents 8.1.7 and 8.2.6. There are several problems with using the 2005 and 2006 cost benefit reports to consider the current Thames Tunnel. First the costs have increased from about £2bn to about £4.1bn, about double.

Secondly the scheme has been split in two, the Lee tunnel from Abbey Mills to Beckton STW and the Thames tunnel from Hammersmith to Abbey Mills. The Lee tunnel will shortly reduce the volume of spills from about 39 Mm³/year to about 18 Mm³/year, about halving the spill. Thus the benefit found would need to be split between the two tunnels. However the 2005 and 2006 benefit assessments include all the benefits attributable to the total length of tunnel. In any case the benefits would have changed since 2006 so the benefits would need updating. Thus the 2005 and 2006 Cost Benefit Reports cannot be appropriate to assess the CBA of the Thames tunnel as currently submitted. However, as CBA evidence, Thames Water have only submitted the outdated and irrelevant 2005 and 2006 Cost Benefit Working Group reports with its Application. Thus there is no valid CBA submitted to the Panel in support of the Development Consent Application.

Defra 2011 cost benefit analysis

In November 2011 defra issued a Costs and Benefits of the Thames Tunnel report (CBA). This is based on the 2006 eftec Stated Preference Survey and the NERA Cost Benefit Analysis, with benefits updated by defra to 2011 and further benefits added.

At the EFRA hearings the government appeared to expect the Panel to also consider that cost benefit assessment so my report considers that in detail.

The Defra CBA considers that the benefit of the Thames tunnel is in the upper half of the range £2,969m to £5,058m, ie £4.5bn. This is similar to the then estimated cost of the Thames Tunnel at £4.1bn. Thus Defra considered that construction of the Thames tunnel is warranted.

My report

I issued a similar report in early 2012. More information is available since then so this report has been updated accordingly. My analysis looks at some of the factors in the two base documents and then the CBA. I also give consideration as to whether the benefit of the Thames tunnel could be sufficiently low that the cost, relative to the benefit, is likely to be classified as “excessive” under the Urban Waste Water Treatment Directive (UWWTD) or “disproportionate” under the Water Framework Directive (WFD).

I then look at how it might be possible to meet the EC proposed up to 20 spills a year in an economical way.

2 Cost benefit Stated Preference Survey by eftec, Dec 2006

Introduction

A Willingness to Pay (WtP) study was done by Eftec, Thames Tideway-Stated Preference Survey December 2006, with field testing begun in October 2006. This was first used to assess the comparative cost/benefit of three alternative tunnel systems.

This Eftec report was then used by NERA Thames Tideway Cost Benefit Analysis December 2006, to assess the benefit cost ratio of two groups of three alternative tunnels. Finally the Eftec and NERA reports were updated by defra in 2011 to provide cost benefit analysis of the Thames Tunnel from Hammersmith to Abbey Mills.

First I will consider the Eftec report and the validity of the descriptions used of the tunnel alternatives and then the validity of the benefit methodology and output.

Descriptions of the alternative schemes

Three schemes were tested by Eftec, a “large” storage tunnel 7.2m dia, a “small” storage tunnel 5m dia, , both from Hammersmith to Beckton STW and a “two tunnel” option with a tunnel from Hammersmith to Battersea and the Lee, tunnel from Abbey Mills to Beckton .

The large tunnel at 7.2m dia is the same size as the currently proposed Thames Tunnel from Acton to Abbey Mills. The main tunnel capex is set out on page ii of the NERA Cost Benefit Analysis Report 2006 as about £2.36bn. The NERA two tunnel cost is £1.8bn. This two tunnel scheme has not been carried forward.

Since the 2006 wtp study was done the large tunnel scheme has been split in two. The Lee tunnel from Abbey Mills to Beckton STW is now under construction and due to be operational by 2015. This tunnel will reduce the annual CSO spill into the Tideway from 39 Mm³ to 18 Mm³, with appreciable benefit.

Description of the outputs of the alternative schemes

Below is the show card used in the etec willingness to pay study

Table 3.1: Baseline and CSO engineering options				
	Baseline - future situation after completion of agreed investment in sewage treatment works ¹	Large Tunnel	Small tunnel	Two tunnels
Year	2014	2021	2021	2021
Fish population	1 or 2 times per year when oxygen levels in the water drop low enough to either kill some fish or prevent migration (e.g. salmon)	Less than 1 time per year when oxygen levels in the water drop low enough to either kill some fish or prevent migration (e.g. salmon)	Less than 1 time per year when oxygen levels in the water drop low enough to either kill some fish or prevent migration (e.g. salmon)	Approximately 1 occasion per year when oxygen levels in the water drop low enough to either kill some fish or prevent migration (e.g. salmon)
Sewage litter	May be visible anywhere along the tidal Thames, but especially visible close to outfalls following overflows Amounts to 10% of all litter	Small amount visible 3 times per year following overflows.	Small amount visible 8 times per year following overflows.	Location-specific. Overall impact is reduced by some two thirds (2/3) but no benefit for the overflows not connected to the tunnels.
Risk of suffering illness through contact with river water	Higher risk following each overflow High risk at all other times	Higher risk only following the remaining 3 overflows per year. High risk at all other times	Higher risk only following the remaining 8 overflows per year. High risk at all other times	Location specific. Overall risk reduced by some two thirds (2/3) . No change for the overflows not connected, which still cause a higher risk from 60 overflow events per year. High risk at all other times
Frequency of overflows	60 times per year on average Fewer in dry periods	3 times per year on average	8 per year on average	60 times per year for some overflows but 3 times per year where the tunnel is built
Water bills	Ongoing and agreed investments in water supply, leakage reduction and sewage treatment will increase water bills	Will continue to increase to finance investments in water supply, leakage reduction and sewage treatment	Will continue to increase to finance investments in water supply, leakage reduction and sewage treatment	Will continue to increase to finance investments in water supply, leakage reduction and sewage treatment

1: The only difference between this and the situation that prevails now is the number of times per year when oxygen levels in the water drops low enough to either kill some fish or prevent migration. This is currently eight and with investments in sewage treatment works will reduce to one or two as in the table.

Below I consider whether the Show Card Table, as shown to interviewees, reflects the actual baseline situation appropriately, that is post the Mogden, Beckton, and Crossness STWs upgrades. (At the time of the interviews the Lee tunnel had not been authorised. Thus the original interviews would have been done when the tunnel scheme included both the Thames tunnel plus the Lee tunnel). In particular the information given on fish kills would appear, subject to further information to be sent to me, to be misleading and reliance on exposure as opposed to actual health incidence seem to me to be overwhelmingly strong points about the inadequacy of the data presented to respondents. It is also appropriate to consider whether the situation post the construction of the Tideway tunnel is properly reflected.

Administrative /benefits jurisdiction

TW customers would be the people who would pay for the investment and hence are referred to in the etec report as the administrative jurisdiction. However the population that can potentially benefit from the environmental improvements incorporates all who see, pass by or purposefully visit the Tideway and hence are called the benefits jurisdiction.

For the 2002/3 stated preference (sp) Willingness to Pay (WtP) study only those in the administrative jurisdiction were included, see TTSS Cost Benefit Working Group Report February 2005 page 17, as those are the ones that would have to fund the costs of the scheme.

The eftec study states, page 11 *“Defining the relevant population for the economic analysis of the CSO investments is relevant both for the cost benefit analysis and for the stated preference survey. In theory, this population should include all who gain or lose as a result of a given investment. In the context of this study, as it is concerned with the non-market benefits of reducing CSOs in the Tideway, the relevant population consists of anyone who sees or visits the Tideway. As discussed in Section 1.3, ideally this should include residents of the UK and tourists. However, since aggregating the benefits across tourists is problematical, this group of the population is excluded from the survey. The rest, ie the UK population, constitutes the benefits jurisdiction.”*

It is difficult to know how often those within and those outside the Thames Valley visit London and see the Tideway. Clearly there are a number in both groups. However a reasonable assumption might be that those who are outside London and the Thames valley who see the tunnel about equal those within the Thames Valley who do not see the Tideway. Thus a reasonable assumption might be that the WTP from the administrative area would be appropriate. However as the distance from London increase then fewer and fewer would see the Tideway. Thus it would become difficult to argue that the WTP of the administrative area should be widened much.

However, for the 2006 eftec sp, wtp surveys were carried out covering the whole of England and both the Thames Water administrative area and the full jurisdiction in all England results calculated. The benefit from the Thames Water administrative jurisdiction alone was found to be less than the cost of the tunnel so the focus of the subsequent CBA was on almost the whole of England, classified as the benefit jurisdiction.

No clear evidence is given as to why the area assumed in the WtP study was changed from the TW customer area, as used in the 2004 study, to all England in the 2006 WtP study.

It is noticeable that the benefit rises from £66m/year in the Thames Water customer area to £174m/year in the all England “benefit” area, see NERA Table 2 page ii. Although many people outside the Thames Valley will know and appreciate the Tideway, there are many more who will not. Although many more people live outside the Thames catchment than within it they are very much less likely to see or benefit from the improvements. Instinctively having the benefit of those living outside the Thames catchment some one and a half times the amount of those living within the Thames catchment seems high. Respondents outside the Thames administrative area were not asked whether they would expect reciprocal assistance with costs falling on their own water company or reminded that Thames sewerage bills are generally lower than those of neighbouring water companies. Thus there may be doubt as to the extent of the benefits assessed from the all England benefits jurisdiction.

Presumably the interviewees were expected to assume that the average water charges in their own company’s area would be going up as historically they had. However they were asked about paying for a single issue, the Tideway tunnel to improve the water quality of the

tidal River Thames. What would have happened if they had also been asked what they would also be willing to pay to improve the water quality of the Severn, the Trent, and the freshwater Thames? Would their willingness to pay for all four have meant the amount they were willing to pay for the Tideway would have gone down? Almost certainly yes.

As a corollary, would the amount the interviewees in the Thames Water area were willing to pay have gone down if they had also been asked to pay for water quality improvements in these other rivers as well, and the improvement of bathing beaches water quality around the coast. The answer is almost certainly yes. However there is no way of knowing the extent of the over-assessment due to the use of single feature assessments outside the administration jurisdiction. WTP for baskets of investments in the context of price review business plans or the all-England valuation of environmental benefits in the context of WFD should prompt critical reconsideration. In Appendix B I consider on the basis of many broad assumptions the WTP based on WFD analysis data. The TTSS included only the benefits from within the Thames Water customer area for sound reasons. Thus the figures of benefit from the so called benefits jurisdiction should, in my opinion, be treated with caution. M

Distance decay analysis

The Eftec Stated Preference Survey report includes the analysis of the three schemes and considers both the mean analysis and the result based on the distance decay function. It also splits the results into the administrative jurisdiction, ie the area covered by the Thames Water sewage function, in effect the River Thames catchment, and the benefits jurisdiction, assumed to be England. The results vary widely.

The mean estimate is shown in table 6.3. The aggregate WTP, central estimate for the administrative jurisdiction in £ per year is

Large tunnel £123M

Two tunnels £100M.

These numbers are reasonably close and are believable, the lower benefits of the two tunnel scheme being similar, but somewhat lower than the large tunnel scheme.

The report then analyses the response on the distance decay basis. That means that as the distance increases the respondents assessment reduces. This seems a logical principle. However the report does not show the data on which it bases the decay function. Thus one cannot see the data plots that lead to the distance decay function. That is an unfortunate deficiency.

For the Thames Water (TW) customers in Table 7.1 the distance decay function results in WTP per year of

Large tunnel £66M

Two tunnel £26M.

This big divergence between the two tables seems odd. The base is the population of the sewage function. For the total administrative function this is 13.6M. Of these the GLA says that 7.6M live in London. None of these are more than about 10 miles from the River

Thames. It seems hard to think that there would be much of a decay function within London. However for the total for the two tunnel scheme to drop to about a quarter of the mean, then the decay function in London, where no one lives much more than 10 miles from the Tideway, must be more, on average, than 50%. I asked eftec for the reasons but did not receive a reply. This does need reconsidering. Since no distance/decay data is provided it is not possible to examine the reasons. However it does show that the output of the report does need examination and reconsidering. M

The all England area decay function for the two tunnel scheme is found to become zero at Sheffield in Yorkshire, 160 miles from London.

The distance decay function for the large tunnel is found to continue to at least 270miles. This boosts the large tunnel so that the annual WTP for the jurisdiction area becomes

Large tunnel £174M

Two tunnels £ 43M.

Considering the closeness of the outputs set out in table 3.1 this wide variation in WTP between the full tunnel and the then two tunnel scheme does seem surprising. The eftec study on page 8 states *“the improvements in the attributes now defined are much more subtle. Therefore, using choice modelling in this study could have resulted in WTP per attribute estimates to not be statistically different from each other.”*

Thus, if the difference in each of the attributes is subtle, and could have resulted in estimates not much different then how come the substantial difference in the end WTP ? This does seem surprising.

Water bills.

Table 4.16(B) gives the median WTP. For the administrative jurisdiction, excluding the protest votes this is shown as £10/hh/year and with the protest votes this is £20/hh/year. However the actual bill increase is quoted as £70/hh/year to £80/hh/year. This seems to show that there will be many households who will be paying much more than they are willing to.

Conclusion

The differences between the scheme attributes are described as “subtle “ by eftec’ . However the difference in benefit between the large tunnel and the two tunnel scheme is considerable. This is not logical and the reasons are not explained.

The distance decay WTP of the two tunnel scheme for the administrative region does not appear to be consistent with the figures for the mean value.

Although the 2004 CBA analysis had used only the Thames Water Administrative area, the area of assumed benefit in the 2006 CBA analysis was extended to the whole of England on the basis that almost the whole population of England would benefit. This change does not appear to be sufficiently supported and seems challengeable. M

3 Thames Tideway Cost Benefit Analysis by NERA December 2006

Introduction

The NERA CBA report of 2006 considers the eftec Stated Preference Survey and then provides the cost benefit analysis. NERA produced a final report dated January 2007 but the differences are a few phrases only and make no change to the points made below. References below are to the NERA 2006 report unless noted otherwise.

NERA calculates in Table 7.2 page 32 the net **benefit** for the full tunnel (option 1c phased) in the administrative jurisdiction as £1.5bn with discounted cost of £2.05 bn. Thus, for the administrative jurisdiction, ie the Thames Water customers who would actually pay for the full tunnel scheme, the cost benefit ratio assessed by NERA was significantly less than 1. Thus the cost would be likely to be deemed excessive under the UWWTD.

For the full tunnel, for the benefits jurisdiction, the net benefits are £3.9bn. Thus the benefit cost ratio was 1.9, with no substantial difference between the variants considered (see Table 3 on page iii). As discussed above, there must be doubt about the validity of extending the benefits to the whole of England where the sewerage charges are already generally significantly higher than in the Thames Water area and the actual benefit of the tunnel much less. M.

NERA identifies a number of other potential adjustments.

Single/multiple issue WTP studies

"It is noted that questions about one environmental benefit, such as a cleaner river, may yield different higher valuations from questions about allocating money across a wider set of benefits. We believe that such factors are legitimate reason for caution in reliance on stated preference results, but we do not consider them further in this report ", page 27.

My understanding of this comment is that people may have in mind a general amount of money they would be prepared to spend on environmental benefits in general. Thus if they are given a wide range of potential benefits, they will scale down the amounts they would be willing to pay on each of the schemes compared to what they would be prepared to pay on a single scheme..

Richard Cookson in his paper "Willingness to pay methods in health care" in 2003 states *"investigators have found that people tend to state a similar amount- roughly £50- for any given magnitude of reduction in the risk of death or injury."* Whilst this statement refers to the health sector there might well be a similar effect generally, ie £50 to be spread around however many benefits were being considered. He continues *"WTP methods tend to inflate valuations of the specific intervention that respondents are asked about, relative to interventions that respondents are not asked about. Asking for respondents to focus on one specific intervention in isolation acts as a kind of magnifying glass for stated WTP. When asked to consider an intervention in isolation, people are willing to pay sums of money far in excess of what they are willing to pay when asked to consider the same intervention in relation to a range of other interventions."*

He also notes that Willingness-to-Pay methods are notably poor at reacting appropriately to the scale of an issue or intervention.

The mean value of the amount Thames Water’s customers were prepared to pay in 2006 for the full tunnel is shown in Table E1 of the Eftec Stated Preference report 2006 as £24.66 /hh/year. This is the basis of the further WTP calculations.

However soon afterwards TW carried out a multi issue WTP for its Business Plan, see below

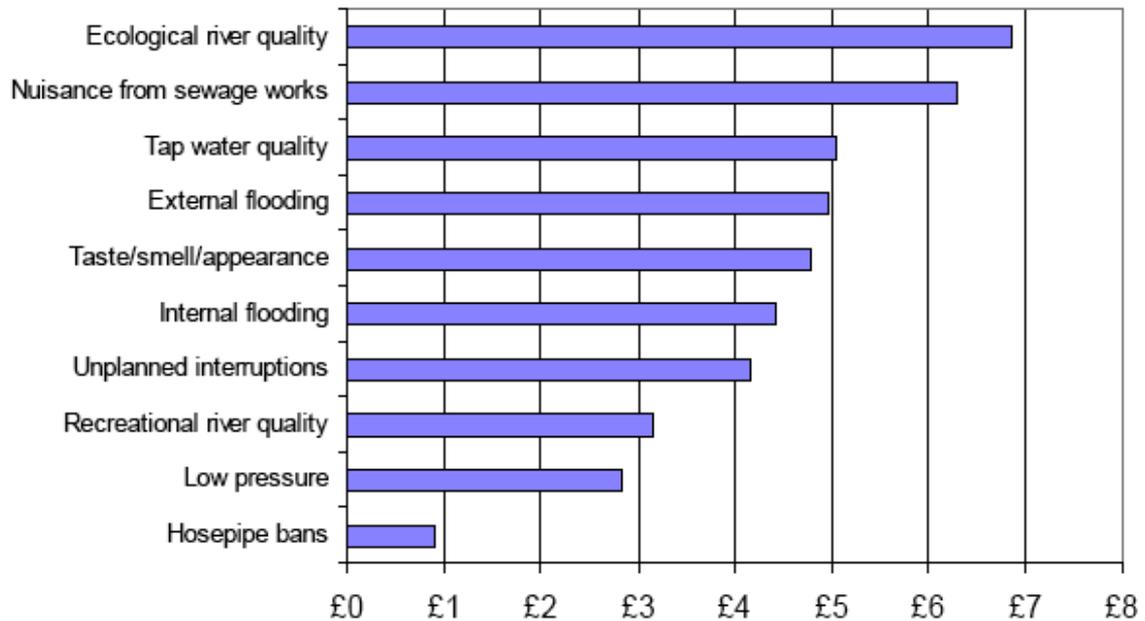


Figure 2: Willingness To Pay for an Improvement to the +1 Level From Stage 1 Stated Preference Surveys

from Annex C-1 page 61

This shows a Willingness to Pay of some £6.9 per household per year for improvements to ecological river quality and £3.1 per household per year for recreational river quality. This is a total of some £10 out of a total willingness to pay of some £43. This of course applies not just to the Tideway but to all the rivers in the Thames Water catchment. Thus, at best, the £25/household/year should be reduced to £10 per household/year, a reduction of 60%. Thus the NERA CBA would appear to be overestimated by about this amount and should be reduced accordingly.

