THAMES TIDEWAY TUNNEL: REINVENTING PFI FOR LONDON'S 'NEXT BIGGIE' (A)

As the press release went out in January 2014 that Andy Mitchell had been appointed CEO of Thames Tideway Tunnel Ltd, the company created to plan and build a 25km 'super sewer' under central London, it was appropriate to review the procurement and contracting strategy for the scheme. Andy, the outgoing programme director of Crossrail, a £14.5bn (final budget) London railway, said:

So am I sad to be leaving the [Crossrail] project? Yes. But the Thames Tideway Tunnel is a hugely important project and I think it is entirely appropriate that the learnings from Crossrail are transferred[1]

The 'super-sewer' project—dubbed the 'next biggie' by the chairman of Thames Tideway Tunnel—was the brainchild of Thames Water Utilities Ltd (Thames Water), UK's largest water company and owner of Thames Tideway Tunnel Ltd. As it happened, London was still relying on the sewerage network built in the Victorian times, reckoned a £50 to £60bn investment in 2013 prices [**Exhibit 1**]. With the city's population nearing 8 million, over 39 million tonnes of sewage were being annually discharged directly into the river. This put the UK in violation of the EU Urban Waste Water Treatment 1991 Directive and subjected it to heavy fines.

The Thames Tideway Tunnel [**Exhibit 2**] was a controversial £4.2bn (maximum anticipated final costs) scheme to boost the capacity of the London's sewerage network. The tunnel was the most critical component of a broader capital program which also included another tunnel, the £635m (final prices) Lee tunnel, and £673m work to upgrade existing sewage treatment plants. Thames Water expected the construction of the tunnel alone to last around 7 years once it obtained planning permission. Tunnelling under London was not for the faint of heart, but the two main sources of controversy around the scheme were actually different. On the one hand, a vocal group of opponents insisted that the tunnel was an inferior solution to fix the lack of sewerage capacity in London vis-à-vis less costly solutions available. On the other hand, many opposed the plan to secure private finance for the super-sewer, which involved a controversial government guarantee to cover any "exceptional risks" during construction—"why should we nationalise the downside and privatize the upside?", a government source reportedly asked.[2]

Aware of the controversies and risks, Thames Water had long decided that building the tunnel was not for them—they argued that the scheme was too big and would damage their risk profile, and if things took a turn for the worse, it could bust the company. Complicating matters public finance was not in the cards. For the Tory-

[1] Pitcher, G. 2014. Mitchell quits Crossrail for top Thames Tideway job. New Civil Engineer, 28 Jan.
[2] Pickard, J., Parker, G. 2013. Public money can build super-sewer, says Letwin. Financial Times, January 23.

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led coalition ruling the UK since 2010, which had pledged to bring down the budget deficit and tame the growth of the national debt, public finance was a no-go.

This left Thames Water and the government, both of which insisted that the scheme was the superior solution, with no alternatives but to seek private finance. Thames Water argued, however, that investor appetite would remain subdued until the scheme was awarded planning consent, and was therefore taking the helm of the planning process. The two parties also reckoned that investors' appetite for the scheme would grow if it was more than a plan on paper. Hence, they agreed to procure a design-build consortium (or consortia) for executing the scheme, and firm up the price and a timescale. The Thames Tideway Tunnel chairman said:

I think it will be an enormously attractive scheme to invest in. … This tunnel is being built with a 120-year life; it's going to last virtually forever and there will be a dividend stream from that for investors. Yes it will be a regulated scheme but there is no reason to suspect it will not be regulated at an attractive level for investors[3]

The sixty-four thousand dollar question was how to procure the tunnelling works to maximise investor appetite. Some in Thames Water favoured letting a single contract to a global EPC (engineering-procurement-construction) company. This would expedite the whole process. Plus, the tunnel was an integral piece of infrastructure that could only be opened in one go, and thus this approach would avoid the need for tricky organizational and work interfaces between consortia.

Others could not disagree more. In the last decade, London had seen a resurgence of major tunnelling works associated with the modernization of the Tube network and Crossrail, the high-capacity train planned to open in 2019 that involved over 42 km of tunnelling under central London. Crossrail Ltd., for example, had chunked the tunnelling works in multiple design-and-build packages [**Exhibit 3**]. Crossrail Ltd., a public agency, had also appointed two consultants as project and programme managers and got them to work together with its own in-house workforce.

Despite opposition to build a private 'super-sewer', and threats of legal challenges against the enterprise, government and Thames Water were confident to get planning consent by the end of 2014 and secure private finance shortly after. Cross-party political support remained strong, with the shadow environment secretary welcoming the environmental benefits and jobs that the project would deliver.

The plan was to conclude procurement of the downstream suppliers and upstream finance early on in 2015. Assuming planning consent was awarded later in 2014, construction could start in 2016. With national elections in Spring 2015, keeping to this timescale was critical to avoid the scheme becoming a political football.

[3] Pitcher, G. 2013. Innovation and collaboration demanded on super sewer. New Civil Engineering, 19 December.

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Thames Water

The water sector in the UK encompassed the provision of potable water supply and sewage treatment. These services had been in the hands of local authorities from the 19th century up to the 1970s when ten public regional water authorities (RWAs) were created, each one covering a river basin area. In the late eighties, the Margaret Thatcher governments forged ahead with the privatisation of the whole water sector. The new policy aimed to create efficiencies, and generate incentives to attract private investment into the sector. All RWAs were sold, creating local private monopolies protected from competition [**Exhibit 4**]. As part of their remit, the companies were made responsible for planning, maintaining, and building new infrastructure so as to provide the necessary water and sewerage services.

The privatised water industry operated under the eyes of three regulators: the Drinking Water Inspectorate (DWI), the Environmental Agency (EA), and the Office of Water Services (Ofwat). The DWI was concerned with the water quality, the EA with river and environmental pollution, and Ofwat was responsible for the economic regulation. Ofwat framed their mission as "making sure that your water company provides you with a good quality service at a fair price". [4] Hence, Ofwat mission was to ensure the monopolists remained profitable and efficient, and were not leveraging their positions to rip off consumers and neglect investment. To this purpose, Ofwat set price caps on the companies' services for 5-year periods, so-called Asset Management Periods, effectively capping their return on investment.