Eftec, during their WtP data collection asked respondents what was their priority for public spending. Table 4.3 shows “*water quality in local rivers*” got 6.2% first preference and 10.3% second preference in the TW area, and 11.6% and 9.2% in the non TW areas. This of course would come out of a larger sum as it included such topics as air pollution, but the amount would need to cover all rivers. Thus, whilst not monetised, it would indicate that the £10/hh in £43/hh would be significantly too high, and could be as low as about £5/hh/year, a reduction of about 80%. In reality to allow for funding of river issues elsewhere, the

reduction ought to be even greater. However I have only reduced the effec single WTP numbers by the 60% reduction found in the multiple analysis.

Mean or median values.

Another issue on which there is no unambiguously correct answer is the choice of mean or median values from the survey results. NERA base numbers are derived from mean willingness to pay.

Mean values are significantly higher values, but “*give weight to those who are willing to pay more money because they are richer*” and to “*those with exceptional environmental preferences over those with average.*” NERA note that “*given difficulties with the mean it is not universally used in cost benefit analysis,*” and that median wtp is more usually used within government for small reductions in death and injury. (Nera p28)

The comparison is given in Tables 4.16 a and b as the large tunnel entire sample mean is £19.30/hh, and the median is £10/hh. Thus changing from a mean value to a median value as would appear generally used, would nearly halve the assessed benefit. As the choice is arguable I have not changed from the mean but it is yet another instance where the benefit assessment may well be appreciably too high, possibly as much as nearly double M.

Interviewees who were not prepared to pay anything

The third material point is interviewees who are not prepared to pay anything., described as subject to some analysis of any reasons given by individual respondents as “protest votes”.

Eftec state page 28 “ *it is necessary to ensure that the responses are valid. In economic terminology, valid denotes responses that reflect true preferences about the changes presented in the questionnaire. The protest responses, on the other hand, are those which reflect other considerations such as dissatisfaction with the institution providing the change or finding the scenario unlikely. Protest responses that concern the analysts most are zero responses.. Given that the WTP estimates of policy relevance are the valid expressions of true preferences, it is general and best practice to exclude protest responses from the sample.*”

“It could be argued that these particular people would really gain some utility from the project’s benefits, but are concealing this, and a cost benefit analysis should therefore reject their response.”

”It could be argued that people’s preferences are what they say, whatever the reason, and they would presumably vote that way, given the opportunity...In our Base Case we rely on the data presented by Eftec, which excludes responses judged by Eftec to represent protest responses.” NERA page 28.

As I understand it so called “protest votes” are believed to be those who would not pay anything towards the scheme, believed to be as a protest against some issue. Thus I question the basis on which the people who refused to pay anything were excluded. There is limited evidence provided on which to do so, and as values were overwhelmingly non-use values, ie from respondents who will not derive direct benefit, is there sufficient justification for such a significant exclusion?

As I understand it the result is to include in the calculation of household willingness to pay only the amount and numbers of those recorded as prepared to pay and excluding the so called “protest” vote who were not prepared, or able, to pay. This average is then applied to the whole population including those who were not prepared to pay. This seems illogical and guaranteed to result in a larger willingness to pay than actually found in the interviews.

The effect of this is shown in eftec table 4.16a for the mean would increase £19.30 to £22.55, about a 15% increase.

NERA continue *“The inclusion or exclusion of such response might make a material difference. For TW customers their exclusion increases the mean valuations by 20 to 30 per cent and increases the medians by 50 to 100 per cent. For non-TW customers the effects are smaller but still material.”*

Clearly this is a serious issue, particularly when assessing the willingness to pay for an investment in a multi billion pound project. Without further data it would seem reasonable, for the mean, that no adjustment be made to the willingness to pay. Thus the eftec and NERA benefits would have been overestimated by about 15%. I have however not taken account of this.

Monetary values

NERA states on page 26 *“The stated preference questions ask households to express monetary values in terms of a constant and ongoing increase in their annual water bill. Unfortunately we do not know whether the values households provided were meant by them as monetary amounts with constant purchasing power or rather as constant nominal monetary amounts whose purchasing power will erode with inflation.... The first interpretation is simpler conceptually and in modelling terms and is what NERA has employed in the Base Case.”*

However there may be respondents who took the question literally, and therefore the benefit amounts used would have been an overestimate. It is not possible to assess the amount of this overestimate. However the NERA sensitivity analysis in Table 8.1 for the deflated WTP values shows that the benefit/cost ratio would drop from 2.04 to 1.4, a drop of 31%. Assuming that 15% of respondents had responded as the second option then the drop in benefit would be about 5%. However I have not adjusted the numbers in my table for this effect. No reduction has been applied by NERA or defra.

Benefit split

The TTSS report split the objectives for the tunnel into three environmental indicators. Thus the earlier, 2003, willingness to pay analysis split the benefits for health, ecology (fish), and litter.

The 2006 WtP survey did not collect data on each of the three benefits separately, just the overall figure which came to £ 3,935m. However the show card did only mention just the same three benefits so it would be appropriate to assume that the total would be on the same basis.

The only evidence on which to split the overall 2006 benefit is on the basis of the 2002/3 survey. This was;

Health	60%	£ 2,400m
Fish kill	15%	£ 600m
Litter/debris	25%	£ 1,000m

Both WtP surveys are for a large tunnel from Hammersmith to Beckton STW but do not include the benefits, or costs, of the STW upgrades. Both talk about the three benefits of reduced risk of suffering illness, reduced fish kill, and reduced sewage litter. The first survey was done in November 2002 and the second in October 2006, thus relatively close in time, so this in itself would not change the split. The only significant difference is that, between the two surveys, a decision had been taken to improve the sewage treatment works effluent standards. The footnote on page 12 of the Eftec stated preference survey states "*The only difference between this and the situation that prevails now,*" ie the same situation as at the time of the original 2002 survey" *is the number of times a year when oxygen levels in the water drop low enough to either kill some fish or prevent migration.*"

Thus there might be a case for reducing the fish kill proportion and increasing the other two. However the fish proportion is, anyway, the lowest at 15%, so the scope for reallocation of fish benefit is very small. For instance, reducing the fish proportion of the benefit to 10%, would only provide another 5% to be allocated to the other two parts. Of importance, this would not change the total base amount of the benefit. I have, therefore, kept the same split as in the 2002/3 WtP survey.

4 Benefit from reducing sewage litter.

Source of litter

Unscreened combined sewer overflows result in both storm water and sewage being discharge to the river under storm rainfall conditions. In addition wind-blown and other debris, such as timber, vegetation, plastic bottles, and suspended sediment are found in the Tideway. "*There are the relatively persistent plastics and paper, and the organic faecal material, both of which may be seen floating in the river or deposited on the foreshore (although the latter may disperse fairly quickly).*" TTTT Vol 1 Objectives 2006 p 10.

TTSS objective.

There is no specific clause in the UWWTD dealing with aesthetic pollution. The TTSS adopted as an objective "*To reduce the frequency of operation and limit pollution from those discharges which cause significant aesthetic pollution, to the point where they cease to have a significant adverse effect.*" This was re-endorsed in the TTTT Objectives report of December 2006.

Baseline situation

Sewage litter is unpleasant to see and reducing it is a worthwhile objective, providing it can be done at an appropriate cost. It is generally accepted that sewage derived litter makes up 10% of the total litter. This figure is from the Tidy Britain Group. There is limited evidence to support this figure but it is a generally used figure. Thus 90% of the litter/debris in the Tideway is assumed to be not sewage derived.

The Health Protection Agency Recreational Users report page 22 states “*The nature of the tideway is such that there is a consistently high level of turbidity at all times.*” Thus the river is a dark turbid muddy colour.

“*Shortly after discharge floating matter disseminates relatively quickly so the plug of sewage effluent moves unnoticed with the ebb and flood of the tide.*” HPA Recreational Users report page 52.

If most sewage waste either sinks or breaks down fairly rapidly, is largely un-noticed and difficult to detect among other larger volumes of litter, it follows that the Tideway investment may not make a great deal of difference to perceptions of litter, except for those recreational users and others who get very close to floating debris.

However some condoms, panty-liners and blue plastic cotton buds can float. There can also be a brown oily build up on boats in certain parts of the Tideway. This is believed by some to be sewage derived such as cooking oil, car oil, or other sources.

As part of their review Jacobs Babbie team did a trip on the Thames on 31st August 2005 and reported “...several days after the most recent rainstorms, floating debris was seen in several locations. The slicks that the TTSS describes in its reports were observed, and, on close inspection, it was clear that some of the debris contained in them was sewage-derived. However, our opinion is that it would not be immediately apparent to a casual observer that the debris was any more than windblown litter and vegetation- a fact reflected in public responses obtained during the TTSS.” Independent review for Ofwat Feb 2006 page 8.

Jacobs Babbie continue on page 9 “*In addition to the slicks, litter was seen to have accumulated on the banks of the Tideway. However much of this is coarse debris which is likely to have originated from sources other than the CSO discharges. Much of the bankside of the Tideway is overlooked from adjoining residential and commercial buildings or is accessible to the public, albeit access to the actual waterside is made only infrequently. Numerous leisure vessels provide visitors to London with river tours. Thus bankside litter deposits may be considered a very visible aesthetically feature from the public standpoint.*”

In which case the collection of all litter by skimmers would be a significant aesthetic improvement.

Some of what is perceived as sewage litter is not. After storm events at Mogden in July 2009 complaints were received. The Environment Agency investigated and concluded:

“*Our findings indicate that the persistent brown solids seen floating in the river and stranded on the foreshore are not sewage related. They are a natural organism, moss like in appearance, which pose no health risk, but can give the appearance of sewage on the water. . .*

During storm events, faecal solids are discharged in the storm sewage. However, these are usually broken up and breakdown within two to four days. Other sewage litter can also be seen immediately after an event but this too usually dissipates fairly rapidly. “

On page 11 Jacob Babbie’s quote from the etec report The Market Benefits of Options for the Thames Tideway appended to the TTSS Cost Benefit Working Group Report which they say states

“...although reducing CSO events would be associated with reduced amounts of sewage litter, this is currently only a small (10 per cent) proportion of the total litter and debris in the Tideway at any one time, and what there is appears to be invisible much of the time, at least as far as individual perceptions are concerned.

This is one of the findings of the SP (TTSS's stated preference survey) as well as being the view expressed by consultees from the London property market. We might expect certain river users to notice a difference, in particular those who come into close contact with the water, such as rowers, houseboat owners and those who frequently walk by the river. However, in general the public are unlikely to detect much visible difference, and this includes owners of riverside property who, as we have just argued, tend to partake in river-based activities from a greater distance... The Thames is a tidal river downstream from Teddington, and levels of suspended silt and mud in the water are naturally high and always will be. Reducing CSO events will not have any impact in this regard.

On the Tideway Tunnel, Jacobs Baktie concluded:

“in general the public are unlikely to detect much visible difference . . . the need for significant sewerage infrastructure investment to deliver a low level of perceived qualitative benefit, and remove a low percentage of the total litter is therefore open to challenge.... whilst there is without doubt impact from sewage solids discharges, the evidence to support investment on the scale proposed is limited.”

Therefore, little aesthetic change in the water is to be expected due to Tideway Strategy options, and this, together with the low correlation between riverside residence and involvement in river-based water sports, suggests that any impact of the Tideway options on property prices is likely to be minor.”

Many would say that the Thames flowing through London is an aesthetic asset at most times and places. The strong demand for residential property overlooking the river is clearly not put off by any potential sights. Efforts by Entec to find a measurable economic impact on housing values failed.

These statements were made about the baseline in 2003. Since then the baseline now includes the Lee tunnel, in itself removing more than half the spill volume, as well as improvements to the water quality and storm overflows from the 5 London sewage treatment works. Thus the effect from sewage litter would be even smaller for the new baseline.

Dispersal, maceration, and the careful placement of some of Bazalgette's storm overflows near and under bridges are no doubt among the reasons why the large volumes of sewage solids reported in the TW [Needs Report 2010](#) are not noticed by the majority of people.

The Entec 2006 Stated Preference survey asked how far respondents reported seeing sewage litter. Of respondents from the Thames area 68% said they were familiar with the Teddington to Gravesend section of the river, Table 4.5 page 23. They tended to believe that sewage pollution was an important factor (perhaps prompted by being asked to participate in a survey about the issue) but the majority had not seen sewage pollution for themselves to any great extent. Two thirds had never seen human waste, over 80% rarely or never, page 25 see table below.

Table 4.9: Q9 - Percentage of respondents seeing different types of litter										
	TW (%)					Non-TW (%)				
	Always	Often	Occasionally	Rarely	Never	Always	Often	Occasionally	Rarely	Never
Packaging, bottles, etc.	32.3	35.7	22.2	5.1	3.7	15.2	29.1	26.6	7.6	16.5
Shopping trolleys / large items	6.5	19.4	36.8	18.0	18.0	7.6	10.1	20.3	16.5	39.2
Condoms	1.7	7.6	20.5	21.1	45.5	3.8	6.3	16.5	10.1	55.7
Syringes	0.6	4.8	9.8	18.0	62.9	0.0	3.8	12.7	12.7	59.5
Sanitary towels	0.8	3.7	13.5	17.7	60.4	1.3	3.8	16.5	11.4	58.2
Fat / grease	3.4	11.5	25.0	20.5	36.2	6.3	2.5	22.8	20.3	39.2
Human waste	0.0	2.2	8.7	15.7	66.0	2.5	6.3	8.9	12.7	59.5
Dead Fish	0.6	4.5	17.1	27.2	48.0	2.5	3.8	10.1	26.6	48.1

Note: This question was not asked to all respondents.

A majority of those questioned had seen bottles and packaging etc which would not generally have come from the sewers. A large majority had rarely or never seen condoms, syringes, sanitary towels, human waste or dead fish. Only approximately 2% of TW respondents reporting seeing such sewage items “*always or often*”.

Interestingly whereas only 2.2% of TW customers had seen human waste always or often, almost 9% of those outside the TW area had. This appears to reflect that the situation is worse outside the TW area than within it. Thus those outside would consider they were paying to clean up a worse situation than TW customers. Thus they might well be prepared to pay more than necessary. No account appears to have been taken of this effect.

Recent action to reduce the aesthetic effect of litter.

Litter collectors.

Since the WTP survey, TW have provided two in-river debris collection skimmers which collect floating litter, including that sewage derived, thus reducing sewage litter and also improving the general appearance of the river.



There are two such vessels Clearwater 1 and Clearwater 2 which together cost £4m and were commissioned in September 2007. They were designed to operate as far upstream as Kew and to navigate London's bridges. In operation, the screens sit 450mm deep below the river surface. Debris is directed on to the screens by the inner hulls of the vessel, where the debris is picked up by mechanical screening equipment and conveyed to the rear of the vessel where it is drained ready for disposal into a refuse barge. In March 2008, after 6 months service Thames Water stated " *The vessels which have collected over 40 cubic metres of litter from the River Thames since September 2007 have greatly contributed to improving its environmental and aesthetic quality, ensuring it is fit for river users, and for this years Oxford and Cambridge boat race crews. To date, the skimmer vessels have been a real success story, enabling us to collect large volumes of litter, which overflows from the sewers during periods of heavy rain.*" Thus the overall aesthetic effect has been beneficial. Thus should not part of the assessed benefit be allocated to the litter collector vessels? This benefit does not appear to have been taken into account

Eftec show cards

"Baseline- future situation after completion of agreed investment in sewage treatment works."

"May be visible anywhere along the tidal Thames, but especially visible close to outfalls following overflows. Amounts to 10% of all litter."

Such a description is extremely vague. It could also apply to the situation post the tunnel.

The quote "*especially visible*" implies an appreciable impact. This seems to be at odds with the quotes about the aesthetic situation as set out in the earlier part of this section.

With the large tunnel 2021

"sewage litter. small amount visible 3 times per year following overflows."

Criteria for unsatisfactory designation

The organisation Thames Tunnel Now has, in the last couple of years, campaigned vigorously for the tunnel to be built. Their website does identify the issues. However it lacks accuracy. "*the tunnel...will stop tens of millions of tonnes of sewage overflowing into London's rivers each year.*" The facts are that once the Lee tunnel is completed the overflow volume will be about 18 Mm³ and the residual once the tunnel is built would be about 2 Mm³/year. Thus the tunnel will save 16 Mm³ of overflow, hardly tens of millions, not even two of them.

The DETR 1997 guidance on the UWWTD states that to identify an unsatisfactory CSO it would need to have "*a history of justified public complaint.*" The Environment Agency have stated "*Unsurprisingly the number of formal complaints regarding sewage debris is relatively few. ...they do not make formal complaints as they know that a solution has been identified.*" Bain email 23rd January 2012. However the announcement that the tunnel was to be built was not made until March 2007. Thus there do appear to be only a few complaints from the public and not enough to meet the criteria of classification as unsatisfactory when the selection of the CSOs that were unsatisfactory was done in 2004, again in 2006 and again in 2008. Further the selection of unsatisfactory overflows was done on a sensible theoretical basis but with no specific evidence of impact being given to support any of the selections.

The email continues *"Since then, with the provision of the skimmers, the situation has improved."* Thus where is the field evidence that the CSOs should continue to be classified as unsatisfactory for sewage litter?

If the number of complaints was relatively few, then one would not expect the public to be prepared to pay a significant amount to rectify the situation.

Amount of benefit

The total baseline amount found in the second WTP study was £3,935m. The split found in the 2003 survey was that about 25% would be allocated to litter/aesthetics. That would amount to about £1,000 m. For a feature that is quoted as *"little aesthetic change due to Tideway Strategy options ...any impact on property prices is likely to be minor, ,non TW interviewees have much worse conditions than on the Tideway,"* and historically the Tideway *"had relatively few public complaints"*, then the benefit assessed does appear excessive.

As a sensitivity analysis I have assessed the effect of reducing the WTP amount by 80%, as proposed in the section on single/multiple issue WTP studies in section 3 . This would reduce the base litter benefit to £200m. The result is discussed in section 9.

Further measures.