Thames Water was responsible for the area of greater London, and thus responsible for supplying potable water to Londoners, maintaining the sewerage network in London, and stopping sewage overflow into the river Thames. Thames Water served over 15 million customers. The company was owned by Kemble Water Ltd. which in turn was wholly owned by Kemble Water Holdings Ltd. Kemble Water Holdings was controlled by a consortium of investors led by Macquarie, the Australian investment group through Macquarie European Infrastructure Fund 2.

The Thames Water company had become a much desirable financial asset, and between 2011 and 2012, Macquarie (who had bought Thames Water in 2006 for £8bn) sold a third of its ownership stakes for undisclosed sums. The BT Pension scheme bought a 13 per cent stake; the deal followed the sale of a 8.68 per cent stake to China Investment Corporation, and the sale of a 9.9 per cent stake to the Abu Dhabi Investment Authority. Thames Water boasted that its long-term institutional investors were 'patient' and therefore 'well suited to the long-term investment needs of infrastructure businesses like Thames Water'.[5]

[4] Ofwat < http://www.ofwat.gov.uk/>

[5] Thames Water website < http://www.thameswater.co.uk/about-us/7565.htm> accessed 4th Feb 2015

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The Thames Tideway Tunnel Planning Process

The history of problems with sewage overflows in London could be traced back to the industrial revolution. In the 19th century, 150 million tonnes on average of sewage flushed directly into the river Thames. The river was therefore biologically dead and in one particular occasion Parliamentarians had to vacate the House of Commons because of the foul stench coming from the river Thames, which came to be known as the 'Great Stink'. With its ever-rising population, the problems grew with each passing year. As a result the Parliament passed an enabling act to start construction of a new sewerage network, designed by Sir Joseph Bazalgette.

From 1859 to 1875 a sewerage network of circa 21,000km was built underneath London. This network turned out extremely resilient. By the start of the XXI century it was serving the needs of 8.4 m people. But an estimated average of 39 million tonnes of sewage were flowing directly into the river Thames annually. The Victorian system had been designed to deal with rainwater and sewage at the same time as this was the only technically viable option in the 19th century, and fully met the standards at the time. But due to the growth of the capital's population and more open land being lost to paving and construction, the amount of rainwater entering the sewerage network was steadily increasing. As a result, as few as 2 millimetres of rainfall now sufficed to trigger a sewage overflow. This caused adverse environmental impacts, unacceptable aesthetic issues, and health risks. This situation also breached the European Union Urban Waste Water Treatment Directive of 1991, threatening the UK with a hefty fine if the country demurred to resolve the problem. However, the EU directive shied away from setting an acceptable amount of overflow, leaving that issue to the UK Environment Agency.

In 2000 Thames Water commissioned the Thames Tideway Strategic Study to consultant Jacobs Babtie to identify potential solutions for the lack of sewerage capacity in London. The taskforce appointed to produce the study published the final report in 2005. The report was chaired by independent expert Chris Binnie, and drew on the views of numerous stakeholders including the Environment Agency, the Department for Environment, Food & Rural Affairs (Defra), and the Greater London Authority (GLA); Ofwat kept an observer status.

The study concluded that to fix the problems it was necessary to intercept sewage before it reached the local rivers, and this required capital investment on the five existing sewage treatment plants and construction of two new tunnels: a 6.9km Lee Tunnel for taking overflows away from the river Lee, and the Thames Tideway Tunnel. The latter was a controversial scheme to build a 32km tunnel under central London for taking overflows away from the river Thames. The Thames Tideway Tunnel would run from Hammersmith in the west of London to Beckton Sewage works in east London. The whole capital program was priced at £1.7bn (2004 prices).

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Thames Water committed to directly finance the two less controversial elements of the capital program (the Lee Tunnel and the sewage treatment works), and forged ahead with the necessary planning applications. But Thames Water also outrightly expressed no appetite to finance the Thames Tideway Tunnel. This led to an impasse. Complicating matters, in 2006, the European Commission started proceedings against the UK for failing to comply with the EU directive of 1991.

By the end of 2006 speculation mounted that the UK government was warming up to the idea of financing the Thames Tideway Tunnel to improve the situation in the Thames river in time for the 2012 Olympic games.[6] Indeed the Minister for Climate Change and Environment announced his support for the scheme in 2007, following a supportive impact assessment by Defra. Confident that the government would possibly step in to finance the tunnel project, Thames Water appointed the global consultant CH2M Hill as the program manager, and tasked the company to oversee the planning application for the tunnel and corresponding design and construction works, stakeholder communication, commissioning, and operational hand-over.

In March 2010, with the UK in the midst of the worst economic crisis since the great depression, the Labour government suggested to direct the Thames Tideway Tunnel scheme to the Infrastructure Planning Commission (IPC) to fast track the planning application process, a scenario allowed by the 2008 Planning Act for major national infrastructure projects. But the plan faced a major setback after the new coalition-led government abolished IPC due to concerns that the statutory body lacked independence. In the meantime, Thames Water had already been granted planning consent for the Lee Tunnel and sewage treatment works, and in January 2010 awarded a contract to build the Lee tunnel for an estimated ££425m.[7]

Challenges notwithstanding, the plan for the tunnel continued to inch forward. And in September 2010 Thames Water launched its first round of public consultation to appraise three different routings and lengths; the Thames Water chief executive, Martin Baggs, announced it by saying "We have got a plan to tackle this problem. It is now time for everyone to review these plans and tell us what they think."[8]

As consultation unfolded for three possible routes of the Thames Tideway Tunnel [**Exhibit 5**], and more information became available from new geological surveys and the actual bids for the Lee tunnel, Thames Water announced that the £1.7bn desktop-based price tag for the whole capital program (upgraded to £2bn in 2006) had evolved, just for the tunnel, to £3.6bn (2010 prices) by September 2010. To attenuate escalation in costs Thames Water decided to bring the length of the Thames Tideway Tunnel down to 25km, ditching its deepest section. In the new

[6] NCE (2006). Green light imminent for £1.6bn London sewer tunnel. New Civil Engineer, 16 November

[7] Gradually, Thames Water moved scope originally part of the Thames Tideway Tunnel project to this contract and by 2013, the Lee Tunnel scheme had already spiralled to a £625m project

[8] Olivia Gagan (2010). Thames Tunnel up for public consultation. New Civil Engineer, 13 September.