Should it be appropriate to introduce measures to reduce the aesthetic impact of litter quickly then floating booms could be placed around the majority of the CSOs, thus retaining the majority of the litter. The litter retained could be collected by a specialist barge at high tide. Based on a budget quotation from a boom provider, the provision of booms would cost about £2m, a very cost effective measure. Such a system is set out in more detail in my [Measures to protect the river environment from the adverse effects of waste water discharges](#) report.

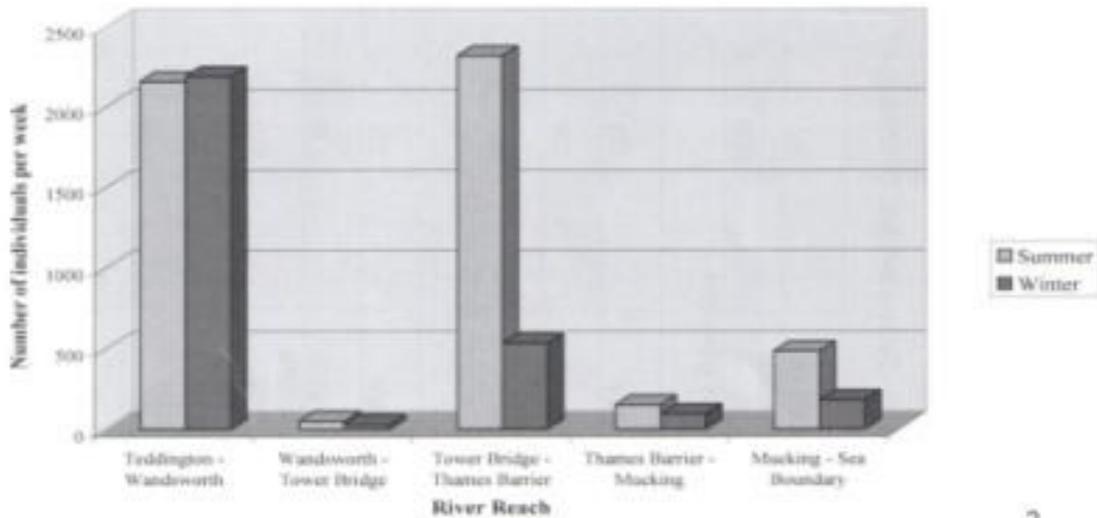
5 Risk of suffering illness through contact with river water.

Occurrence

Those using the river for recreation can be adversely affected by polluted river water. This could include bathers, swimmers, occasional visitors to the foreshore, dinghy sailors and water skiers in the London Docks, and rowers, mostly in the upper Tideway.

The histogram below shows the numbers involved in recreation. The right hand bars are people downstream of Mucking. This is over 15 miles downstream of the most seaward CSO at Beckton. The people are mostly dinghy sailors off Southend, another 10 miles seaward. Thus they would effectively be outside of the influence of the Tideway CSOs. The Tower Bridge to Thames barrier group are almost entirely dinghy sailors and water skiers in the London Docks.

Figure 1 Watersports Activity on the Thames Tideway



Thus some 90% of the recreationalists are in two limited areas of the Tideway.

TTSS objective

Objective set by the TTSSG *“To help protect river users by substantially reducing the number of “elevated health risk “ days following CSO discharges.”* The TTT in 2006 changed this to *“To help protect river users by substantially reducing the elevated health risk due to intermittent sewage discharges.”*

Baseline conditions

“Risk of suffering illness through contact with river water. Higher risk following each overflow. high risk at all other times.”

Large tunnel scheme.

The description of the large tunnel states *“ Higher risk only following the remaining 3 overflows per year.” “High risk at all other times.”*

These comments do not reflect that it is the numbers of people who have contact, and where people have contact with the river, that matters most. The two main places are the Putney area for rowers and the docks area for dinghy sailors and water skiers. Thus the text was somewhat misleading and does not reflect the need or the benefit.

Current health situation

Bathing

The Health Protection Agency (HPA) report The Thames Recreational Users Study 2007 states on page 48 *“The 95 percentile of indicator organisms in the upper tideway permanently remain above the WHO microbiological standards for recreational water and this represents a potential health risk to recreational users.”* Thus there is a background health risk in the Tideway irrespective of the CSOs.

However the *“WHO guidance is only aimed at bathers”* total immersion and risk of ingestion *“and as such is not necessarily indicators of risk to other recreational use such as rowers, sailing etc...”* HPA page 8

“There is evidence to suggest that the influence of secondary treated effluent from Mogden sewage treatment works is as great as that of the less frequent but common CSO discharges.” HPA 2007 page 54.

Since then the bathing situation has changed. The Tideway is not a designated bathing area under the Bathing Water Directive so there are no statutory water quality requirements.

On 1st July 2012 the Port of London Authority enacted *“a new byelaw to control swimming in the busiest part of the Thames between Putney Bridge and Crossness by making it necessary to get the prior consent from the harbour master.”* *“Here you encounter a fast running tide, bridges and eddies which can drag a person underwater in a trice. And there are also passenger vessels which carry over six million people a year and 1,000 tonne barges carrying freight.”*

Putney to Crossness is almost all the length of the Tideway affected by CSOs.

There is a quote about a swimmer having to have *“the event carefully planned and managed with safety boats in attendance at all times.”* From a discussion with the PLA, I understand that there has been one licence issued for one swimmer to go on one occasion from Putney to Vauxhall.

The PLA web site states *“The use of Personal Water Craft is restricted to Fobbing Creek and West Beach Southend.”* *“Windsurfing is only advisable on the tidal Thames to the west of Putney bridge.”*

At Mogden, the large STW upstream, the effluent water quality standards have been improved as part of the Mogden STW upgrade completed in March 2013. Further, 8 storm tanks have been provided to reduce storm spill frequency and volume. Spills have been reduced from about 100 spills a year to about 20 spills a year, with much reduced spill volumes and improved quality.

Dinghy sailors and water skiers in the London Docks

If thought necessary, it would be possible to provide water treatment plants to deal with bacteria in the top up water for the London docks and this should much reduce the health risk there at low cost, roughly estimated as about £3m. This would be much more appropriate there than reducing CSO spills.

Rowers in the upper Tideway

The main recreational users of the Tideway are the rowers in the upper Tideway.

The key information from a major study of health risks to recreational users in the upper part of the Thames (upstream from Putney Bridge) is summarised in the TW 2010 Needs report: *“An assessment of health impacts upon recreational users of the River Thames was conducted and reported by the Health Protection Agency in 2007. This report, which quoted*

an EA estimate of between 3,000 and 5,000 recreational users of the tidal Thames... While there was evidence of an elevated health risk (gastric infection) to recreational users in the upper Tideway two to four days after a CSO spill event, the rate of gastric infection among recreational users was very low (12.8/1000/year) compared to the general population (190/1000/year). This may be due to the relative good health and fitness of recreational users, a greater awareness of hygiene and health and safety issues, and a developed immune response to infection from repeated exposure, which results in asymptomatic infection.”

The fact that gastric infection rates among recreational users in the upper Tideway are less than one tenth of the incidence level in the population as a whole, is a fair indication that the Thames health baseline, and the possible impact of the intervention, are not significant on a national scale in terms of the potential health impact.

NERA did an analysis on the basis of the government guide on Managing Risks to the Public which discusses the Quality Adjusted Life Year as a tool for cost effectiveness analysis of health impacts. NERA states that around £30,000 QALY appears to be increasingly accepted by government as a method of valuing health impacts. NERA did an analysis of the values of the potential health benefits based on the number of recreational users, annual risk of infection, average duration of illness expressed as % of a year, and value of quality of life adjusted life year. This assumes that some measure was able to cure all reported gastric events, most unlikely as some gastric events would have been caused by other sources.

*“for example, assuming that number of recreational users per year (N) is 5,000, the risk of infection during each year (R) is 18/1,000, the average duration of illness as a fraction of a year (D) is 3/365, and the value of a QALY (V) is £30,000, and assuming that the loss of quality of life during the period of illness is total, this would lead to an estimate of the annual cost of the health impact (=N*R*D*V) of £22,000. The corresponding discounted present value of such a stream of annual costs in perpetuity, if discounted the pure time preference rate for utility of 1.5 per cent specified in the Treasury Green book, is £1.5 million.” Page 29 of the NERA cost benefit analysis.*

The previous CBA had assessed 60% of the total benefit as related to health benefits. Thus this would be about £2,400m. The sum of £1,5m found by the QALY is miniscule in comparison.

Validity of stated preference Willingness to Pay methodology for health effects.

Let us consider the general validity of sp WtP.

In para 13 of the 2011 CBA, defra state *“Furthermore, there is the general uncertainty surrounding benefit assessments of this type (ie derived from a survey of Willingness to Pay for essentially unmarketed goods and services.)”*

A relevant paper is Willingness to pay methods in health care written by Richard Cookson from the Health Policy and Practice Department of University of East Anglia and published in Health Economics. He states

“First , WTP responses tend to be under sensitive – although not necessarily totally insensitive – to the magnitude of benefit . ..Using high quality contingent valuation survey

designs, and rigorous experimental methods, investigators have found that people tend to state a similar amount – roughly £50 – for any given magnitude of reduction in the risk of death or injury . This has the effect of exaggerating implied monetary values for life and health for relatively small risk reductions. More generally, under-sensitivity to the magnitude of benefit tends to inflate valuations of interventions that yield relatively small benefits.”

“Second WTP methods tend to inflate valuations of the specific intervention that respondents are asked about relative to interventions that respondents are not asked about. Asking respondents to focus on one specific intervention in isolation acts as a kind of magnifying glass for stated WTP. When asked to consider an intervention in isolation, people are willing to pay sums of money far in excess of what they are willing to pay when asked to consider the same intervention in relation to a range of other interventions....So valuing each item in isolation can lead to sum totals of WTP in excess of the available budget. WTP methods tend to be biased in favour of ...the particular intervention being evaluated, as opposed to other ones not being evaluated.

It has been suggested that QALYs are out of date. It is more plausible to suggest that the WTP approach is out of date. Health care payers have been reluctant to embrace cost-benefit analysis based on WTP methods.”

Expert advice from NERA was to the effect that QALY was an increasingly accepted valuation tool within government and the health service as a method of valuing health impacts, being widely used by the National Institute of Clinical Effectiveness (NICE) and the Health and Safety Executive.

The Treasury guidance on Managing risk to the public recognises the possibility that public valuation of a risk may not accord with expert assessment of a risk. Para 4.38 is relevant.:

“...it is important to recognise that while all have the same rights to raise their concerns, the extent to which those concerns are valid should primarily be considered by those who have the knowledge, skills and experience to measure or estimate the strength of relationships between cause and effect, the probability of harm occurring, and the range of uncertainty, by their systematic observation, empirical data collection or rigorous modelling.”

The principles set out in the “Treasury” guidance, see section 2.5, underline the need for policy to be evidence-based and for expenditure to be proportionate to the seriousness and probability of the risk to be managed. One useful step would be to complete a hazard concern assessment using the methodology outlined in Annex A to HMT guidance Managing Risks to the Public. Overall it seems likely that under most headings, a concern assessment would rate the Tideway issues at the lower end of the five point scale. If this is so, a very expensive solution to Tideway CSOs would not normally be justified.

HMT states that, if action is justified, a more detailed expert risk assessment should be carried out. This should include,

- Hazard identification
- Risk characterisation
- Risk estimation
- Risk evaluation

No expert would value a health intervention without some information on *exposure*, *risk* of developing illness after exposure, and the scale or *incidence* of illness to be prevented. Participants in stated preference surveys in both 2003 and 2006 were asked to value health risk after having been given only one (exposure) of the necessary three heads of information.

Proportionality is a consideration when the Tideway water quality interventions are assessed in comparative terms with other public health options. The Thames water quality projects together will cost some £5bn, with about half allocated to the improvement of health.. A major extension or refurbishment of a London Hospital can cost £50m. A consistent approach to public health management would question expenditure equivalent to the cost of 50 hospital refurbishments if it addressed an unknown reduction of low levels of minor illness in a small, maybe 5,000, more healthy group who decide on their own level of exposure to the avoidable risk. This is one reason why a QALY valuation of the health benefits of the Thames tunnel project should be completed and substituted for the health element in stated preference survey valuations of benefits.

Thus, to ensure consistency with Treasury Guidance on best practice, the health risk analysis benefit should be based, not on the sp WtP, but on the QALY based analysis.

Thus the benefit should be the QALY £1.5m, rather than the £2,400m implied by the 2006 stated preference valuation. Because of the residual risk from treated but un-disinfected effluent, even the £1.5m QALY estimate may be an overestimate.

6 Fish sustainability.

Fish in the Tideway

Fish have been taken as a representative feature for general ecology. There are over 100 species of fish recorded as having been found in the Tideway in recent years. Some are residents, some migrants and some stragglers (visitors). A more detailed analysis of some aspects is set out in Appendix A.

Objective

Following the aim of the UWWTD to protect the environment from the adverse effects of urban waste water, fish were chosen as the indicator of ecology, the TTSS developed standards that would **deliver a sustainable fish population in the Tideway.**

Current conditions

Fish kills

There have been major fish kills in the Tideway in 2004 and 2011. However these were in the Chiswick/Barnes stretch downstream of Mogden STW but several kms upstream of the first CSO at Hammersmith. It appeared that they were caused primarily by spills from Mogden STW, possibly by activated sludge carryover from the STW into the river, with little input from the Tideway CSOs. There have been occasional fish kills in the tributaries but these are not to do with the Tideway CSOs.

In March 2013 the upgrade of Mogden STW was completed. This has reduced the spills there from about 100 a year to about 20 and reduced the spill volume from about 6 Mm³ a year to probably about 1. A subsequent major spill from Mogden STW in May 2013 showed dissolved oxygen conditions in the Upper Tideway at 80% saturation remained favourable to all fish species.

The TTSS dissolved oxygen plots showed that chronic conditions of low dissolved oxygen occur in the lower Tideway, caused by the poor effluent conditions of Beckton and Crossness STW. The TTTT Objectives report 2006 p 9. "*The major influence on the chronic standard of 4 mg/l is the performance of the STWs and the planned upgrading largely achieves this standard.*" "*Improvements have already been identified and agreed to meet the standard of 4 mg/l.*" These STWs are being up-rated with the intent that these chronic dissolved oxygen conditions will be dealt with. The contractual completion date for the larger Beckton works is March 2014.

On 13th January 2014 I was provided by the Environment Agency with a good schedule of storm discharges and recorded fish kills on the Tideway for the previous 10 years starting with the event on 21st October 2003, see Appendix C. There were 3 recorded fish kills resulting from spills from Mogden STW, two resulting from spills from Abbey Mills Pumping Station, and one from a spill in the Tideway killing one fish.

The covering email states; "*Often, because these incidents occur during storm events, or at night, or in areas where there is little public access or use, there can be large mortalities of fish, particularly juveniles, that will pass unnoticed.*" When fish die they float or are left on the foreshore. Thus fish kills occurring at night would be seen during daylight. Secondly the majority of fish kills occur in summer when temperatures are high but then there are more hours of daylight. Secondly fish kills are not just spot situations but would occur where the water had too low a dissolved oxygen content, probably several hundred meters. The tide would also carry dead fish up and down river so any Tideway event would spread over an appreciable distance. The Tideway has extensive public access to the river side and there is also significant river traffic on the Tideway, thus any significant fish kill would be seen. Certainly two of the fish kills in the Barnes/Chiswick area were extensively reported.

EA continue "*it is preferable to use the much more comprehensive data obtained for the Tideway Tunnel Strategic Study.*" I chaired the TTSS but have no recollection of any fish kill event bar one on 3rd August 2004 due to Mogden STW spills. I have been unable to find any other fish kill data from this period. I asked the EA on about 14th January 2014 for the data to which they refer but so far none has been provided. In any case data from prior to 2005 would be of limited relevance due to change of conditions. Thus I believe the information in the EA schedule on fish kills in the Tideway due to the CSOs and Abbey Mills to be sufficiently robust.

Mogden is not included in the Tideway water quality model. Thus there were 3 fish kills in the Tideway in ten years. That would indicate that the Table and dissolved oxygen modelling, which show about 45 fish kills over ten years, does not reflect the actuality of 3 fish kills over the same period and needs to be reconsidered. In any case the sewer model for the future uses an assumption of constant per capita consumption whereas it should be in line with TW WRMPs. Thus sewer flows and spills in the future are appreciably over-assessed and need reconsidering.

The Environmental Statement non-technical summary 30.3.1 states “significant beneficial effects would be likely once the Tideway Tunnel is operational this is due to a reduction in the occurrence of dissolved oxygen related fish mortalities...”

Mogden STW has been dealt with. The Lee tunnel, now completed and operational in 2015, will deal with Abbey Mills. That leaves one fish kill of one fish in the Tideway over 10 years due to the Tideway CSOs. This is before the STW upgrades and the operation of the Lee tunnel. Thus the tunnel can provide no meaningful benefit for fish.

Migration

There are a number of fish species that migrate through the estuary to spawn in freshwater. This includes salmon and sea trout. There is very limited information about how many salmon could migrate and why some of them might not. Currently less than 10 salmon a year migrate but in the 1980s and 1990s several hundred migrated each year. The paper to the Regional Fisheries, ecology and recreation advisory Committee meeting on 20th September 2010 included a graph of recorded salmon catch in the Molesey trap and this is shown below.

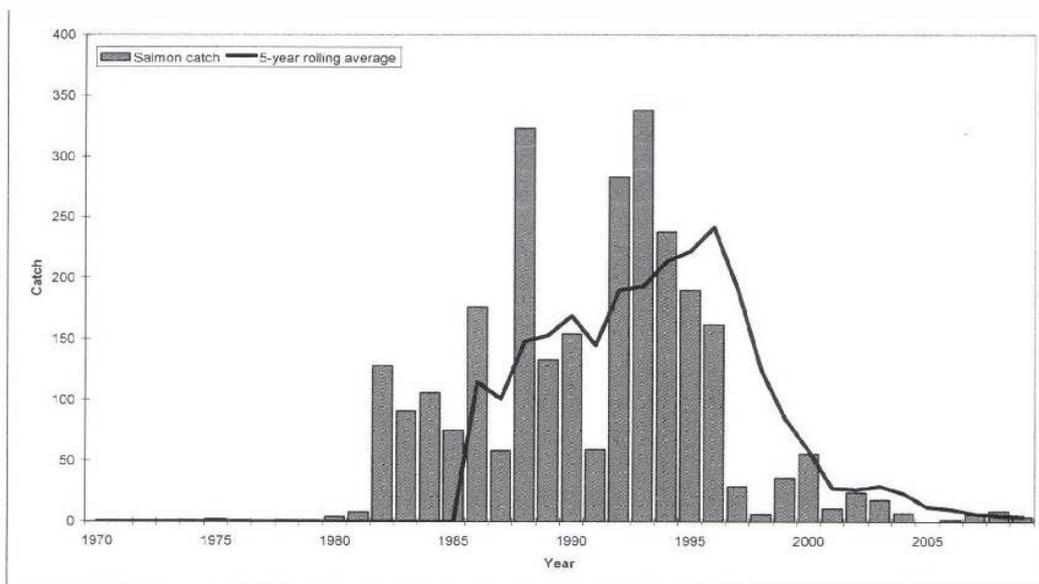


Figure 1 - River Thames recorded salmon catch and five year rolling average

From this it can be seen that up to 300 salmon a year were migrating through the Tideway then. The Tideway water quality has not deteriorated in the meantime, rather it has improved. Thus the reason for the drop in numbers cannot be deterioration of the Tideway water quality. Thus, even though water quality was worse in the 1980s, salmon migration through the Tideway does not appear to have been appreciably impeded.

Use Benefit

The potential use benefit of re-establishing a salmon fishery can be assessed by its capital value based on the number of salmon caught each year. I have been unable to find numbers of the number of salmon caught before the pollution of the 1800s and I doubt if they exist. The Environment Agency salmon data shows the greatest number of salmon returning in the last century was 338 in 1993. The rod catch for that year was 16. Considering the issues of

marginal spawning habitat, spawning water quality and rising temperature due to climate change, an average of 400 salmon caught by rod each year sounds an upper bound. I am informed that the capital cost of the fishing would be worth about £8,000 per salmon caught. On these assumptions the benefit would be £3m. Thus the potential use benefit would be far too small an economic benefit to justify major investment.

Show card description

The 2006 show card description, for fish is based on the number of “occasions when the oxygen levels in the water drop low enough to either kill some fish or prevent migration (eg salmon).” The baseline states “1 or 2 times a year”. With the large tunnel “Less than 1 times a year.”

Based on the total baseline benefit of about £4bn and the 2003 split of 15% to the fish attribute, the fish benefit in the CBA would be £600m.

Excluding the fish kills due to Mogden, with only three fish kills in the River Thames during the ten years from 2004 to 2013 inclusive reported, the actual condition appears to be not only below the WTP show card of 1 to 2 fish kills a year but also below the less than 1 fish kill per year expected of the tunnel. Thus the WTP show card value cannot be allocated to the tunnel. Further with only one fish recorded as having been killed by the tideway CSOs in ten years there seems no doubt that, post the lee tunnel becoming operational, fish would be sustainable. If so then no financial benefit could be allocated to the tunnel from fish and the ecology.

Economic benefit of improving the Tideway so fish are sustainable.

The question then becomes whether there is actually an economic benefit for the tunnel improving the dissolved oxygen conditions in the Tideway beyond that achieved by the current works. This is looked at in detail in Appendix C.

On the basis of the evidence and assumptions above, it is concluded that

On the basis of the evidence below it is concluded that

1. The objective of the UWWTD is to protect the environment from the adverse effects of waste water discharges. Since it is recognised that fish are the most sensitive indicator of ecological quality, the decision was taken to derive standards that are protective of relevant fish species. The objective is to limit ecological damage by ensuring that fish species are sustainable.
2. The TTSS carried out trials on a representative suite of fish to establish their response to dissolved oxygen conditions. Salmon were the most sensitive. From these trials a table of dissolved oxygen standards was established.
3. The two big fish kills in 2004 & 2011 were primarily due to Mogden STW overflows.
4. Mogden STW has now been upgraded. Spill frequency has dropped from about 110 spills a year to about 20 spills a year, the limit proposed by the EC. Fish kills as a result of its overflows should not occur in future.
5. Beckton and Crossness STW are currently being upgraded to remove the chronic low dissolved oxygen conditions in the middle/lower Tideway and these are due for completion in 2014.
6. The sustainable mortality of various species depends on the factors such as length of life and a sustainable mortality. For salmon it was found to be 30%.

7. Further major investment could only be warranted by the need to provide sustainable conditions for the most sensitive fish species that will be present for sufficiently long to warrant the expenditure.
8. Migration and spawning conditions for salmon in the Thames catchment are not favourable but are being improved.
9. Salmon numbers have reduced to an average of less than 10 a year, 2013-3. They are considered by the EA as not sustainable in the Tideway in the short, and medium term and the Dr Friedland model shows that salmon would not be sustainable in the long term, primarily because of adverse temperature and marine conditions.
10. Salmon are the most sensitive fish species so if they are no longer sustainable then they need to be replaced by a similar species or the D.O. Table reconsidered. The additional fish species mentioned are all more tolerant of low dissolved oxygen (DO) than salmon and/or not sufficiently established. Thus the D.O. table needs reconsidering.
11. A meeting on 31st May 2012 discussed fish but the notes contain points that were not heard at the meeting and the notes were subsequently challenged.
12. In earlier years over 300 salmon migrated through the Tideway, so adverse dissolved oxygen conditions would have had limited effect on migration.
13. The 2011 analyses by TW of CSO and water quality conditions in 2021 were based on increasing dry weather flows in the sewers, and thus show deteriorating Tideway D.O. conditions. The 25 year Thames Water (TW) Water Resources Management Plans show reducing water delivered and reducing leakage, hence sewer dry weather flows will be reducing. Hence the conditions predicted in the models for future years are worse than would actually occur. Consequently the models need re-running with the latest information.
14. Storm runoff will be affected by climate change. The Met Office has said that during winter increases in heavy rain may start to be discernible in the 2020s whilst any changes in summer are not expected to be discernible for many decades. Also middle rainfall events will get smaller. TW has assumed that water temperature increase will be 0.4C more than the air temperature increase. No justification has been provided for this odd assumption which would adversely affect dissolved oxygen conditions. Any re-run of the models should include the latest climate change information.
15. Dr Turnpenney has developed a Tideway Fish Risk Model. This multiplies the proportion of stock in each river zone by month by the probability of standard breach to arrive at a risk factor. This is then multiplied by the mortality to assess the population effect. This is a powerful tool.
16. The Tideway Fish Risk Models risks for salmon were described as “precautionary” in the challenged roundtable meeting notes, hardly a strong basis for supporting a £4.2bn project.
17. TFRM output descriptions state FARL “*not sustainable incidences zero.*” Tideway Fisheries Review 2010 “*Tideway fish populations should already be sustainable.*”
18. The post tunnel TFRM are based on increasing sewer flows in 2021 and are thus not robust.
19. The AMP4 TFRM assumes that all salmon are present in the Tideway for 7 months of the year. In reality they are assumed to take about two weeks to migrate through the Tideway over a 3 to 4 month period. Thus only a small proportion would be affected by any one spill. Thus, at the time of any one spill, there will be those who

have not yet entered the Tideway and those that have already arrived in freshwater prior to the spill.

20. The AMP4 post current works dissolved oxygen plot for Threshold 2 shows 1.15 dissolved oxygen failures a year on average. It would, on average, take about three weeks for a failure plume to exit the Tideway, thus failure conditions could last for the equivalent of less than a month a year on average. Salmon migrate over a three to four month period in the summer. Combining these factors, then the population level effect would be less than the 30% impact which is the limit of sustainable conditions for salmon.
21. Thus the AMP4 conditions, prior to construction of the tunnel, would indicate that, in the unlikely case of there being sufficient salmon, the salmon would be sustainable.
22. Thus, post the current works, fish in the Tideway would be sustainable and, subject to the future conditions not worsening, no further works would be required to meet ecology sustainability.
23. With only one fish recorded as having been killed by Tideway CSOs over the last ten years, and all fish species being able to tolerate 10% mortality a year and still be sustainable, then no economic benefit can be attributed from fish/ecology to the Tideway tunnel.

Conclusion

Over the last 10 years there have only been 3 fish kills in the main Tideway, compared to the 45 shown by the models. Thus the models may not be reliable. Also the fish kills are already below the less than 1/year assumption for the tunnel in the WTP study. Thus none of the WTP economic benefit can be used in the cost benefit analysis. Further, the record shows that only one dead fish was recovered from the Tideway over the last 10 years as a result of Tideway CSO spills, thus once the Lee tunnel has become operational, fish in the Tideway would be sustainable and no economic benefit can be ascribed by ecology to the tunnel.

7 Cost and Benefits of the Thames Tunnel, defra November 2011.

Introduction

In November 2011 defra issued a Costs and Benefits of the Thames Tunnel report (CBA) based on the 2006 eftec Stated Preference Survey and the NERA Cost Benefit Analysis, with benefits updated by defra to 2011 and further benefits added.

Validity of previous WTP study

DEFRA have taken the 2006 WtP survey results and revalued them at 2011 prices, along with certain other upward adjustments. However some of the baseline descriptions in the 2006 Stated Preference Survey are no longer valid, such as the impacts on fish populations and the description of the public health baseline. Economic circumstances and the outlook for incomes growth is harsher now than at the time of the 2006 WtP survey. There is less optimism about income growth, greater fear of redundancy, worse perceptions of the future for benefits and taxes etc and pressure to constrain spending on other services and public goods is much greater. A single-issue stated preference survey would now take place in a wholly changed financial environment. In addition HMT prefers economic expert analysis rather than stated preference survey and willingness to pay.

Other benefits.

The defra 2011 CBA report states in paragraph 3 a number of benefits for which there is no assigned financial benefit included in the analysis.

- *“Avoidance of damage to London’s reputation as a business and tourism centre.”*
The current reputation is based on the current situation. The eftec report page 25 shows over 80% of respondents rarely or never saw human waste. The defra report A strategic and economic case for the Thames Tunnel November 2011 states on page 5, *“It is unlikely at present that businesses are put off locating to London due to the presence of raw sewage in the River Thames.”*

The situation is being improved by the construction of the Lee tunnel which will remove about half the current overflow volumes, and the sewage treatment works upgrades, particularly the upstream Mogden STW, and the downstream Beckton STW. These schemes are together costing some £1.2bn. Thus the Tideway water quality will, in any case, improve, and, in so far as conditions in the river are noticed, so will London’s reputation. No reference appears to have been made in the defra CBA to the benefit on this point from these beneficial actions

- *“Avoidance of any long-term adverse impact on the desirability and value of riverside property.”*
See comments above. Whilst sewage litter is most offensive if seen close up by someone on the water or on the river bank, sewage litter is only estimated to make up some 10% of all litter, thus totally removing all the sewage litter would only reduce overall litter by some 10%. Would that be noticeable? In any case the velocity of the tide is such that the river is generally seen as dark brown and not over attractive. Even with no litter this will not change.

No scheme will be able to remove all overflows and I understand that there would still be some 3 overflows a year from the full tunnel. The Thames Water table of June 2011 shows the residual overflows would still be some 2.3Mm³ / year on average.

Entec Environmental costs and market benefits of reducing combined sewer overflows December 2006, looked at this but found that other factors dominated and they were unable to put any figure against the benefit of different water qualities. Thus the eftec conclusion that the benefit on riverside property would be “minor”.

- *Reduced sewer flooding in some locations.”*
In para 5.2 on page 20 NERA state *“The eftec report discusses the possibility that the options may lead to a reduction in, but not removal of, the risk of sewer flooding to a small number of households, as the options will reduce the risk of these properties experiencing sewer flooding in times of heavy rainfall. However, the magnitude of the reduction in the risk is very uncertain and therefore the impact values derived from willingness to pay and avoided costs of flood defence are also very uncertain. Overall, the uncertainty and the magnitude of this impact is exceptionally high, with a lower bound of zero. For these reasons we consider it prudent to exclude this estimate from the Base Case. We consider its inclusion in the*

sensitivity analysis in section.” The analysis is shown in Table 8.1 on page 38 and this shows a sensitivity net benefit of £86m.

Entec in its draft report Environmental costs and market benefits of reducing combined sewer overflows, December 2006 identify some 150 properties at risk of flooding and state on page 46 *“If all of the 150 properties who may experience a reduced risk of flooding ...experience a reduction to zero risk, this would be valued at £20.1million.”* However this is the upper bound and in Table 3.4 Entec assess the Medium value as about £7m. This appears more reliable than the NERA figure. Even if this were appropriate it would have a minimal affect on the overall benefit and would not change the overall conclusions.

- *“Energy generation from extra volumes of sewage sludge captured at Beckton Sewage Treatment Works (otherwise lost through sewer overflows)”* That is true but is misleading as very much more energy would be used to pump out all the tunnel contents, some 37 Mm³ per year on average from some 60m to 80m below ground level. Entec, in their draft December 2006 report Environmental costs and market benefits of reducing combined sewer overflows, in table 3.8 on page 52 assess this as about 15GWh/year, 15,000,000 kWh/year.
- *“Short-term employment, economic growth or regenerations impacts related to construction.”*

True, but there are no UK manufacturers of large tunnel boring machines, and if investment to finance the tunnel is raised overseas, (the consortium owning Thames Water is largely overseas owned), there is a long term loss to the UK in remunerating it from sewerage charges at the expense of alternative household consumption. This could be of the order of £600m a year for as long as the impact on charges lasts, which I believe would be the nominal life of the asset assessed by ofwat when fixing charges, probably about 60 years.

Whereas a new road or new railway will encourage other long term economic growth it is difficult to see that the tunnel scheme will lead to significant long term economic growth.

Cost estimates

“Latest project costs have been taken from Thames Water (version Rev05b dated September 2011)... Total £4.059m(at 2011 prices).”

These are a big increase on the 2005 TTSS cost estimates of £1.7bn, and the 2006 RIA estimate of about £2.2bn.

In para 6c defra state *“In July 2011 Thames Water identified some additional project costs arising from extension to the programme to 2022, and changes to the project following phase 1 and 2 consultations, as well as developing the delivery route. It has been assumed that these costs (totalling £244m in 2011 prices) are not included in the Rev05b base cost update above.”* This would increase the capital cost of the Acton to Abbey Mills tunnel to some £4.3 bn, and the cost of the Acton to Beckton tunnels to some £4.9bn.

This estimate compares with the Hammersmith to Beckton tunnels of the TTSS which, in the 2005 reports, were estimated to cost £1.7bn.

The defra Regulatory Impact Assessment March 2007 the cost estimate was about £2.2bn.

In the 2010 Stage 1 consultation the Thames Tunnel from Hammersmith to Abbey Mills was estimated to cost £3.6bn. With the Abbey Mills to Beckton STW Lee tunnel costing £ 0.6 bn, the scheme cost became £ 4.2bn.

The EFRA Committee interviewed Thames Water and the Committee's report says that Thames Water are "*confident that the project could be delivered within the current estimate.*" My memory is that this was £3.6bn at the time but I cannot find hard copy reference to any number.

The Stage 2 consultation issued by TW in November 2011 gives the Thames Tunnel cost as £ 4.1 bn, making a total cost of £ 4.7 bn.

The previous water tunnel under London, the London Water Ring main, was held up for several months due to hitting a fault with high volumes of water, and, on another occasion, hitting unrecorded deep piles. The Tideway tunnel is generally deeper so should not hit piled foundations but knowledge of the geology cannot be complete.

Thames Water have not provided a breakdown of the capital cost in the public domain so it is not possible to assess what level of contingencies have been provided. However my understanding is that it does not include financing charges which on such a large and long construction period project would be significant.

The capital cost increase is much faster than inflation. This must raise doubt as to whether the out turn cost, in real terms, will not increase further.

Regarding the Water Industry(Financial Assistance) Act, Defra stated in their press release on 3rd February 2012 that "*This Bill will enable the Government to...provide contingent financial support for exceptionally large or complex water or sewerage infrastructure such as the proposed Thames Tunnel in London.*" I have been unable to identify at what level it has been agreed that contingent financial support would be provided. However it does appear that general tax payers are now at risk should the project exceed some financial limit.

GDP deflator

Defra state in para 9, page 4 "*The GDP deflator has been used to update the aggregate present Value benefit figure from 2006 to 2011 prices- an increase of 10.6%. The resulting estimate of £4,353m..*"

The Treasury GDP deflator does show an inflation increase of about 10.6% over this period.

Apportionment of benefit

NERA in their 2006 report stated "*The Abbey Mills discharges are very large...and they discharge into a river which, relative to the Thames , is very small. This may be of little consequence at present as the area is little used, but with the Thames Gateway development this will presumably change.*"

The Defra November 2011 CBA report about the benefits states *“The resulting estimate of £4,353m has then been apportioned 60% to the Thames Tunnel and 40% to the Lee Tunnel. These proportions are high level estimates based on the share of overall Combined Sewer Overflow tonnage which will be handled by the two tunnels.”*

In my view the split should be on the basis of benefit to the rivers Lee and Thames from the two phases of the scheme. However, that is difficult to apportion, there is no reason to change the defra assumption that the split should be on the basis of spill volumes. The June 2011 analysis by Thames Water shows the current spill as 39 Mm³ and that, with the Lee tunnel improvement, this would reduce to about 18 Mm³. However about 4Mm³ of the reduction is a reduction of spill at the Greenwich CSO which I understand to be due to the upgraded Crossness STW being able to take more flow. Thus the benefit of that amount should be to the STW upgrades and not to the Lee tunnel. The residual amount from the Thames tunnel would be about 2 Mm³. Thus the split on a tonnage basis would be about 16/33, ie 48% to the Thames tunnel not the 60% chosen by defra. This is significant and, following the methodology selected by defra, the CBA analysis should be adjusted accordingly. M.

Lee tunnel acting as a transfer conduit

Further, the Thames Tunnel cannot function without the Lee tunnel taking the flow from Abbey Mills to Beckton STW. Thus part of the benefit of the Thames Tunnel ought really to be transferred to the Lee Tunnel. It is difficult to assess how much the benefit of the Thames Tunnel is overestimated due to this effect but a figure of about 10% might be of the sort of order of magnitude. I have not included this adjustment in my analysis.

Period of appraisal

The Treasury Green Book recommends that *“costs and benefits should normally be extended to cover the life of the assets.”* NERA consider the life of the tunnel would be 100 years. The main interceptors have been in place for nearly 150 years and are still in good condition and are functioning well. (My great grandfather, the first Chief Engineer of London, was responsible for them for a period and was also responsible for some of the early sewage treatment at Beckton.) Thus, such an asset as a sewage tunnel, might well reach, or exceed, the 100 years.

However NERA considered and rejected an evaluation period beyond 60 years.