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design the tunnel would no longer run to the Beckton Sewage Works in the East, but stop at Abbey Mills. At this point, the Thames Tideway Tunnel would connect to the new Lee Tunnel, which in turn would go on to connect the system to Beckton Sewage Works. This option attenuated the risks of tunnelling works and could be completed by 2020, assuming no extraordinary delays in getting planning consent.

The first round of public consultation revealed difficulties in determining suitable shaft sites (needed to assemble and lower the Tunnel Boring Machines or TBMs into the ground) and other sites to support the construction works. Local communities in London vehemently opposed to having construction work sites nearby, anticipating years of traffic disruptions, noise in the night, and property blight. In particular, each site surrounding the shaft locations was expected to cover an area equivalent to three football pitches. In response, Thames Water decided to evaluate alternative work sites and further engage with the local communities.

As the planning process forged ahead, and Thames Water and government started to prepare Londoners for expecting an increase in the water bills up to £40 a year in order to pay for the new tunnel, opposition to the 'super sewer' became more vocal. Already in 2006 a review of the 2005 study commissioned by Ofwat suggested an alternative solution capable of capturing 70% of the spills at half the cost. And in 2007, another expert in urban drainage called the super-sewer a "white elephant". The Ofwat chairman expressed concerns with the scheme too:

Without being pessimistic, this is more complicated than anything undertaken by any water company since privatisation, and for some considerable time before that. … As with any major tunnelling scheme, there are elements of uncertainty. There may be problems with ground conditions that turn out to be worse than expected. [9]

Challenges notwithstanding, Thames Water managed to see off opposition and avoid a potential stand-off by contesting the opponents' claims and data; the company also succeeded to sustain cross-party political support and government's support for the super-sewer. The scheme faced again strong headwinds in 2011 after the government formed a commission to address the concerns raised by several London boroughs. Complicating matters the former chairman of the 2005 study announced a change in his views over the value of the tunnel, proposing instead a shorter tunnel. Unexpectedly, the Thames Tunnel Commission sided with the former chairman, arguing that Thames Water should look at alternatives. Specifically, the commission asked if a combination of a shorter tunnels and green infrastructure (sustainable drainage systems) could be better value for money.

A chorus of opponents joined the debate calling the big tunnel a Victorian solution appropriate for the 19th, but not the 21st century. Opponents argued that the

[9] Mylius, A. (2007). Ofwat questions £2bn Thames Water storm water tunnel plan. New Civil Engineer, 29 March

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scheme was a rushed, old-school solution, which did not account for more modern solutions combining separation of effluent and rainstorm sewers and development of sustainable urban drainage systems. They also asked the government to investigate Thames Water's potential conflict of interests as a project promoter[10].

During the debate, Thames Water chose to dig in on opposite sides, suggesting that the opponents were short sighted and had not offered "a viable, economic or timely alternative"[11]. They also pointed that alternative solutions were more expensive and would fail to intercept all combined sewage overflow points and required building sewage works in highly urbanised areas. Following this, the government reaffirmed his backing of the scheme, with the Environment Secretary Richard Benyon stating: "We continue to believe that a tunnel represents the preferred solution for dealing with the untreated sewage that is polluting the River Thames".[12] Other supporters notably the Thames21 charity followed suit—their chief executive Debbie Leach said: "Research has shown clearly that Thames Tunnel is the best solution, and we need it delivered without delay"[13].

Late in 2011, Thames Water announced that the budget for the Thames Tideway Tunnel, had risen again from a £3.6bn (2011 prices) to £4.1bn (2011 prices) excluding costs of financing. The new forecast, Thames Water said, included £0.9bn in contingency funds. Considering that extensive geological data had been gathered from boreholes and site surveys, the contingency was way bigger than the 10 to 15 per cent typically set aside for major civils projects promoted by private entities, but in line with contingency levels in the public sector. Thames Water also pushed back the timeline three years, estimating that construction for the tunnel would not start before 2016, and therefore the tunnel would not be operational before 2023.

Reactions to these announcements followed suit. Ofwat, the industry regulator, expressed concerns with the impact on the customer bills in the long term. The opponents in turn seized the slippage in the project performance targets to argue that there was time to undertake more modelling of hybrid solutions. They also challenged as to whether Defra had set the standards for compliance (a 4% maximum of allowable discharge) unnecessarily high.

In response to the second round of public consultation, Thames Water changed the plans for 16 of its 24 construction sites and committed to more investment to mitigate noise at night to allow for 24 hour working on the tunnelling works. Thames Water also continued acquiring land (almost £300m) for preferred work sites to leave the options open. A major win for Thames Water was the 2012 government's decision to safeguard the route, and thus write to three London

[10] Kavanagh, M. (2011). Super-sewer's price rises £500m. Financial Times. 3 November.
[11] Stimpson, J. (2011) Thames Tunnel: Mega-sewer row continues. New Civil Engineer, 10 November
[12] Stimpson, J. (2011) Battle lines drawn over Thames Tunnel. New Civil Engineer, 4 November
[13] Stimpson, J. (2011) Battle lines drawn over Thames Tunnel. New Civil Engineer, 4 November

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boroughs directing them to refrain from granting planning permission without authorization on several sites potentially required for the scheme.

In March 2013, after two years and two rounds of consultation with the public and statutory bodies, Thames Water submitted a 50,000 page planning application rooted in a reference design to the Planning Inspectorate. Confident that it would gain planning consent—the lengthy document covered 24 proposed construction sites in detail as well as project-wide issues—Thames Water started to sketch out a procurement strategy with a view to start construction in 2016. OJEU regulations were designed to ensure fair and equal competition, but involved lengthy procurement scenarios. The more packages put out for tender, the longer the process would likely last. Of course, it also urged to resolve the financial issues.