NERA consider, page 6 *“ However projecting such costs and, more especially, benefits well beyond half a century into the future entails considerable uncertainty, potentially of massive economic, social and/or environmental changes that may render any tunnel worthless, and without any likely alternative use, or scrap value. Financial cost and benefits are subject to changing economic conditions and technologies. There is perhaps much more uncertainty about the environmental baseline, given the potential changes to the physical environment of the Tideway(arising from for example climate change and changes in urban environment). There is also uncertainty about whether the preferences of the population will remain constant over time.*

The assumption that outcomes will remain constant over time would imply that the average number of preventable sewage discharges into the Thames that will occur annually and the

environmental impacts that the option generates remain constant. This assumption, along with the assumption that preferences remain constant would, in our view, appear unrealistic over the 100-year life of the tunnel. In our analysis we therefore rely on a shorter appraisal period of 60 years which, although a significant period of time, is perhaps a more realistic useful lifetime. In our analysis we therefore rely on a shorter appraisal period of 60 years..."

Thus, while the tunnel is likely to continue to be able to be a physically usable asset beyond 60 years, NERA question whether the risk of change would mean it could not be relied on to continue to be of benefit thereafter.

Let us look at what could lead to the tunnel not being needed or used sometime in the future.

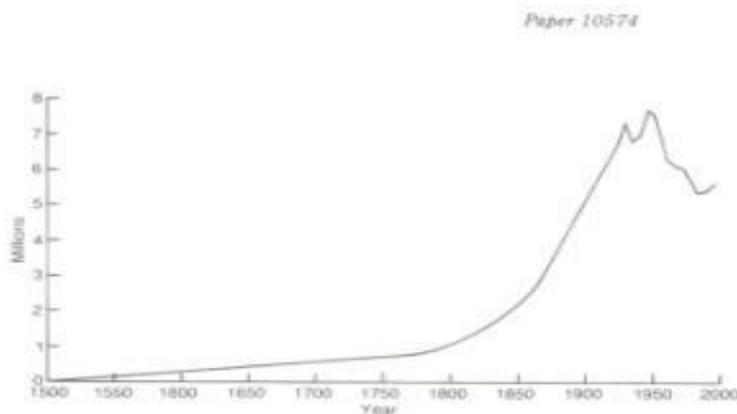
Population changes

Interestingly the population of London, as shown by Ian Benstead of Thames Water in his ICE paper on the London Water Ring Main, peaked at about 8 million in about 1940, and then fell by over 2 million over about the next 40 years, see diagram below. The natural growth of London's current Anglo-Saxon population is fairly neutral. The main increase in population is in immigration. It is always possible that immigration stops or is curtailed by government changing the terms on which labour mobility or migration is permitted (whether within or without the EU) and there will be changes over time in the relative attractions of the London or UK labour market.

in adverse economic situation .

Reduced dry weather flow

Thames Water, in their WRMP, are predicting reduced per-capita water usage and this could reduce dry weather flows in the sewers, thus increasing their ability to convey storm flows.



the city into the Thames, such as the Walbrook and the Fleet. Sheets soaked in carbolic were

Fig. 1. Population of London since 1500

SUDS

In the past, SUDS in London has not been incorporated much in new development or as a retrofit. The 2011 defra Water White Paper includes proposals that SUDS should be

incorporated more in future development. This approach is likely to be strengthened further in the future and would reduce flood runoff and hence the storm runoff.

Energy use

All overflows into the tunnel have to be pumped out for treatment at Beckton STW. According to the NCE of 15th December 2011, the Beckton pumping shaft is some 86.5m deep. Thus one could expect an average pumping head of some 70m. The total spill currently is some 39 Mm³/year. The spill once the full tunnel is constructed is shown on the TW table as 2.4 Mm³/year. Thus the annual energy use would be some 37 Mm³ pumped through an average of some 70m. This has been calculated in the 2006 Solutions Working Group report Vol 1 as about 15GWh/year, 15,000,000 kWh/year.

It is possible that with climate change it becomes no longer allowable to use this much electrical energy, thus rendering the tunnel unused.

Changed social and environmental standards.

As an illustration, it is not possible to predict years ahead what new Directives will emanate from Europe. When our coal fired power stations were constructed in the 1960s and 1970s, who would have envisaged that they would be forced to close by EU Directive in 2015.

Conclusions

With the unknowns of the population changes, reduced water use, benefit of widespread SUDS, and future European Directives, it is difficult to argue with the NERA assessment that it is not sensible to assume a longer benefit assessment period than 60 years.

Defra 2007 RIA

Indeed that was what was done by defra in its 2007 RIA analysis "*In the defra 2007 RIA an appraisal period of 60 years was used for the then Tideway options.*", para 10 of defra CBA 2011. In the 2007 RIA page 61 it is said that projecting benefits over a 100 year time frame "*is an area of considerable uncertainty.*" It is difficult to see that projecting benefits over the 100 year time frame has got any easier since then.

Defra 2011 CBA

In the defra 2011 CBA it states in para 10 "*In this update of the analysis we have taken the Treasury Green Book recommendation that the appraisal period should be taken as the useful life of the assets.*" The footnote states "*In this update we prefer to take the Green Book recommended appraisal period to maintain consistency with other public projects (especially in the water and flood management context), and consider uncertainty separately.*"

The economic assessment of the Tideway tunnel does not appear to be against any other water scheme. Certainly I have been unable to find any such comparison in any of the cost benefit analyses. However there is the need to assess the alternative tunnel schemes against each other, and also against the key criteria of "Excessive Cost" under the UWWTD and "Disproportionate Cost" under the Water Framework Directive. Thus there does not appear to be a sound case for extending the period from 60 years to 100 years.

However, without further reasoning, defra state “ *As such the estimated benefits accruing to the Thames Tunnel have been extended over the 100 year period, by dividing by the cumulative Green Book discount factor for 60 years (26.2285) and multiplying by that for 100 years (29.8125).*” This has increased the benefit by about 14%. M

Conclusion.

I cannot see a sufficiently robust reason to extend the period of assessment from the 60 years assumed by NERA and by defra in the 2007 RIA and have retained the original 60 year period.

Disbenefits

There will be some impact and disbenefits in the course of construction. I. I can find no reference to those in the NERA or defra cost benefit analysis.

However Entec in their draft 2006 report Environmental costs and market benefits of reducing combined sewer overflows set out in Table 4.1 the range of a number of effects during construction. For instance this includes delays to traffic. The upper range comes to about £85m. My understanding is that these are not included in the cost benefit assessment. In my view they should be. Thus I have included half the upper bound in my analysis, both of disbenefits and benefits. M

There may also be some health disbenefits for low income families arising from the steeply increased cost of water, some £70-80 per household per year, There would also be general disbenefits. One is the large amount of energy required to pump out the tunnel

2011 Range of benefit

The defra CBA 2011 para 10 continues “*This gives a 100-year “basic” benefit figure for the Thames Tunnel in 2011 prices of £2,969m. We take this as the lower end of the likely benefits range for reasons set out below.*”

The benefit appears already to have been increased on weak grounds due to the following.

The change from benefit in the Thames Water customer area, as in the 2003 CBA, to almost all England but not considering that the sewerage charge in the Thames Water area was, generally, appreciably lower than in the non TW interviewee area, and that this does not appear to have been explained to the interviewee, seems likely to overestimate WtP.

Based on the multiple choice WTP in the TW Business Plan then the single issue WTP should be reduced to 40%, or even lower.

Using normal Treasury supported QALY function for health risk instead of WTP would reduce the benefit to £1.5m.

An issue specific WTP elsewhere would appear to reduce the fish benefit to about £15m.

The basis of the distance/decay function is not provided and its application appears inconsistent.

Benefit estimate split between the Thames and Lee tunnels was proposed by defra to be on a tonnage basis. This was assessed as 60% to the Thames Tideway tunnel. Based on the June 2011 Thames Water water modelling, the proportion of the benefit applied to the Thames Tunnel should have been 43%.

The benefit provided by the Lee tunnel to the Thames tunnel by conveying the effluent from the Thames Tunnel was ignored.

No robust justification has been provided to increase the NERA period of appraisal from 60 years to 100 years, a 14% increase.

These factors alone would reduce the benefit assessed for the full to tunnel greatly, see table in section 9. Thus the statement above that the benefit £2,969m is the minimum is not robust.

2011 Range of benefit increases

However the defra 2011 CBA report continues in para 11 *“Since the 2007 RIA a number of issues have emerged which suggest a revised view of aggregate benefit of the Thames Tunnel should be taken...Two of the issues (population and real income growth-see below) might have been foreseen at the time, “ they were considered at the time, so this text is misleading “, see below but given the much lower cost estimate for the tunnel at that point, there was probably a degree to which the benefits were seen as “high enough” to demonstrate a good economic case, “ I can find no such mention in the NERA or RIA reports so no evidence to support this hypothesis “and the return on further analysis was seen as weak.” Both population change and real income growth were indeed considered by NERA, see below.*

“With the costs of the tunnel somewhat higher “ actually about double ***“it is now worthwhile “*** essential if the analysis is to have a benefit cost ratio greater than 1 ***“to revisit these issues.”***, my emboldening.

How strong is this argument? The revaluation process seems to have ignored the factors pointing to overvaluation in 2007, and gone against professional advice by selecting some means of enhancing valuation which were considered to be weak or inadvisable at the time.

The defra CBA para 11 then considers three further factors which could increase the benefits, population increase, real income growth, and spill volumes.

Population increase effect on the tunnel spills and benefit

CBA para 11 a) *“The original RIA analysis did not take account of the impact of population growth on benefit. There are two issues here. First, population growth is likely to impact on the baseline CSO spill frequencies and volumes over time, so the benefits of the tunnel may be expected to increase against this baseline (subject to the tunnel’s capacity, though separately Thames water estimate this is not likely to be a constraint given future climate and population forecasts- which have informed design).”*

I have considered the effect on population increase on the dry weather flow in the interceptors in section 6 of the Project Justification Review. Population increase would, in

theory, increase dry weather flows, thus increasing spill frequencies and volumes. This is considered in detail in my Project Justification Review.

However, based on a number of assumptions, and the figures in the Thames Water revised 25 year Water Resources Management Plan 09, reductions in per capita water use due to better appliance water use efficiency, increasing metering, water charging by incentive tariffs, and reduced leakage, result in computed dry weather flows in the future being below, or similar to, those in 2006. See the Table below.

Tideway tunnel analysis of future dwf						
	2006	2011	2021	2031	2050	2080
Population in London supply M	6,531	6,625	7,333	7,732		
Water into supply MI/d wrp	2180	1972	1846	1881		
Less target headroom WRMP	nil	nil	nil	nil		
garden watering l/h/d m/um	14	12.5/15.9	13.8/15.6	16/16.4		
Less garden watering MI/d	90	98	108	124		
net supply MI/d	2090	1874	1738	1757		
total leakage MI/d	677	540	398	394	390	390
supply less leakage MI/d	1413	1334	1340	1363		
Unit consumption (incl non hh) l/h/d	216	201	182	176	168	158
Becton & Crossness population M	5.24	5.59	6.222	6.527	7.205	8.073
Water delivered MI/d pop pcc	1,132	1124	1132	1149	1210	1275
60% of leakage	406	324	236	236	236	236
Total dwf base	1,720					
Infiltration from rain and river MI/d	182	182	182	182	182	182
Total projected dwf			1,550	1,567	1,628	1,693
account for recession in pop growth			18	30	53	90
Adjusted dwf		1,630	1,532	1,537	1,575	1,603
TW DWF from image 13, MI/d	1,720		1,941		2,050	2,220
Overestimate of DWF MI/D			409		475	617

Thus there would be no significant increase in benefit for the tunnel in changing population. In the same paragraph, see below, defra does acknowledge the numbers in the TW WRMP. It should use the full set of data available in the WRP tables as above.

Population benefitting in the future

“Secondly, as the population increases, so does the “benefits jurisdiction”, ie the number of people expected to enjoy the environmental benefit of the tunnel. Based on the population forecasts for London reported in Thames Water’s Water Resources Management Plan... and no further growth beyond 2035...this leads to an overall increase in aggregate 100-year present Value benefit from £2,969m ...to £3,391m (an increase of 14% overall).”

First it should be pointed out that the benefit taken in the WTP is not just the population of London but that of England. Population growth currently is greater in London than in the country as a whole. Thus increasing benefit by the London population growth is over-assessing the increase. M

Further, since the period being considered is some way ahead, it should be pointed out that London’s population went down between 1940 and about 1980 by about 25%. In addition UK natural Anglo-Saxon population growth rate is negative and population growth is maintained only by high immigration and the high fertility of immigrants. Immigration could be stopped by government, or EU action, or by economic conditions. Thus, over the next 60 to

100 years consideration period, there can be no guarantee that population will have increased by the amounts projected. However I have accepted the numbers proposed by defra.

Real income growth

Defra analysis

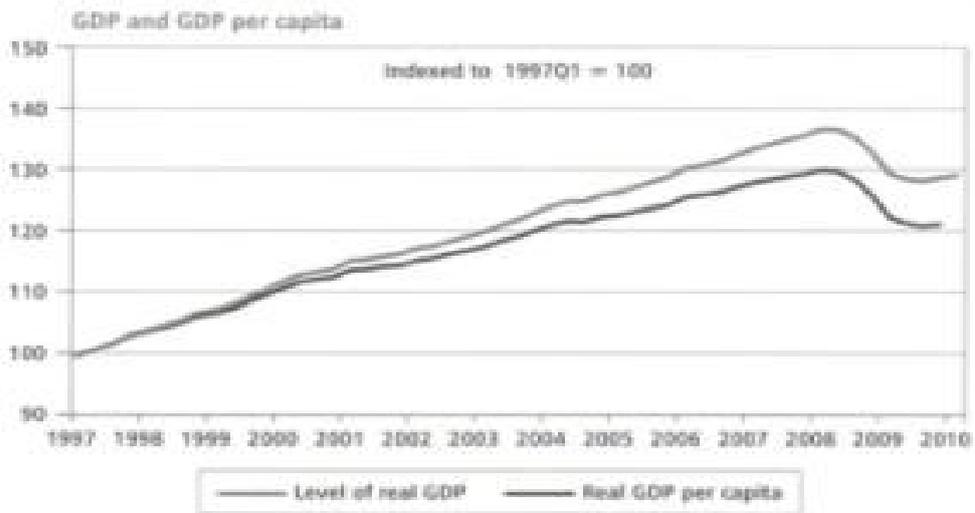
The defra 2011 CBA para 11 b states *“Similarly, the original RIA analysis did not take account of the effect of the real income growth over the life of the tunnel on benefits. In fact it is common practice in environmental appraisal to uprate “Willingness to Pay” based estimates for public or environmental goods for real income increases...Real income growth would be expected to increase the benefits of the tunnel – because environmental benefits are observed to have a positive income elasticity (i.e. people value the environment more as wealth increases.)”* Note this is increased wealth that correlates with increasing WTP.

“The basic benefit estimate of £2,969m has been uplifted to account for real income growth, “ note this is real income growth “but assuming only modest growth over the next few years, in line with the current economic situation. ONS GDP estimates have been used for growth to the period to 2010, followed by Treasury estimates of mid-term growth to 2014 followed by an assumed return to the long term growth rate (2% per annum) beyond. Using this profile leads to an increase in the aggregate present Value benefit estimate of 33% to 3,948m. “ para 12 states “It might also be argued that any uplift in nominal value in the benefits from 2006 to 2011 could also be questionable given the recession over this period (although not applying the uplift in general prices to the 2006 benefits estimate would reduce it only by around 10%)” M

2006-2011

A report for the GMB reported in the Daily Telegraph of 29th December 2011 stated that the average **fall** of living standards when wage rises were compared with inflation over the previous four years had been 5.9%. Newspaper articles are weak evidence and I do not have a copy of the actual report , but it is likely that the trend is downwards. It is also likely that, as family incomes get squeezed, falls in living standards could result in a larger fall in willingness to pay.

Since elsewhere population growth has been used as an adjustment, one measure is the GDP per capita. Box 1.2 from the 2010 Budget red Book shows that between 2006 and 2010 GDP and GDP per capita fell, see the lower line in the chart below.

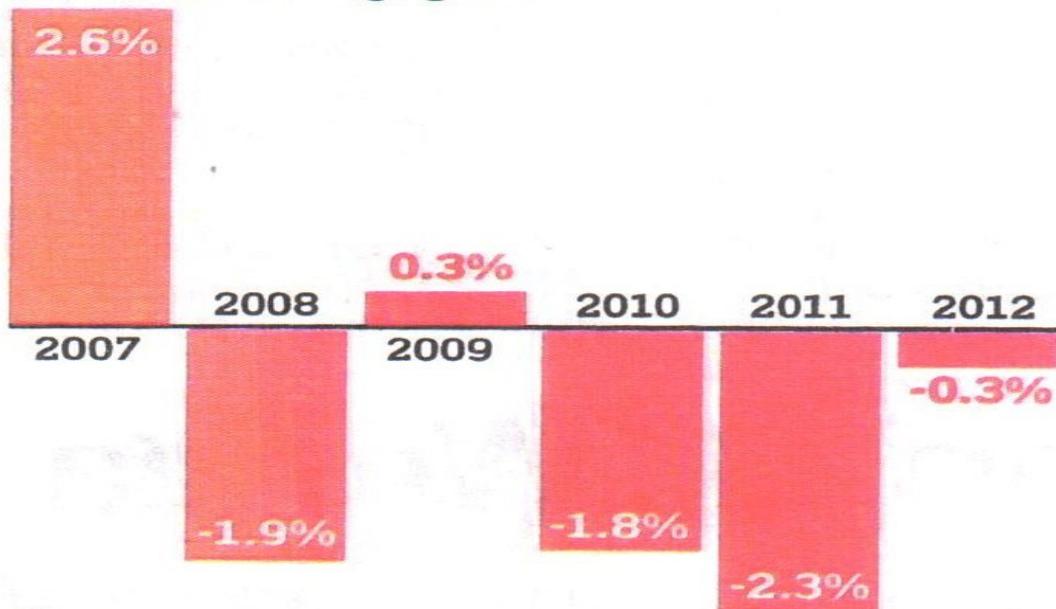


Source: Office for National Statistics

Thus it would be difficult to support any benefit growth from income growth between 2006 and 2011. Thus I have deducted the 10% growth assumed in the defra report, as confirmed below.