Financing the Thames Tideway Tunnel

The private water service companies in England were responsible for operations, and infrastructure provision, and expected to raise finance for new infrastructure themselves securitised against future expected revenues. It was the job of Ofwat, the industry regulator, to determine by how much bills could be raised each period, and determine the companies' allowable return on capital investment.

By 2014, Thames Water and government announced that they expected customer bills to rise by a maximum of £70-80 a year to finance the £4.2bn (2013 estimate in 2011 prices) super sewer, with an increase of £40 to the average household bill by 2019-20. But the number of years the cost of the tunnel would be charged to customers remained unclear. Thames Water also expected a 20 per cent chance of the final costs of the project being less than £4.2bn. And it expected planning and development costs to account for around 20% of the £4.2bn cost of the project.

According to a cost-benefit analysis by the UK government, quantifiable benefits of the scheme would be between £0.70 and £1.20 for every pound spent. This was a relatively low benefit to cost ratio, but the government argued it did not account for fines avoided and contested the quantifications of the benefits to the environment. And the fact was that the regulator had already authorised Thames Water during the period 2010-2015 to make a return on the capital investment in buying land and in developing the planning application and procurement for the super-sewer.

Having ruled out financing the totality of the scheme in 2010, Thames Water decided to go out for tender for a specialist to provide legal, financial, and commercial advice. This specialist would assist in developing a new delivery model and select an Infrastructure Services Provider similar to a private finance initiative.

Some politicians and even a former Ofwat director-general argued that Thames Water was dodging its responsibilities. After all, the company was already in charge of a £6.5bn 5-year capital programme (2010-15) and the regulatory capital value of

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all its assets was over £10bn (£10.9bn at March 2013). Opponents pointed that the company had an obligation to put aside funds for substantial investments and should be willing to make a rights issue. Had the company not made large dividend pay-outs, the critics claimed, it would not have curtailed its ability to finance the tunnel out of its own cash flow. After all, only in July 2012, the company had paid £74m to shareholders and benefited from exceptional gains because of a tax cut.

But the company did not cave in, and government showed no intent to force Thames Water's hand. There was also no appetite in government to directly finance the scheme despite dissenting opinions pointing that in most countries a scheme of the complexity and size of the Thames Tideway Tunnel would be financed by the state rather than the private sector. Still, the government insisted that water companies were attractive to institutional and sovereign wealth investors, and thus saw no reason why private finance could not be secured for building the tunnel at a reasonable economic cost. This was a bargain that Thames Water was happy to take. And in 2012 Thames Water appointed UBS banking group to lead attempts to raise private finance by the end of 2013. The plan was to mirror a balance characteristic of the water industry (60 per cent debt and 40 per cent equity).

The plan turned out, however, more complicated to implement. National legislation did not contemplate a situation whereby a private investor would take ownership of a large infrastructure project in a monopolistic fashion, and thus promulgating new law became an imperative for the Tory-led government. And in 2013, the Specified Infrastructure Projects Regulations were finally promulgated. The new legislation made it possible to tender for a new company—so-called infrastructure provider (IP)—to finance and deliver a significant infrastructure project, effectively allowing Thames Water to offload Thames Tideway Tunnel Ltd on the market.

In the specific case of the £4.2bn Thames Tideway Tunnel scheme, the IP would be awarded its own licence from Ofwat (under the Flood and Water Management Act 2010). Thames Water in turn would be allowed to increase the consumer bills to account for the IP's capital investment, but would enter into contract with the new IP, passing the associated revenue collected on to them. The IP was expected to raise its own finance which was estimated to amount to £2.8bn (2013 estimate in 2011 prices) in the worst-case scenario. The IP would be free to determine their financing structure, which could include bank lending, loans from the European Investment bank or bond issuance. Thames Water, in turn, remained responsible for financing: first, the Lee tunnel and the sewage treatment works; and second, an estimated £1.4bn (2013 estimate in 2011 prices) of the Thames Tideway Tunnel project corresponding to the costs of applying for planning consent, enabling works, and managing work interfaces with its own capital program and assets.

The plan was to tender the IP early on in 2015 in order for construction to start in 2016. Once the IP would become the legal owner of the Thames Tideway Tunnel Ltd, the IP could let the formal contracts with the company(ies) that Thames

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Tideway Tunnel Ltd (while under the ownership of Thames Water) would have selected to design and build the tunnel. The IP was also expected to enter into contract with the programme management delivery partner, a job that CH2M Hill had been performing for Thames Tideway Tunnel Ltd. After IP licence award, the project team from Thames Water/Thames Tideway Tunnel Ltd (around 100 people) would be transferred to the IP. Hence, the deal-makers argued, the IP was not required to have much in-house construction expertise as procurement of the delivery partners and the supply chain would be done prior to its appointment, and the Thames Tideway Tunnel workforce itself would move across to the IP ranks.

The deal became quite controversial right after the UK government announced that to reduce the downside risks for the IP and attract investors: first, there was a predefined maximum to be financed by the IP; and second, the government would provide a contingent financial support package (under the Water Industry Financial Assistance Act 2012). This meant that the government was prepared to offer a public guarantee to cover any 'exceptional risks' in the construction. The financial support package was being worked out between Defra, the UK Treasury, and Thames Water, and would expose tax payers to a certain amount of risk.

The announcement of a public guarantee was expected to make the deal even more attractive for private investors. For one, unlike traditional public-private partnerships, the revenues would be paid out during the construction period as customer's bills were poised to increase from the project onset. The equity risk profile itself was not dissimilar to other regulated water service providers; still, the arrangement was a first of its kind and thus investors could argue that it justified a risk premium. The debt similarly was expected to achieve a high investment grade rating like that for mainstream water service companies [**Exhibit 6**].