EARNINGS SLUMP

UK annual real wage growth



For



Source OECD

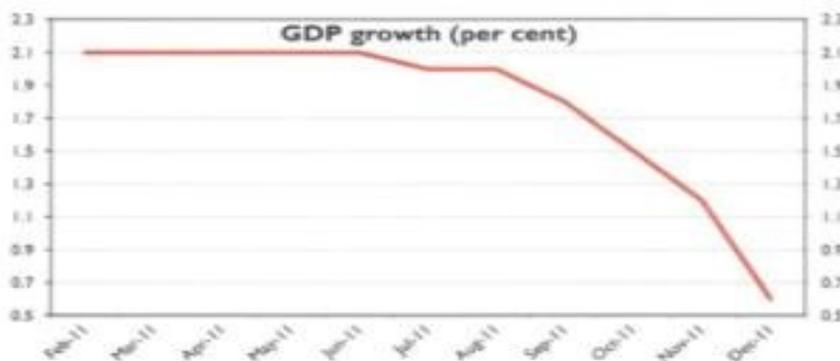
growth in real income, the defra CBA uses growth data from the ONS for GDP growth. For changes between the wtp survey date and the revaluation, it would seem more straightforward to use a direct measure of changes in income in relation to RPI. The Institute of Fiscal Studies publishes data based on the family resource survey showing declining real incomes between 2006-7 (the year of the wtp survey) and 2011-12 (the year of the revaluation based on the survey). During this period UK real household income before housing costs fell by 4% for mean income and 4.5% median. After housing costs the fall was

6.5% mean and 7.5% median. As both the wtp survey and water industry price control relates to the RPI + K formula, it seems reasonable to assume that if a repeat survey had been held in 2011, or indeed in 2014, people would have been more aware of pressures on their incomes than in late 2006 when the survey was conducted. Thus a more reasonable assumption would appear to be that the mean after housing costs number be adopted which would be a fall of 6.5%.

2011-2014

Para 11 b continues *"followed by Treasury estimates of mid-term growth to 2014"* The OBR Budget forecast, C2 page 77, was *"GDP to grow by 2.3% in 2011, rising to 2.7% to 2.9% in the later years of the forecast."* Over the 4 years this would amount to about 10.6%. No specific figures have been given in the CBA for which Treasury estimates were taken. Treasury estimates have been downgraded several times in recent times so these high growth forecasts can no longer be considered robust. As an instance 2012 GDP growth, forecast to be 2.0 in August 2011, had, by December 2011, declined to 0.6%. Whilst in 2013 it was rising again it is not in a way that would tend to resolve affordability issues.

Average of independent forecasts for 2012; GDP growth, CPI and RPI inflation and claimant unemployment



Since the original draft of this report in December 2001, the economy has been weak. Below are the actual and forecast numbers from the Table B.1 of the OBR outlook in the Treasury Autumn Statement 2013

	2011	2012	2013	2014	Total
GDP	0.9	0.2	0.6	1.8	3.5%

The 2014 figure is the Treasury forecast. This total of 3.5% compares with the defra assumption of a total of about 10.6% growth.

This is at a time when RPI was running at about 3%, and thus the cost of the tunnel, quoted at 2011 prices, would have risen at about that rate. In any case the GDP numbers already include the population growth, so including both population and GDP would be double accounting. M

2014 onwards

“followed by an assumed return to the long-term real growth rate (2% per annum) beyond.”
“Using this profile leads to an increase in the aggregate present Value benefit estimate of 33% to £3,948m.” This is the uplift of the basic benefit estimate of £2,969m by 33% to come to £3,948m. Thus the 10% allowed for the period 2006 to 2011, see above, is included within the 33%. Deducting the 2006 to 2011 nominal growth of 10%, as stated above, would reduce the total growth to about 23%. M.

Analysis of the period 1982 to 2010 does show a rate that is about 2% a year.

Holding the 2006 survey values constant and then uprating from them implies that people remain content to pay a rising proportion of declining real incomes on water and sewerage charges, in effect paying water charges at RPI + K while incomes are not keeping pace with RPI. Given the sharp concurrent pressures on household energy bills, this seems unrealistic. The National Audit Office has published data on the extent to which the combined impact of foreseeable infrastructure investment for both energy and water sectors has severe affordability impacts, and is not coordinated or realistic.

With the current world and euro situation, the weak economy in the Euro area which is our main export market, along with the fragile UK economic situation, the threat of EU tax on the City and the downgrade of the credit rating of both Euro countries and the UK, this assumption currently looks decidedly optimistic. There is also the real household income negative income after housing costs fall of 6.5%.

However GDP growth already includes population growth in arriving at GDP. That is, part of the growth in GDP is because there are more people to do the work. Thus to include both the growth in population and GDP growth becomes double accounting, albeit one may be larger than the other.

As NERA says in its CBA report, it is important to be cautious when carrying out economic assessments. The analysis already includes London population growth of 14%. Thus, already having had a period of significant falling real incomes and with an uncertain longer term outlook, a reasonable assumption would be no growth in household income per head or willingness to pay per head during this period.

Spill volumes

Defra 2011 CBA para 11 c states *“It has become apparent that the spill volumes from the Combined Sewer Overflows are somewhat worse under the baseline (no project) case than previously thought. Thames Water now estimates an annual spill volume of 40Mm³ rather than 32Mm³ used in the 2007 assessment.”* I have searched the 2007 etec report Stated Preference Survey. The only reference is on page 11 that the information is *“presented in Showcard C3 (see Annex 5) and is also shown in Table 3.1 below.”* There is no mention in Table 3.1, or show card C3 on page 14 of Annex 5, of any spill volume. Thus the respondents cannot have had any spill volume in mind when responding to the questions.

In any case the TW spill volumes are based on the dry weather flows into the sewers increasing with population. Looking at Thames Water 's Water Resources Management Plans, the water delivered that gives rise to sewer dry weather flows is actually forecast to

go down due to demand management measures such as metering and tariffs. Thus, even if the logic were to be correct, there would be no additional benefit.

“Given that the Thames Tunnel reduces volumes to a fixed level consistent with meeting the Urban Waste Water Treatment Directive, the implied benefit of the tunnel is therefore likely to be larger than previously estimated.” This is not understood as there is no fixed volume or spill frequency or “level” in the UWWTD.

“Accounting for a small change since 2007 in the estimated residual spill volume of the tunnel, the net change is a 24% additional reduction in spill volume arising from the project (based on current conditions.) Assuming this equates simply to a 24% increase in benefit, the benefit estimate would be £3,694m. It should be noted that this estimate does not apply any diminishing marginal benefit in reducing spill volumes however, which may be an overestimate.”

Benefits depend on both the spill, the existing water quality, and the location. Thus, if the water quality was sustainable for all fish species then a reduction in the amount of spilled water would make no significant difference. Thus it is erroneous to assume a direct link between spill volumes and benefit. Thus the so called 24% increase in benefit is illogical and not supported. As shown in the section above there appears anyway to have been no mention of spill volumes in the original WTP survey, thus it is the benefit level, 3 overflows per year, that would have been considered. Thus a 24% increase is not valid.

In para 12 of the 2011 CBA defra state “...not c which may not be robust”. In line with defra, my assessment excludes spill volumes.

Benefit upperbound

In para 12 of the CBA defra state “A nominal but arguably conservative “upper bound” on the range of revised benefits from the Thames tunnel has been calculated by combining “tests a) and b) above (but not c which may not be robust) which gives a figure of £5,058 as a 100-year present value figure. As such, the quoted range of benefit for the Thames Tunnel is now put between £2,969m and £5,058m.”

a) is the assumed population growth and b) the real income growth from 2006 onwards. The CBA 2011 para 10 states “This gives a 100-year “basic” benefit figure for the Thames Tunnel in 2011 prices of £2,969m. We take this as the lower end of the likely benefits range for reasons set out below.” Taking the 2011 updated figure of £2,969m, adding the defra assumed 14% for population growth, and the defra assumed figure for real income growth of 33%, my maths gets to an upper bound figure of £4,502m. Thus the defra figure of £5,058m is not understood and appears to have been overstated by about 10%. If so this would effectively be an arithmetical error of about £500m, a significant amount. M

It is possible that the defra calculations included the presumed GDP deflator from 2006-2011 of 10.6%. However my belief is that the 33% real income growth increase covers the period from 2006 and therefore it would not be valid to take that increase twice.

I have considered the various factors above and, for the reasons stated, do not support the upper bound figure of £5,058m.

“Whilst it might be argued, for the above reasons, that the upper bound could defensibly form a new “central estimate”, we are cautious about claiming this at this stage, especially given the delicate economic situation and the uncertain impact of this on real income growth in the near term. It might also be argued that any uplift in nominal value in the benefits from 2006 to 2011 could also be questionable given the recession over this period (although not applying the uplift in general prices to the 2006 benefits estimate would reduce it only by around 10%)...On balance we would argue that the benefit is more likely to be in the upper half of the range than the lower half.”

Further, to reach this upperbound figure defra has included both population growth and GDP growth. But does not Gross Domestic product already include for population growth? If it did it would be double accounting.M

Defra CBA conclusion

The 2011 defra CBA para 14 states *“In conclusion, we present a range of estimated monetary benefit for the Thames Tunnel of £3.0-£5.1bn, but without making a strong statement about the most likely point within it. Rather we suggest it is reasonable to assume that benefit will be in the upper half of the range, given some systematic underestimates in the 2007 analysis.”* I have examined the so called underestimates and consider any such underestimate to be minimal.” *Given estimated costs of £4.1bn,”* this does not include the extra costs of £244m shown in para 6 M *“ this suggests that the tunnel will be cost-beneficial (ie benefits will be at least as high as costs). Furthermore, given an economic entity (whose current GDP is broadly £250-£300bn per annum) the broad conclusion that the tunnel is a net beneficial investment for “UKplc” would appear reasonable.”*

“15 The Thames Tunnel cost and benefit estimates above should be viewed as high-level, to support the ongoing government position on what is ultimately a private sector investment, but will continue to be developed and refined as the project develops.”

My analysis, using similar methodology but with revised assumptions is set out in section 9 in tabular form.

8 A strategic and economic case for the Thames Tunnel, defra November 2011

Introduction

In association with the Cost and Benefits report 2011 defra issued a report Strategic and economic case for the Thames Tunnel 2011. This included a significant repeat of the Cost and Benefit report so, where this has already been considered by me, I will refer back to the relevant text in my report.

Current discharges

Page 3 states *“In a typical year 39 million cubic metres of untreated sewage discharges into the River Thames.”* As a reason for constructing the Thames tunnel this is misleading on two counts. M

First the Lee tunnel is already being constructed and, once that is finished in about 2015, the amount of annual discharge into the Thames will reduce to about 18 Mm³, less than half the figure quoted, see the Table of Performance dated June 2011.

Secondly it is not just untreated sewage that is discharged. This is emotive. It is storm water, ie rainfall, mixed with some foul sewage. For major storms this is a much diluted discharge. The TW report SCITTER Storm Sampling 2005 of sampling storm flows at the Acton Storm Tanks showed that on average storm flows had less than 1% suspended solids and no sample exceeded 2 1/2% suspended solids.

Page 4 box “ *CSO discharges now happen more than once a week on average*”. This implies that many of the CSOs spill at this frequency. Actually this is not true as the Table of Performance shows that the highest average spill frequency is Hammersmith which spills at 51 spill a year on average, ie less than one a week. There are only 15 CSOs that spill more than 20 times a year. Thus this point is misleading. M

Future discharges

Page 2 and page 4 refer to the sewer system overflowing “*in future even on dry days*.” Again this is not true. The statement is based on the postulation by Thames Water about 2010 that the sewer dry weather flow would rise in line with population growth, increasing dry weather flow by about 13% by 2021 and 30% by 2080. Since then Thames Water’s 25 year Water Resources Management Plan shows that, despite increasing population, but because of demand management due to metering and tariffs, water delivered and leakage would reduce by about 10% by 2021. Thus the existing sewer system could cope and there would be no spill during dry days. M

Page 5 “*Without a solution, the river is predicted to deteriorate*”

This is based on the TW assumptions that dry weather flow in the sewers increases because leakage and per capita consumption stay the same in future, thus relating dry weather flow directly to population growth. Thus spill frequency and volume would increase.

However taking TW figures in their 25 year Water Resources Management Plan 09, for population, per capita demand, and leakage, by my analysis, dry weather flow up to 2035 might not exceed that in 2006, see my Measures Report , section 7.

The storm events in winter may increase but are not critical for dissolved oxygen because there is a greater river flow and hence greater dilution, and the winter temperature is much lower, see image below. The Met Office have said that summer storms are not expected to change for many decades. Thus, on my analysis, it would be unlikely that the interceptor sewers would overflow more during critical dry weather conditions for several decades.

Increasing temperature in the river in the future may be an issue. I understand this would be about 2C by 2050 and about 3C by 2080. This would need careful study.

Page 3 “ *An increasing population is leading to more houses, and increasing urbanisation is leading to a loss of green space to help water drain away.*” Whilst this sounds sense for most expanding towns, London is a finite area and the density of population and buildings is already very high, and the amount of green space available for new building is very limited. Currently about half the population live in flats and, in recent years, the new construction has

been greater than 80% flats. The projections are, I believe, for the proportion of flats in new build to rise even further. In contrast there is greater pressure from central government, see the recent Water White Paper and Planning Authorities for developments to increase green space and adopt Sustainable Urban Drainage systems (SUDS) measures with reduced runoff rates. Thus there is likely to be more green space.

London

Page 5” *Improvements to the water quality in the River Thames through the construction of a tunnel could lead to wider long-term benefits to London’s reputation (eg as a tourist destination) and economy.*”

Misleading, see bullet 1 in **other benefits** in section 7.

Maintain attractiveness for inward investment

Page 5 “ *the Thames Tunnel project should help to maintain the attractiveness of London for inward investment.*”

Misleading, see bullet 1 in other benefits in section 7

Property value

Page 5 “ *and could have an impact on the value of existing property and limit future development.*”

Misleading, see bullet 2 in **other benefits** in section 7

Economic activity

Page 5 “ *We believe that the project itself will lead to considerable economic activity-funded in the long run by customers while in the short term it should attract inward investment and could give a boost to economic activity.*”

Very misleading, see bullet 5 in **other benefits** in section 7. As the words are “customers” this reads as if written by Thames Water, the scheme promoters. Who else could use such words?

In any case water charges will go up by some £70-£80/year for householders and probably similarly for businesses. Thus the economic activity will reduce because of the money taken out of the economy to fund the tunnel.

Paying for the tunnel

The Strategic and economic case for the Thames Tunnel Nov 2011 states on page 13 “ *On the basis of current estimated costs, the tunnel will result in an average maximum annual customer bill impact of £70-80 at 2011 prices...Ofwat estimates that “this” would see about 15% of households spending more than 5% of their disposable income on water and sewerage bills. This would be the second highest by a “water and “ sewerage company, behind South West Water at 16%.*” The government has announced a subsidy of £50/household for South West Water customers, acknowledging that their water bills are too high. For many Thames Valley water users, such as in Oxford and Swindon, this bill

increase of some £70 to £80 per year on average, at a time of economic difficulty, for a facility they may not have benefit often, may be of appreciable concern.

Uncertainties

Page 14, *“Some uncertainties are inevitable for a project entailing long, costly, and geologically complex sewers being built in a heavily urbanised area. ... There are also uncertainties about whether our estimate of risks is accurate”* This reads as if it was written by Thames Water as only they will know the risks and costs. It would be interesting to know how much of this defra report was written by Thames Water. Most of the tunnel is under the River Thames which is not an urbanised area. However the connection shafts are on land adjacent to the river.

“and whether the project can be structured in such a way as to attract the required finance.” Although Thames Water have known of the problem since the UWWTD was promulgated in 1990, have known that the tunnel was the likely and a costly solution since 2000 and were instructed to construct it in 2007, they have consistently issued dividends to their shareholders comparable to the profits, ie have retained little financial reserves with which to support the financing of the tunnel. M

Importantly this section does give cause for concern that the project cost could yet go higher than the current estimate. This is especially so as the cost estimate of the whole tunnel has increased from £1.7bn in 2005 to about £4.7bn in 2011. Only about 15% of this increase would be due to inflation. The London Water Ring Main tunnel struck a water bearing fault and delayed construction for several months. The knowledge of the geology is limited so is still a significant risk. Since TW have not provided any scheme cost breakdown or risk allowance it is not possible to comment further. This must raise doubt as to whether real costs could increase even further.

The Water Industry (Financial Assistance) Act gives the Secretary of State powers (but not duties) to *“provide contingent financial support for complex water and sewerage infrastructure such as the Thames Tunnel in London.”* The level at which this could/would be provided has not been disclosed so it is difficult to comment on its likely effect.

Conclusions by defra

Page 15 states *“There is an environmental case for action in the Thames: the current level of discharges from CSOs into the Thames is excessive, resulting in large fish kills”*

Two large fish kills have been recorded in the last 10 years, 2004 and 2011, both in the Kew/Barnes stretch significantly upstream of the CSO interceptor system which starts about Hammersmith. Thus the Tideway CSOs that would be intercepted by the Thames Tideway Tunnel were not the prime cause of these fish kills. The cause of these fish kills has been dealt with by upgrades to the Mogden STW completed in March 2013. This has reduced both spill frequency from about 100 spills a year to about 20 spills a year as well as greatly reducing the spill volumes and strength of the spill. The improvement was demonstrated by a big spill in May 2013 which resulted in no fish kill and no dissolved oxygen drop below 80% saturation, much higher than that required to result in a fish kill. Thus, post the completion of the Lee tunnel, it would appear that only one fish has been recorded as being killed in the

Tideway from CSO spills in the last ten years and that the Tideway fishery would become sustainable without further large expenditure..

The benefit of bubbler and skimmer systems has not been included in the models.

“adverse health impacts”

The Tideway is not a bathing water so is not covered by the Bathing Water Directive so there are no specific health standards. Further the PLA has now banned bathing in most of the Tideway, except with a specific licence for navigational reasons. The Putney rowers are about ten times as healthy as the general population.

The only other significant group of recreationalists is the dinghy sailors and water skiers in the London Docks. These are confined bodies of water and the small amounts of top up water could be treated cheaply.

“sewage litter”

Only 10% of the litter is sewage derived. From the eftec study of TW customers, 2/3 rarely or never had seen human waste. The EA has informed me on 18th January 2012 that *“Unsurprisingly the number of formal public complaints regarding sewage debris is relatively few.”* The use of a number of collection booms and skimmers had not been included in the consideration.

“and odour related problems”

In my time associated with the project I have not seen any reports of an odour problem. I have also lived in London and, when conditions were worse, worked in an office beside the river without noticing any odour problems.

“In addition there is the economic case to support the tunnel. It will secure at least £3bn to £5bn worth of economic benefits (where estimable) for a whole life cost of around £4.1bn (present value before considering financing arrangements).” See the next section, and the Table in it, where, by my calculations, the benefits, would be about £310m or, if the fish species are sustainable after the current works are completed, as shown in Appendix C, then the benefit would be only £190m. Were the minor benefit of litter reduction to be only £150m in 2006 costs then the disbenefits of the construction impact would result in negative benefit.

Not mentioned

The possibility that higher sewerage charges will displace other household consumption, or even water industry investment options, or the ability to increase government revenue, is nowhere mentioned.

These seem weak reasons for the £4bn of capital expenditure.

“Finally, the tunnel meets our statutory requirements under the UWWTD and will reduce the risk of infraction fines against UK.” Yes, but is there a cheaper way of achieving this, for instance by a combination of measures, see section 10 below.

9 Conclusions of the CBA review

The DEFRA CBA report has been somewhat selective in concentrating on those areas where there is an arguable case for up-rating benefits estimates: population growth, payment by those outside the Thames Water area who would not actually pay for the works, significant income growth during the economic problems, and asset life, while ignoring those uncertainties which support an alternative view that the benefits are significantly overstated: overvaluation of health benefits well beyond the level and severity of illness that could be affected by the tunnel project, the provable tendency of single issue willingness-to-pay surveys to over-value, the failure to give respondents significant information about the scale of avoidable illness, and a proper sustainability assessment of fish and aquatic ecology.

For Thames Valley water users, such as in Oxford and Swindon, the bill increase of some £70 to £80 per year on average, well in excess of the mean willingness to pay, at a time of economic uncertainty, for a facility that they may not have benefit from often, may be of appreciable concern. My analysis appraises the defra cost benefit assessment and uses the same basic methodology.

The CBA says the benefit of the Thames Lee tunnel split should be done on the basis of the spill volume (tonnage) saved. Instead of Thames/Lee being 60/40 this would be 48/52.

The future growth of benefit is based on both population growth and GDP growth. However GDP includes population growth. In any case GDP has been negative over recent years and the economic growth is uncertain. Some forecasts show GDP/head as negative. Thus I have taken just the population growth. However the population growth is quoted for London. It is being applied to the whole benefit area so should be the growth in that area. I don't have the relevant figure but London population growth is higher than the national average so the growth should be lower.

Taking the 2011 updated figure of £2,969m, adding the defra assumed 14% for population growth, and the defra assumed figure for real income growth of 33%, my maths gets to an upper bound figure of £4,502m. Thus the defra figure of £5,058m is not understood and appears to have been overstated by about 10%. If so this would effectively be an arithmetical error of about £550m, a significant amount.

On the basis of the assumptions above, the benefit would be £310m, see summary table below. This is little more than 8% of the cost estimate of the Thames Tunnel, of £4.1bn.

In which case it would appear that the full Thames Tunnel would be "Excessive cost" under the UWWTD and "Disproportionate cost" under the Water Framework Directive.

In any case this analysis assumes the baseline WTP amount for fish of £600m. As shown above, it would appear that, post the STW upgrades, fish would become sustainable and even more certainly post completion of the Lee tunnel. This would reduce the total benefit to about £180m.

Were the litter benefit, classified as "*minor*" by Eftc and with "*relatively few public complaints regarding sewage debris*", be not a basic £1,000m but £200m then, because of the adjustments and the disbenefits, due primarily to construction impacts, the total benefit could become £8m.

This table takes the base amount found by the effec WTP study, £3,935m, splits it according to the ratio found in the 2003 wtp,. The three dated columns are how particular factors were taken account of in the three cost benefit analyses. The right hand column is my assessment, and the column on its left the reason for the change. GDP includes population change. GDP has been negative and the future is uncertain so I have accepted the population change and ignored GDP changes. For details see the relevant sections.

Item	2003/5	2006/7	2011	Comment	Adjust
	CBA	CBA	CBA		ment
Base amount			3,935m		3,935m
WTP table				Parts have a misleading description. Special measures not considered.	none
Water bills				No mention of size of TT increase	none
Health	Separately	combined	combined	QALY not WTP	To £1.5m
Fish	Separately		combined		none
Litter/aesthetics	separately		combined	Property benefit minor	none
Jurisdiction	Admin	A+B	A+B	Benefit Jurisdiction doubt	none
Single/multiple	single	single	single	Multiple in FBP	-60%
Other rivers				No allowance. ? half	none
Mean/median			mean	Median about half of mean	none
Protest votes	included	included	Excluded	15% increase	none
Distance decay	No	Yes	Yes	Results look odd	none
Monetary values	no	No	No	15% constant nominal	none
Thms/Lee split	NO	No	TTT 60%	Corrected split	-52%
Benefit of Lee T	No	No	No	Lee tunnel needed for Thms T	none
Appraisal period	60 years	60 years	100years	60 years	No increase
			+14%		£192m
Reduced hh flood			no	Entec Table 4.3	+£7m
Disbenefit	no	no	no	Half upper of £85m	-£42
Base amount					£157m
GDP deflator 06-11			+10.6%	Fall of 6.5%	
2011			2,969m		£157m
Population rise Ldn	No	No	+14%	Benefit area	+14%
amount			3,391m		£180m
Real income growth	NO	No	+33%	GDP includes population	zero
Spill volume			Not included		Not included
Amount			4,502m	Basis of this not clear	£180m
Quoted range			2,969-5,058	. ? £4,502.?maths	
Mid point benefit			4,013m		

In Appendix B I analyse the draft report by Dr Paul Metcalf on Update of CRP WFD Benefit values-Economic Component dated June 2012. This uses a WTP survey to assess the benefit of improving water bodies to meet WFD criteria. On the basis that the tunnel would move the Tideway from Moderate status to Good status, which it would not, the range of benefit would lie between about £114m and an absolute maximum of £676m, probably nearer the lower end of the range. Whilst there are many assumptions in my analysis it does provide independent support to the output of my analysis of the Tideway tunnel benefit.

Potential infringement fines

Both the Judgment and the Advocate General's opinion state clearly that the environmental harm continuing if the project is not built need to be compared with the cost of building it, and if the costs vastly exceed harm there is no obligation to do more. It seems that no argument based on disproportionate cost was submitted by the UK. The outcome might have been different if a realistic valuation of benefits had been used. As fines for continuing infringement would be based partly on the value of environmental harm, there seems to be no advantage to the UK in continuing to overstate and inflate values by including impacts such as employment and hypothetical health benefits which are not relevant to the measure of compliance. Thus it would seem in the British Government's interest to state the actual environmental impact, and the harm involved.

10 A combination of measures

Thus the health aspect does not warrant major expenditure, the litter designation did not appear to meet the designation requirements, and salmon appear to be unsustainable as a species, but even if they were sustainable as a species, then post the current works, all fish appear to meet the sustainability conditions as there has been only one recorded fish killed from the CSO that would be collected by the Thames tunnel. The post Lee tunnel situation would fail the dissolved oxygen table established by UK under the Water Framework Directive but, as this is supposed to ensure fish sustainability, there must be great doubt about the relevance of the table. The benefit at about £180m would mean the tunnel would be "*disproportionate cost.*"

"The Coalition in its Our Programme for government section 2 Business has stated "*We will end the so-called "gold-plating" of EU rules, so that British business are not disadvantaged relative to their European competitors.*" In this case the disadvantage would be the cost on business and people in paying the substantially increased sewerage charges.

The HM Government Reducing Regulation Made Simple 2010 page 5 says there are four elements to the new approach

A new decision-making structure to bring greater discipline and transparency to the way in which decisions on regulatory issues are taken

Opening existing regulation up to tougher, more meaningful, scrutiny.

The vision for Ministers includes to *encourage and challenge civil servants to actively explore creative, non-regulatory solutions to achieve desired policy outcomes.*

Whilst the PINS would not normally look at alternatives to schemes set out in an NPS, at the EFRA hearings in February 2011 on the draft NPS for wastewater, the government in response to Q205 said that “*the IPC will look very carefully ...at alternatives.*” In response to Q209 the Minister replied “*the IPC will look at issues relating to this scheme and alternatives....*”

Treasury requirement

The HM Treasury Green Book states on page 17, para 5.3 “*Creating options. This step involves preparing a list of the range of actions which government could possibly take to achieve the identified objectives. The list should include an option where government takes the minimum amount of action necessary (the do minimum option) so that the reasons for more interventionist actions can be judged.*”

I propose that a do minimum cheaper option be considered for all the Tideway CSOs as required by the Treasury and this is set out below.

Current works

Current works include the upgrading of the Mogden, Beckton, and Crossness STWs along with the construction of the Lee tunnel costing some £1.2bn, a not inconsiderable sum.

Fish sustainability

I have received the Environment Agency schedule of fish kills in the Tideway. This shows that, ignoring fish kills due to Mogden STW, there were only 3 fish kills in the Tideway over a ten year period. Thus the situation is already well down the WTP show card of less than 1 fish kill a year. Once the Lee tunnel is operational the fish kill record shows only 1 fish killed from a Tideway CSO spill in ten years. Thus none of the WTP benefit for ecology can be allocated to the Thames tunnel.

In addition it would appear that fish would be sustainable in the Tideway thus there would be minimal benefit for ecology in constructing the tunnel.

In addition there is the fixed oxygen injection facilities at Mogden and elsewhere, ? Barnes, along with the bubbler boats. If there is still any doubt that the dissolved oxygen condition in the Tideway is making fish unsustainable, then a fixed oxygenation system similar to that employed in the River Seine at Paris could be implemented estimated to cost about £10m.

Health of recreationalists

Thames Water already notify rowers of CSO discharges which enables them to take what action they wish.

The HPA study, aligned with the NERA QALY analysis shows that an alternative and more objective way of valuing health benefits would reduce them to £1.5m NPV. As no measures at present planned would remove human pathogens from treated effluent the continuing exposure will be significant whether the tunnel is built or not.

Should it be considered necessary to improve the health of the dinghy sailors and water skiers in the docks, then a small water treatment plant to treat the top up water, could be provided.

Aesthetics

There is no scientific data to support the classification of those CSO that are causing impact. In 2011 the EA said there were relatively few public complaints.

There are two litter collecting boats. In March 2008, after 6 months service Thames Water stated “ *The vessels which have collected over 40 cubic metres of litter from the River Thames since September 2007 have greatly contributed to improving its environmental and aesthetic quality, ensuring it is fit for river users, and for this years Oxford and Cambridge boat race crews. To date, the skimmer vessels have been a real success story, enabling us to collect large volumes of litter, which overflows from the sewers during periods of heavy rain.*”

Providing an oil collector might be beneficial to deal with the oil based slicks, cost maybe £2m.

If thought appropriate, booms could be placed around most of the CSOs to retain floating debris which could then be collected by a special boat, cost about £2m, very cost effective.

Reducing the spill frequency would improve matters further.

Spill frequency

The UWWTD requires that spills only occur “during unusual rainfall conditons”. Previously it had been presumed that this would mean about 10 spills a year.

However the Advocate General’s Opinion of the infraction proceedings, January 2012, states in para 48 “*On several occasions, however, both in the pre-litigation stage and before the Court, the Commission did indicate that, as a rule, exceeding **the limit of 20 overflows a year** would be a cause for concern, suggesting a possible failure to fulfil obligations. Despite all its limitations and without prejudice to the need for a case-by-case assessment, a numerical criterion of that nature may be reasonable and acceptable as it had been determined by comparing the practices existing in the various Member States.*” Emboldenment added by me.

The judgement of the European Court, para 28, states that the Commission “*does not propose a strict 20 spill rule but points out that the more an overflow spills, ...the more likely it is that the overflow’s operation is not in compliance with Directive 91/271.*” Thus it is possible that a spill frequency up to 20 spills a year would be allowed.

As an instance, the approved uprated Mogden STW has spilled 13 times in the 7.8 months April to 25th November 2013 which would indicate that a spill frequency between about 20 times a year has been accepted by the EA,

Thus, whilst the 20 spills a year criterion was not formalised by the EC or by the British Government, such a criterion would appear to be acceptable, particularly where environmental conditions would be likely to be met, as shown to be the case earlier in this report.

(Note the tunnel is designed to achieve about 3 spills a year but at substantial cost of £4.1bn at 2011 prices. The government is in other contexts very critical of approaches which gold plate or over specify in relation to European measures.).

20 spills a year would be much easier to achieve.

Measures to reduce spill frequency

The previous studies of alternative measures included a totally new foul sewer system, screening the outfall, and SuDs. These studies were constrained by the knowledge available at the time.

There are now a number of ways of reducing the spill frequency

Correcting the dry weather flows in the sewers for the projected WRMP water delivered and leakage

Reducing the flow into the sewers by further demand management measures.

Diverting some of the sewer flow to other sewer catchments.

Removing some of the restrictions within the sewer systems

Physical real time control to make maximum use of the existing sewer capacity.

Limited detention capacity where appropriate.

Sustainable urban drainage systems and Blue green Infrastructure

Some of these have been looked at as single actions by TTSS and TW and found to be excessively expensive on their own.

A study was done to assess the spill reduction in Putney using SuDs techniques and it was found that, ignoring any infiltration storage, the system would not meet the 10 spills a year criterion applied then. However subsequent analysis by TW showed that the CSO spills were less than previously thought and it appeared highly probable that SuDs there would meet the EC 20 spills a year criterion.

Catchment	Existing system spill frequency Appendix E	Existing system spill frequency TW Model 2011	Appendix E 50% impermeable removed	Likely revision 50% impermeable removed
West Putney	59	26	52	about 20
Putney Bridge	33	33	16	stays at 16
Frogmore	29	19	10	less than 10

Combination of measures

However, I have not been able to find any significant study which has looked at a combination of all of the measures for the London CSOs.. My belief is that this is a requirement.

The defra River Basin Planning Guidance Vol 2 August 2008 states in 9.4 "*As river basin planning principle makes clear the Environment Agency should consider the full range of measures which are available.*"

In 9.5 the RBPG states "*The WFD requirement is to make judgements about the most cost effective combination of measures, so it is important that the Environment Agency considers the inter-relationship between measures.*"

The letter from defra to the EA Regional Director 4th April 2005 states "*Defra is committed to obtaining the best value for money. I know that the Agency shares this commitment and will continue to treat value for money as an important consideration in assessing solutions proposed.*"

Thus a study should be carried out on how a combination of measures would perform.

It would need to look at what could be achieved at more economical cost considering all the measures would be used where they were most economical.

For instance separation could be utilised those areas close to the Tideway where the current system is almost entirely combined. Other such areas could include areas being considered for upgrading such as Counters Creek, a key area.

Sustainable drainage systems(SuD)s/ blue green infrastructure (BGI), in particular for new developments and where road surfaces need renewing.

Infiltration of storm water into the natural ground where appropriate,(probably much more available than expected by the Environment Agency.)

Critical storms for the river would be summer thunderstorms.However these storms tend to be local convective storms and would be unlikely to cover all of London. Thus some of the interceptors may well have spare capacity under such conditions. Further, the current fixed diversion weirs were constructed many years ago and may no longer be set optimally.Thus implementing real time control / Active System Control with rainfall radar, water level sensors, and moveable weirs might well provide appreciable benefit.

Analyses would need to take account of future sewer flows in line with projections of water delivered which is not increasing in the way used in the previous analyses.

There may be a few restrictions that increase spill frequency. For instance the connection between the Fleet sewer and the Northern Low Level Interceptor is known to be too small and to aggravate the CSO spills.

Recommended investigation

Following the requirement to make judgements about the most effective combination of measures, it is recommended that defra set up an independent panel to investigate whether

a combination of measures as set out above would be appropriate, effective, economical and acceptable to the EC. That way it could be seen to be ensuring that customer bills were not increasing unnecessarily.

11. Final conclusions

Rowers are about one tenth as prone to gastric problems as the general public. Whereas the **health benefit** was assessed by the WTP assessment at some £2,400m, a Quality Adjusted Life Year Analysis, as used by NICE for health benefit assessment, showed that if normal health service methodologies were used, the amount warranted spending would be only £1.5m, and it is highly unlikely that the investment proposed would be justifiable as there would be many more cost effective options for improving public health.

Post the Mogden STW upgrade, the upper Tideway does appear to have become sustainable to fish.

Regarding ecology and **fish** it would appear that, post the Lee tunnel and the STW upgrades, fish are sustainable in the Tideway. If thought appropriate fixed dissolved oxygen injection facilities could be installed in the Tideway similar to those on the River Seine in Paris.

CSO spills can result in adverse **aesthetics**. However there have, in the past, been few public complaints and the general assessment is that the impact is limited. If thought appropriate, booms could be placed around most of the CSOs to retain floatables which could then be collected by specialist boat.

My analysis appraises the defra cost benefit assessment and, uses the same basic methodology.

The Thames Water WTP survey for its 2009 Business Plan showed that the single choice over-estimated the WTP compared with the multiple choice and should be reduced by about 60%.

The CBA says the benefit of the Thames Lee tunnel split should be done on the basis of the spill volume (tonnage) saved. Instead of Thames/Lee being 60/40 this would be 48/52.

The future growth of benefit is based on both population growth and GDP growth. However GDP includes population growth. In any case GDP has been negative over recent years and the economic growth is uncertain. Some forecasts show GDP/head as negative. Thus I have taken just the population growth. However the population growth is quoted for London. It is being applied to the whole benefit area so should be the growth in that area. I don't have the relevant figure but London population growth is higher than the national average so the growth should be lower.

Taking the 2011 updated figure of £2,969m, adding the defra assumed 14% for population growth, and the defra assumed figure for real income growth of 33%, my maths gets to an upper bound figure of £4,502m. Thus the defra figure of £5,058m is not understood and appears to have been overstated by about 10%. If so this would effectively be an arithmetical error of about £550m, a significant amount.

The table shows that, on the basis of these assumptions, the benefit as assessed in the defra CBA report of between £3bn and £5bn could be as low as £310m. This is little more than 8% of the cost estimate of the Thames Tunnel at £4.1bn.

In which case it would appear that the full Thames Tunnel would be “Excessive cost” under the UWWTD and “Disproportionate cost” under the Water Framework Directive.

In any case this analysis assumes the baseline WTP amount for fish of £600m. As shown above, it would appear that, post the STW upgrades, fish would become sustainable and even more certainly post completion of the Lee tunnel. This would reduce the total benefit to about £180m.

Were the litter baseline benefit, classified as “*minor*” by Eftec and with “*relatively few public complaints regarding sewage debris*”, be not £1,000m but £150m then, because of the adjustments and the disbenefits, due primarily to construction impacts, the total benefit would become negative

Were there to be problems with the fish sustainability then, in addition to the current bubbler boats, fixed bubbler systems could be provide as in the River Seine in Paris. To reduce litter impact on aesthetics, floating booms could be provided around most of the CSOs to retain floating litter.

The sewerage system would still fail the UWWTD for too frequent CSO spills. Whereas a spill frequency of 10 spills a year had been chosen as the standard, at the Infraction Proceedings the European Commission proposed 20 spills a year.

Several single option solutions have been studied, but, as single solutions, they have all been found to be too expensive.

The RBPG states “*The WFD requirement is to make judgements about the most cost effective combination of measures, so it is important that the Environment Agency considers the inter-relationship between measures.*” Thus the Agency has an obligation to study the most cost effective combination of measures.