Amidst the controversy over the deal, the relationship between Thames Water and Ofwat went on a collision route after Thames Water, which claimed to be the lowest-priced provider, asked in August 2013 to impose an 8 per cent rise on customer bills for 2014-2015. This rise would be on top of a planned 1.4 per cent rise above inflation as part of an existing five-year pricing settlement. The company argued the increase was needed to cover the cost of bad customer debts due to the economic downturn, preparations for the construction of the 'super sewer', new regulation, and costs of making repairs to private sewers (a new obligation). But the claim fell flat in an environment of lower than expected borrowing costs and low inflation in construction prices. And by October, the regulator rejected proposals from Thames Water, and its chief executive said:

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We have looked at the details and do not believe the current evidence justifies an increase in bills. … We will challenge these proposals and question the company strongly on their reasons."[14]

The Ofwat decision was so more critical considering that in December 2013, Thames Water planned to submit its business plan for the next price review, which would cover the period from 2015 to 2020. Ofwat was not expected to announce a decision on these prices before January 2015. But Thames Water business plan included claiming an allowable return on £655m for expenditure with activities on the Thames Tideway Tunnel project, including enabling and interface works, effort to procure an IP and the construction supply chain, £110m of additional activities in case the appointment of the IP was delayed, and a £136m risk provision.

Procuring a Project Supply Chain

Confident that there was investors' appetite for financing the scheme, Thames Water needed to resolve the procurement strategy for the design and construction works. This involved crucial strategic decisions that would set the internal and external boundaries and thus the organizational design structure of the whole project delivery enterprise to be created. The solution was not clear cut, though.

For its 2015 to 2020 capital programme, Thames Water planned to use an "alliance" model, and select four design-build entities and a programme manager. Selection would happen through a short tender phase based on fee and quality, although the ratios between the two remained undisclosed. But the Thames Water goal was to move to what the company called "behaviour-based procurement". Alliance members would be incentivised financially on a risk/reward basis, but based on programme-wide performance of the alliance as a whole, not on individual members or projects. The Thames Water capital delivery director said:

We can assemble all the right individual companies, but we need to form a team…So we are looking for companies with a real track record that can embrace working in a collaborative manner…This may be more about not pouring concrete than pouring concrete. … we've to face the affordability challenge from the customers' point of view, so we need to get more bang for our buck. The way to get that is to innovate[15]

But the Thames Tideway Tunnel was a different kettle of fish from the AMP6 capital programme. It was a massive tunnel under central London that could only become operational once all the works would be completed, although construction was planned to happen simultaneously on 24 work sites across London. One possibility, to maximize competition for the works, would be to chunk the 25km

[14] Kavanaghh, M. (2013). Ofwat rejects Thames Water's plans for 8% rise in customer bills. Financial Times.
[15] Cole, Margo (2013). Finding a Perfect match. New Civil Engineer, 17 January

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tunnelling works into 3 to 5 design-build packages, perhaps taking advantage of the varying geological conditions along the route [**Exhibits 7.1, 7.2, 7.3 and 8**].

Alternatively, Thames Water could go after a major multinational consortium capable to design and build the tunnel, for which Thames was proposing a budget envelope of £2.8bn, including a sizeable but undisclosed amount of contingency funds. A single consortium approach would substantially reduce the number of organizational interfaces, but would arguably impair competition for the job.

And then there was the question of what type of commercial contract they should adopt—a fixed price type of contract, a reimbursable contract with a fixed mark-up, a target contract with some pain-gain share mechanisms built in? Somehow the use of the latter, so-called NEC 3 Option C[16], had become mainstream in major projects in the UK including Crossrail. But it was right to ask the question as to whether this form of contract would still be the most suitable approach for the super-sewer. The Chairman of the Thames Tideway Tunnel, Sir Neville Simms, said:

There is an overarching specification for this project but there is room for contractor collaboration and one hopes [the bidders] will use that to come up with ideas that can be incorporated into the scheme. Innovation, collaboration and co-operation are important - this is the modern way of building things.[17]

Another important question related to the weights to attribute to the technical and commercial pieces of the bids in the selection process. Traditionally, the commercial section would be kept locked up until the technical scoring was out of the way. But a decision was still needed on the weight of each element for the final score. Should the cost element count 50 per cent, seventy per cent, more or less?

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Clearly Thames Water had strong endorsement from the government to sell Thames Tideway Tunnel Ltd. The scheme had been in the works for more than a decade [**Exhibit 9**] and was reassuring to see cross-party support remained strong. But uncertainty was high on how much return on investment should be offered to the future IP, how much risk should tax-payers take, how to incentivize the IP and

[16] NEC 3 option C was a target contract. Hence while the client retained the cost and time risk linked to contractual changes, the financial effects of cost overruns or savings were shared between the client and the contracting suppliers through a pain-gain share mechanism. Used effectively, target contracts aimed to give contractors incentive to deliver a project on time and to budget and to collaborate with the client. But if costs fell out of control, the contractors could still be expected to seek to increase the target via compensation events, asking the client to foot the bill.

[17] Pitcher, Greg (2013). Innovation and collaboration demanded on super sewer. New Civil Engineering, 19 December.

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Thames Water to deliver the tunnel efficiently, and how customers should pay for it [**Exhibit 10**]. It was also unclear how the enterprise would be regulated, its governance structure, who would be authorised to draw from contingency funds, and how to cap the profits if the cost of the designing and building tunnel turned out substantially less than $2.8bn. Uncertainties notwithstanding, Thames Water was confident that the Planning Inspectorate would give them the go ahead later in 2014. They were also ready to vigorously fight any legal challenges that opponents might launch. But arguably it would be difficult to sell Thames Tideway Tunnel Ltd unless the design and construction costs were nailed down. Amidst so much uncertainty, one thing was clear. With national elections looming, it urged to resolve procurement of finance, and get a grip on the scheme's price and timescale.

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Exhibit 1 – London sewer history (reprinted from Thames Tunnel Major Project report 2010. New Civil Engineering, September)

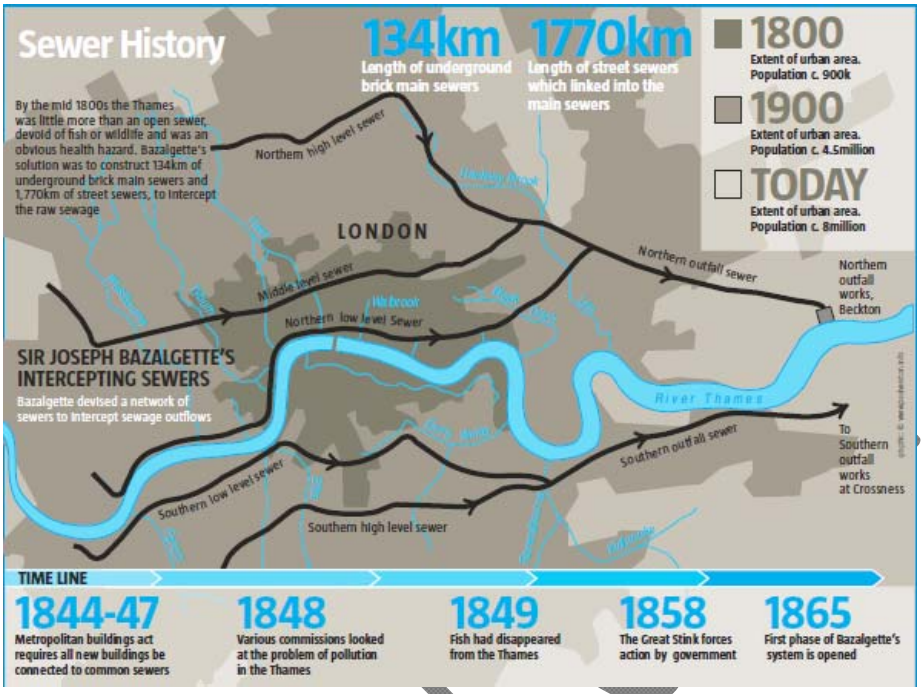

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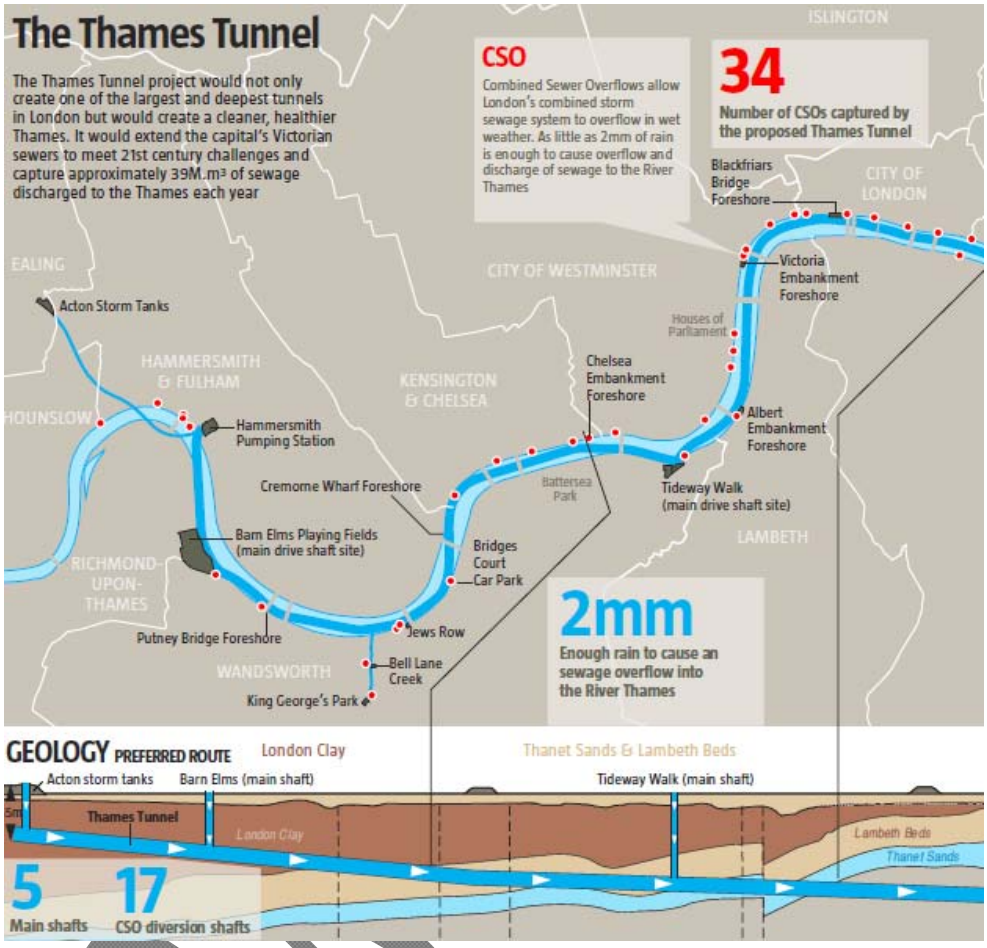
Exhibit 2 – Map of Thames Tideway Tunnel (reprinted from Thames Tunnel Major Project report 2010. New Civil Engineering, September)