The measures, which could be combined, include, revise sewer dry weather flows to conform with WRMPs, further reduction in water demand, sewer diversion to other catchments, sewer separation where economical, SuDs and BGI, real time control, detention tanks, etc.

A study is proposed to identify how a combination of measures might reduce the spill frequency sufficiently at an economical cost.

12 Recommendations

It is recommended that defra set up independent panels to review;

1. Benefit achieved by the current works.
2. The ability to reduce the CSO spill frequency by implementing a combination of measures including reducing sewer flows by water demand management and other measures, SuDS, Blue Green infrastructure and infiltration, separation of some combined sewers, real time control, and other measures,.
3. A cost benefit analysis be carried out of the tunnel and also of the combination of measures.

Chris Binnie MA, DIC, HonDEng, FREng, FICE, FCIWEM

11th February 2014

Appendix A Table of Performance

LTT ID	EA Cat	CSO Name	Existing System & Existing STW 2006 (June 2011)			STW Improvements and Lee Tunnel 2021 (June 2011)			Recommended Phase 2 Consultation Scheme 2021 (June 2011)		
			Total Volume (m ³) ^a	No. of Spills ^a	Spill Duration (hrs) ^a	Total Volume (m ³) ^a	No. of Spills ^a	Spill Duration (hrs) ^a	Total Volume (m ³) ^a	No. of Spills ^a	Spill Duration (hrs) ^a
CS01X	Cat 1	Action Storm Relief	212,000	20	152	225,800	30	162	0	0	0
CS02X	Cat 2	Stamford Brook Storm Relief	500	2	2	500	2	2	400	2	2
CS05X	Cat 1	West Putney Storm Relief	24,200	26	112	26,400	28	119	1,500	1	4
CS37X	Cat 3	L11 Brook Green	0	0	0	0	0	0	0	0	0
CS03X	Cat 2	North West Storm Relief	2,800	1	1	4,100	1	1	700	1	1
CS04X	Cat 1	Hammersmith Pumping Stn	2,208,000	50	648	2,352,100	51	690	103,600	1-3	16
CS06X	Cat 1	Putney Bridge	68,100	33	107	70,800	33	111	1,600	1	3
		Upstream Putney Bridge Total / Maximum^b	2,626,000	50	1,023	2,800,000	51	1,086	108,000	3	26
CS07A	Cat 1	Frogmore SR - Bell Lane	17,300	26	124	18,100	27	130	500	1	4
CS07B	Cat 1	Frogmore SR - Buckhold Road	85,600	19	68	88,600	21	72	1,500	1	3
CS08A	Cat 1	Jews Row - Wandie Valley SR	300	1	2	2,900	1	5	0	0	0
CS08B	Cat 3	Jews Row - Falcon Brook SR	7,400	2	7	7,500	4	410	91,000	7	31
CS11X	Cat 2	Church Street Pumping Stn	708,000	10	282	770,000	10	281	56,900	0	0
CS12X	Cat 2	Queen Street Pumping Stn	1,120,000	8	206	1,260,000	0	0	0	0	0
CS13A	Cat 2	Smith Street Main Line	1,400	4	8	1,500	4	8	1,500	4	8
CS13B	Cat 2	Smith Street Relief	0	0	0	0	0	0	0	0	0
CS14X	Cat 1	Ranelagh	283,000	26	142	305,700	27	153	18,500	2	10
CS15X	Cat 1	Western Pumping Stn	2,046,200	37	200	2,323,900	41	228	244,500	4	24
CS17X	Cat 1	South West Storm Relief	227,900	12	38	238,400	13	40	3,900	1	3
CS16X	Cat 1	Heathwall Pumping Stn	654,900	34	200	748,300	38	246	62,500	4	26
CS18X	Cat 2	Kings Scholars Pond Storm Relief	1,400	2	4	1,800	3	5	500	1	2
CS19X	Cat 1	Clapham Storm Relief	12,700	5	12	14,400	6	15	7,900	1	5
CS20X	Cat 1	Brixton Storm Relief	264,600	28	131	278,600	29	137	5,700	1	4
CS21X	Cat 2	Grosvenor Ditch	2,600	3	7	3,000	4	9	500	1	3
CS39X	Cat 3	Horseferry	3,400	3	7	3,800	3	7	300	1	2
CS40X	Cat 3	Wood Street	0	0	0	0	0	0	0	0	0
CS22X	Cat 1	Regent Street	22,200	4	12	25,700	8	19	0	0	0
CS23X	Cat 1	Northumberland Street	71,500	13	34	88,400	14	43	300	1	2
CS24X	Cat 2	Savoy Street	8,400	18	47	8,500	18	47	1,400	4	7
CS25X	Cat 2	Norfolk Street	0	0	0	0	0	0	0	0	0
CS26X	Cat 2	Essex Street	2,100	3	6	2,300	3	6	0	0	0
CS27X	Cat 1	Fleet Main	521,100	20	73	571,200	23	83	36,800	4	14
CS42X	Cat 3	Pauls Pier	0	0	0	0	0	0	0	0	0
CS55X	Cat 4	London Bridge	8,300	7	14	8,900	7	14	4,300	5	10
		Downstream Putney Bridge to London Bridge Total / Maximum^b	6,086,000	40	1,745	6,784,000	42	1,975	546,000	5	19
CS28X	Cat 1	Shad Thames Pumping Stn	91,900	15	70	100,400	15	69	71,300	4	14
CS43X	Cat 3	Battle Bridge	0	0	0	0	0	0	0	0	0
CS44X	Cat 3	Beer Lane	0	0	0	0	0	0	0	0	0
CS45X	Cat 3	Iron Gate	200	1	2	200	1	2	300	1	2
CS46X	Cat 3	Nightingale Lane	0	0	0	0	0	0	0	0	0
CS49X	Cat 3	Cole Stairs	0	0	0	0	0	0	0	0	0
CS50X	Cat 3	Bell Wharf	0	0	0	0	0	0	0	0	0
CS29X	Cat 1	North East Storm Relief	782,400	31	286	847,400	31	303	84,300	4	32
CS51X	Cat 3	Ratcliffe	0	0	0	0	0	0	0	0	0
CS31X	Cat 1	Earl Pumping Stn	539,000	26	184	593,900	30	207	50,500	4	26
CS30X	Cat 1	Holloway Storm Relief	7,800	8	18	8,400	9	23	7,000	2	9
CS52X	Cat 3	Blackwall Sewer	0	0	0	0	0	0	0	0	0
CS36X	Cat 2	Wick Lane	0	0	0	0	0	0	0	0	0
CS32X	Cat 1	Deptford Storm Relief	1,471,500	36	252	1,976,000	39	343	161,300	4	29
CS33X	Cat 1	Greenwich Pumping Stn	8,322,500	51	672	3,940,100	28	240	571,500	4	35
		Downstream London Bridge to Greenwich Total / Maximum^b	11,215,000	51	1,484	7,466,000	39	1,187	946,000	4	147
CS56X	Cat 4	Isle of dogs Pumping Stn (Foul only)	12,900	6	9	13,100	6	10	13,100	6	10
CS35X	Cat 1	Abbey Mills Pumping Station from STATION F	15,319,000	56	873	0	0	0	0	0	0
CS35X	Cat 1	Abbey Mills Pumping Station from STATION A	4,099,800	45	403	0	0	0	0	0	0
CS57X	Cat 4	Canning Town Pumping Stn	0	0	0	0	0	0	0	0	0
CS34X	Cat 1	Charlton Storm Relief	600	2	3	900	2	3	900	2	3
CS53X	Cat 3	Henley Road	0	0	0	0	0	0	0	0	0
		Downstream Greenwich to Henley Road Total / Maximum^b	19,432,000	56	1,288	14,000	6	13	14,000	6	13
		Crossness STW Storm Tanks	308,300	5	27	50,200	3	8	50,600	3	9
		Tideway CSO				609,100	3	19	698,300	3	22
		Total / Maximum^b to the River (CSO + Tunnel Overflow)	39,667,000	56	5,567	17,723,000	51	4,288	2,363,000	6	408
Sewerage Treatment Works ^c		Beckton Catchment	444,610,000		8784	508,290,000		8784	508,240,000		8784
		Tunnel Pump Out	n/a		n/a	6,201,000		791	22,128,000		1551
		Beckton STW (Catchment + Tunnel Pump Out)	444,610,000		8784	514,490,000		8784	530,370,000		8784
		Crossness STW	200,560,000		8784	230,940,000		8784	230,280,000		8784

Notes
a. All CSO spills less than 100m³ have been removed. Volume, number and duration of spills have been adjusted accordingly.
b. For Volume and Duration, the sum of all CSO spills in the reach is reported. For Number of Spills, the maximum number of spills in the reach is reported.
c. Typical Year Model simulation is only for 270 days. The table includes infilling the remaining days with average daily DWF for Beckton and Crossness STW.

Appendix B Alternative method of benefit assessment.

I have a copy of the draft report Update of CRP WFD Benefit Values-Economic Component by Dr Metcalf dated June 2012 which updates the Environment Agency National Water Environmental benefit (NWEB) survey estimates of Water Framework Directive (WFD) benefits. Unfortunately I cannot find a copy of the final report.

The WFD requirements are similar to those of the UWWTD, hence the benefit found would be very similar.

“The NWEB survey covers all natural and artificial, inland and coastal water bodies. It therefore includes rivers and canals, lakes and reservoirs, and transitional and coastal waters.” P 14 Thus the derived benefit would include the Tideway which is a transitional water.

“The NWEB survey was designed to evaluate the non-market benefits of WFD improvements...” p 16

“...the values obtained are fully consistent with the context of a nationwide programme of simultaneous improvements.” p 21. Thus the WTP would take account of the issues between single and multiple WTP.

*“The relevant benefits of WFD improvements selected to be covered by the stated preference study include those relating to improved condition for **recreation** in or around the water, improved **aesthetic** appearance of the water environment, and non-use benefits deriving from the provision of **improved ecosystems**.”* Page 17. My emboldening. Thus the totality of benefits in the CBA should align well with the NWEB.

Table 1, page 11 shows the average benefit by status change in £000/km/yr. For the Thames from moderate to good status this is £42,400/km/year.

The Tideway is currently at “moderate” status and I understand that, even if the tunnel were constructed, the status would remain at moderate. However a reasonable assumption for comparison would be that the length of the Tideway which the post STW upgrade and Lee tunnel completion then the length which fails the DO standard is from -8km to +30km. This is at half tide so one could add 15km tidal excursion to these numbers. This would amount to about 55km.

Thus applying the average benefit amount would result in £2.3m/year.

The Environment Agency have provided the spreadsheets referred to in the third para of the introduction. These show that the Thames catchment currently has 712 km out of 4,600kms in good status. It also shows that the benefit in converting to 45% Good and also improvements to the lower two WFD river classes as a central estimate of £51.5m/year. The spread sheets use as one example the split between the two actions as being 1:1., thus the benefit of converting the relevant lengths of Moderate to Good status would be about

£26m/year. To achieve 45% Good out of 4,600km would mean the Good becoming 2,070km, which, with 712 km already being good, means the conversion of 1,358kms from Moderate to Good. Assuming a Treasury discount factor of about 26, then the total benefit would be about £676m.

On a prorate basis this would mean the 55KM of Tideway would result in a benefit of £27m/year..

However the value of the benefit of the Tideway would be more than the average benefit. However it could not exceed that of the full amount of £676m NPV. Were one to assume that the benefit in the Tideway would be 5 times what it would be elsewhere in the catchment then the improved section of the Tideway would represent 17% of the total improvement benefit which would be about £114m NPV.

This cannot represent an accurate figure as there are too many broad assumptions but it does give an indication of the general ballpark of the benefit.

Appendix C Environment Agency record of fish kills in the Thames Tideway 2003-2013

Classification	EA comments	Notification Identifier
Category 3 - Water	Storm discharge, no reported fish kill	197529
Category 2 - Water	Category 2 pollution incident due to poor water quality from storm sewage discharges. Eels reported dead by eel fishermen but no dead fish or invertebrates were seen following incident attendance. Fish kill suspected but no	234023
Category 2 - Water	Category 2 pollution incident due to storm sewage discharges. Several carp reported dead but not verified by EA attendance	317681
Category 1 - Water	Category 1 incident, fish kill in tideway due to storm discharges and poor effluent quality. Unknown number of eels recorded killed in fishermens nets	329236
Category 3 - Water	Storm discharge, no reported fish kill	400805
Category 2 - Water	Category 2 pollution incident reported due to large volume of oil spilled at Chiswick marina. 2 dead fish reported, unknown species.	405308
Category 3 - Water	Storm discharge, no reported fish kill	427028
Category 3 - Water	Storm discharge, no reported fish kill	435975
Category 3 - Water	this is an incident of dead eels in keepnets - not typical fishkill	436584
Category 3 - Water	Storm discharge, no reported fish kill	509263
Category 3 - Water	Storm discharge, no reported fish kill	510007
Category 1 - Water	Category 1 incident, fish kill in Bow Creek due to sewage discharge from Abbey Mills. Reported 500 bream, 50 eel, and other 100 other fish killed	533804
Category 3 - Water	Storm discharge, no reported fish kill	537138
Category 3 - Water	Storm discharge, no reported fish kill - significant impact on DO	608672
Category 3 - Water	Storm discharge, no reported fish kill - significant impact on DO	611822
Category 3 - Water	Storm discharge, no reported fish kill - significant impact on DO	681789
Category 1 - Water	Category 1 incident, eels reported dead in nets by fishermen. Unknown number reported, fish kill due to storm sewage discharges	696005
Category 3 - Water	Storm discharge, no reported fish kill - significant impact on DO	706550
Category 3 - Water	Storm discharge, no reported fish kill	776289
Category 3 - Water	Storm discharge, no reported fish kill	813791

Category 3 - Water	100 dead fish approx, due to algal activity	821848
	Royal Albert Dock, site attended by EA	
Category 3 - Water	200 dead roach and around 30 dead carp,	831498
	Woolwich docks, due to thermocline inversion, site attended by EA	
Category 3 - Water	Storm discharge, no reported fish kill	888629
Category 3 - Water	Storm discharge, no reported fish kill	896103
Category 3 - Water	Storm discharge, no reported fish kill	897660
Category 3 - Water	Storm discharge, no reported fish kill	903808
Category 3 - Water	Storm discharge, no reported fish kill	904556
Category 3 - Water	Storm discharge, no reported fish kill	904929
Category 3 - Water	Storm discharge, no reported fish kill	910218
Category 3 - Water	Storm discharge, no reported fish kill	917091
Category 3 - Water	Storm discharge, no reported fish kill	921758
Category 3 - Water	Storm discharge, no reported fish kill	990918
Category 3 - Water	Storm discharge, no reported fish kill	997515
Category 3 - Water	Storm discharge, no reported fish kill	998172
Category 3 - Water	Storm discharge, no reported fish kill	998817
Category 3 - Water	Storm discharge, no reported fish kill	1009926
Category 3 - Water	Storm discharge, no reported fish kill	1012268
Category 3 - Water	Storm discharge, no reported fish kill	1014129
Category 3 - Water	Storm discharge, no reported fish kill	1022782
Category 3 - Water	Storm discharge, no reported fish kill	1030834
Category 3 - Water	Storm discharge, no reported fish kill	1040033
Category 3 - Water	Storm sewage pollution in Chelsea, 1 dead fish reported, site attended by EA	1095027
Category 3 - Water	Storm discharge, no reported fish kill	1138741
Category 3 - Water	Storm discharge, no reported fish kill	1143955
Category 3 - Water	Storm discharge, no reported fish kill	1159247

Notification Date	EA Water Management Region	EA Water Management Area	Location
21/10/2003	Thames Region	South East - Thames	Upper Tideway. Isleworth.
03/05/2004	Thames Region	South East - Thames	Erith Marshes
04/06/2005	Thames Region	South East - Thames	Old Deer Park
24/06/2005	Thames Region	South East - Thames	Abbey Mills and Tideway
21/05/2006	Thames Region	South East - Thames	Old Deer Park
08/06/2006	Thames Region	South East - Thames	Chiswick Bridge
13/08/2006	Thames Region	South East - Thames	Old Deer Park
14/09/2006	Thames Region	South East - Thames	Creekmouth - Tideway
18/09/2006	Thames Region	South East - Thames	Coldharbour
29/06/2007	Thames Region	South East - Thames	Chelsea Bridge
02/07/2007	Thames Region	South East - Thames	Old Deer Park
24/09/2007	Thames Region	South East - Thames	Bow Creek
09/10/2007	Thames Region	South East - Thames	Old Deer Park
29/07/2008	Thames Region	South East - Thames	Old Deer Park
07/08/2008	Thames Region	South East - Thames	Jenningtree Point
26/05/2009	Thames Region	South East - Thames	Old Deer Park
07/07/2009	Thames Region	South East - Thames	Old Deer Park
12/08/2009	Thames Region	South East - Thames	Albert Bridge
02/05/2010	Thames Region	South East - Thames	Old Deer Park
16/08/2010	Thames Region	South East - Thames	Old Deer Park

12/09/2010	Thames Region	South East - Thames	Gallions Reach
17/10/2010	Thames Region	South East - Thames	North Woolwich
26/05/2011	South East Region	North East Thames	Old Deer Park
22/06/2011	South East Region	North East Thames	Old Deer Park
28/06/2011	South East Region	North East Thames	Old Deer Park
17/07/2011	South East Region	North East Thames	Chelsea Bridge
19/07/2011	South East Region	Kent & South London	Old Deer Park
21/07/2011	South East Region	North East Thames	Chelsea Bridge
04/08/2011	South East Region	North East Thames	Old Deer Park
25/08/2011	South East Region	Kent & South London	Bugsby's Reach
11/09/2011	South East Region	North East Thames	Old Deer Park
15/05/2012	South East Region	Kent & South London	Barking Reach
03/06/2012	South East Region	Kent & South London	Chelsea Bridge
06/06/2012	South East Region	Kent & South London	Old Deer Park
07/06/2012	South East Region	Kent & South London	Halfway Reach
06/07/2012	South East Region	North East Thames	Creekmouth
10/07/2012	South East Region	Kent & South London	Old Deer Park
15/07/2012	South East Region	Kent & South London	Old Deer Park
06/08/2012	South East Region	Kent & South London	Old Deer Park
25/08/2012	South East Region	Kent & South London	Chelsea Bridge
23/09/2012	South East Region	North East Thames	Hammersmith Bridge
17/03/2013	South East Region	North East Thames	Battersea Reach
25/07/2013	South East Region	Kent & South London	Barking Reach
05/08/2013	South East Region	Kent & South London	Barking Reach
13/09/2013	South East Region	North East Thames	Hammersmith Bridge