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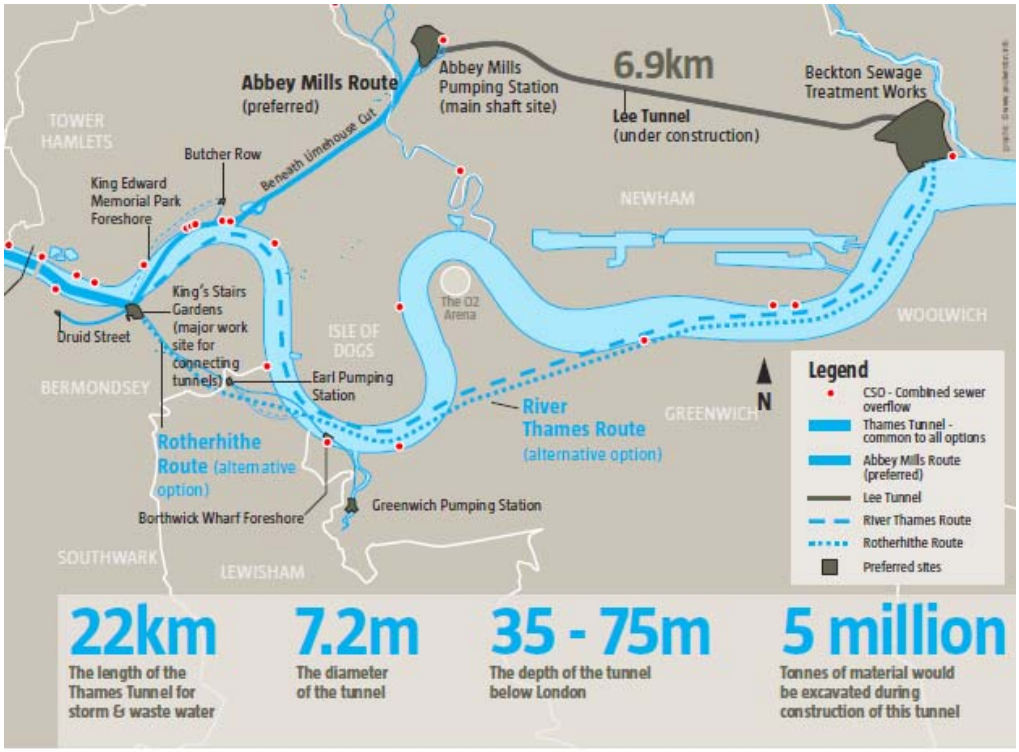

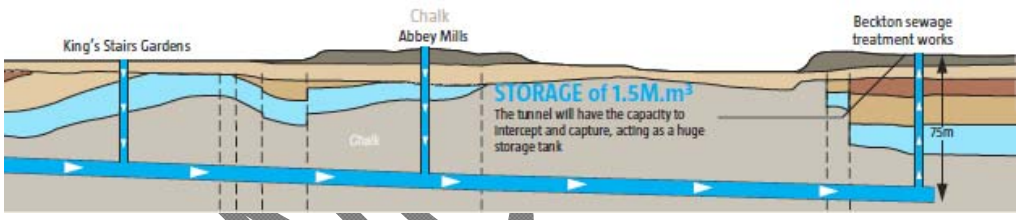

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Exhibit 3 - Sketch of the Crossrail Contracting and Procurement Strategy

Colour stands for the company, while pattern stands for the contract type.

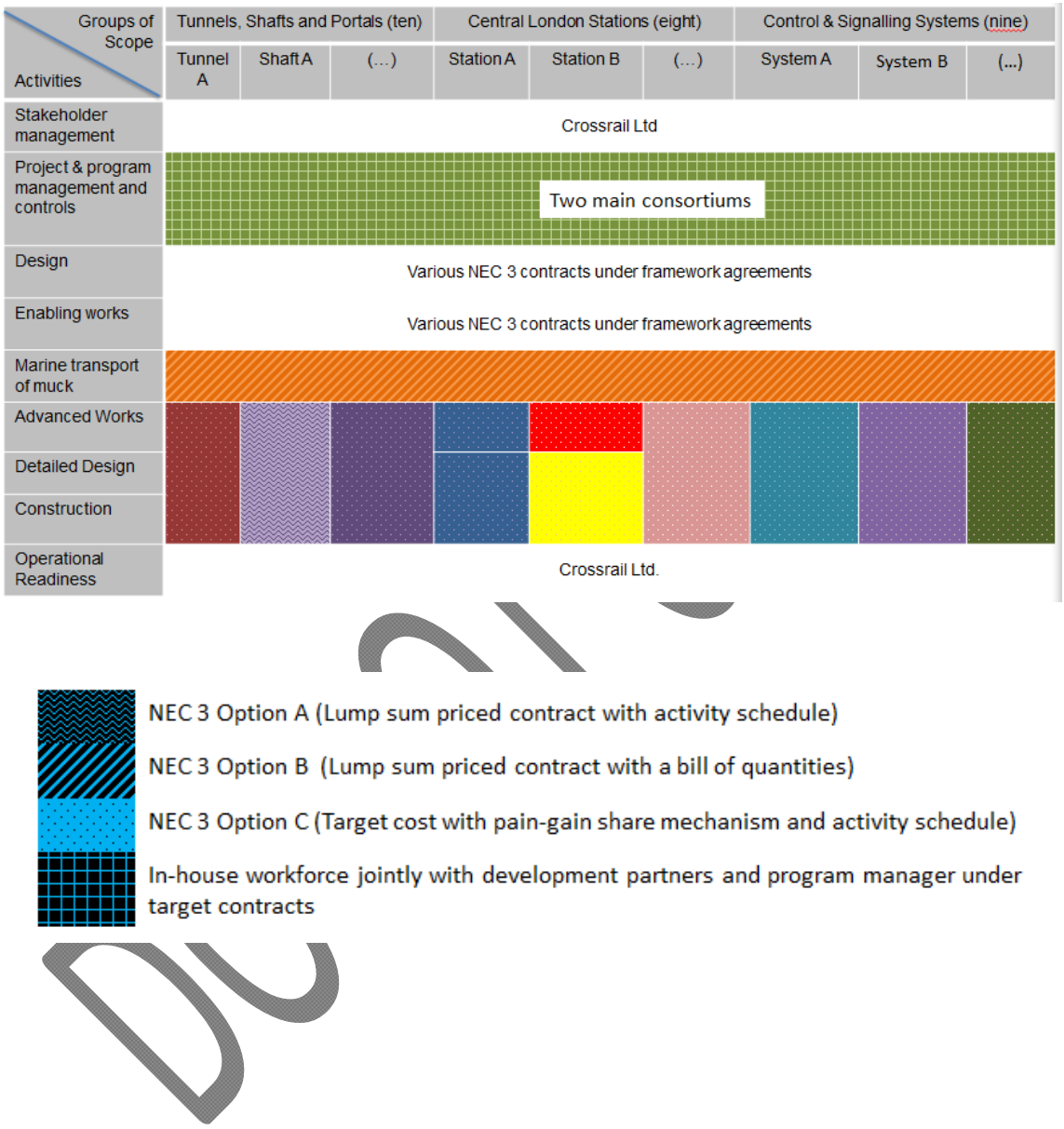


Exhibit 4 – Water & Sewage companies in the UK (reprinted from www.Ofwat.gov.uk, Water company contact details. September 2014)

Exhibit 5 – Times Tideway Tunnel route options in 2010 (New Civil Engineer, 16 September)

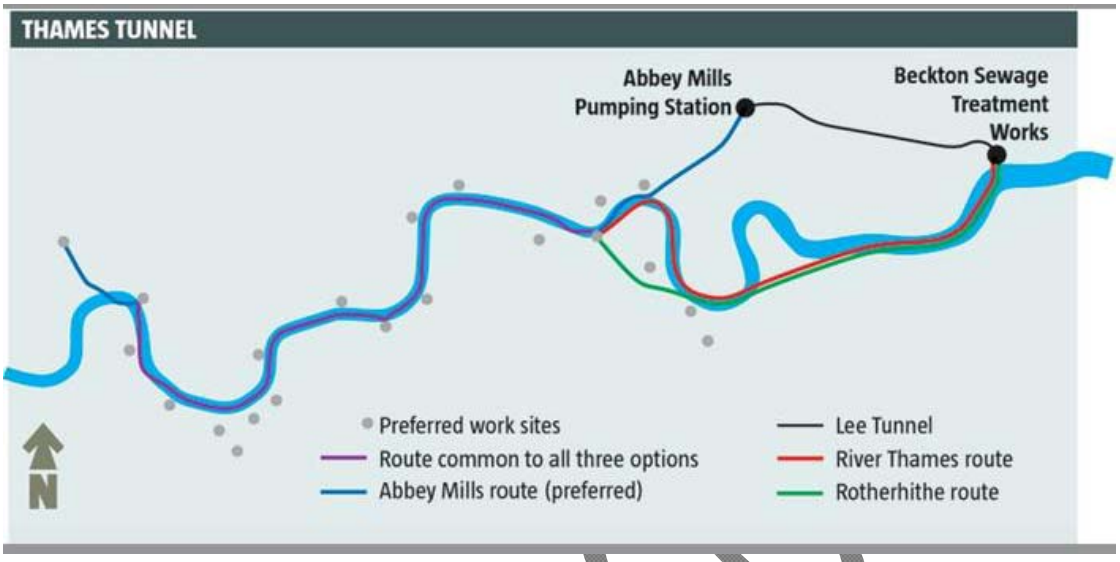
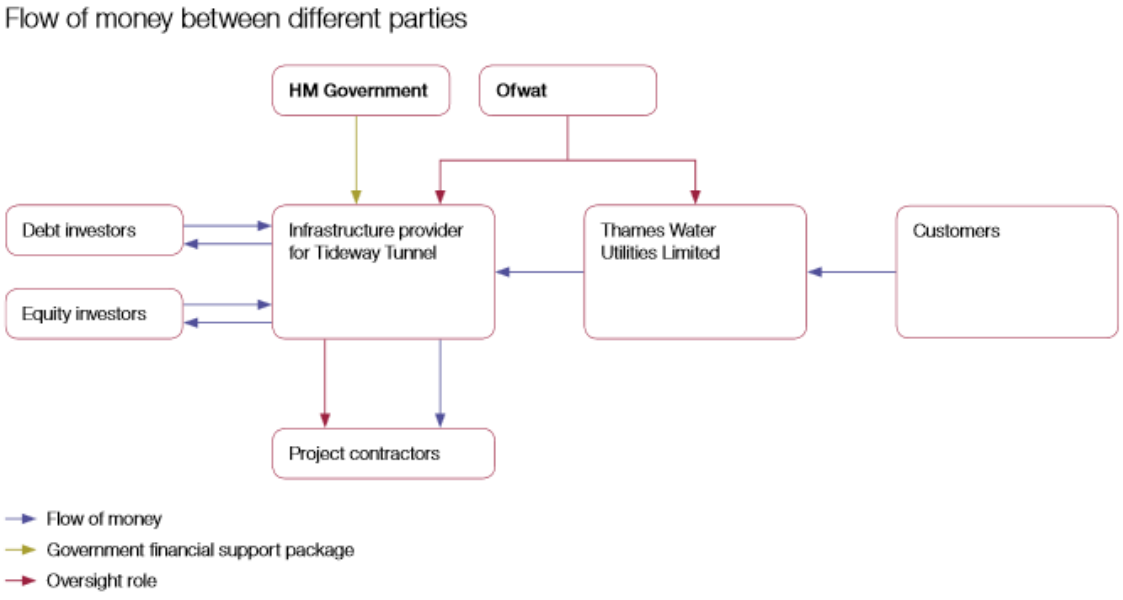


Exhibit 6 – Flow of money between different parties (National Audit Office, 2014, "Thames Tideway Tunnel: early review of potential risks to value for money")



Note

1 In addition, the infrastructure provider may pay the government a fee relating to the financial support package, although at the time of writing this had not been confirmed.

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Exhibit 7.1 - The Thames Tideway Tunnel: The Plan as of 2013

The 25km Thames Tideway Tunnel was set to have a diameter of up to 7.2m and to last for at least 120 years. Running up to 65m below the river Thames, it would be one of the deepest tunnels ever bored underneath London. The plan was to set up 24 construction sites, 11 of which located on the riverbank. The tunnel would be bored using 3 main shafts from where the tunnel boring machines (TBMs), each one the width of three buses, would be lowered into the ground. Complicating the tunnelling works were geological and supply chain factors. Geologically the tunnel was expected to encounter three different types of ground conditions and materials along the route, each one expected to require some substantial differences in drilling approaches. From a supply chain perspective a limited number of TBMs were available in the global market, and thus long lead times were to be expected.

Another technical challenge was how to remove and dispose of the underground material taken out of the tunnels, the so-called muck. In the case of Crossrail for example, one contractor had been appointed to provide river transport, an economic and environmentally friendly approach. All muck was therefore being transported off-site via boats to Wallasea Island, a new habitat for local wildlife and plants. But the use of a single contractor was not without its problems as the contractors responsible for tunnelling retained direct impact on the quality of the muck, particularly the amount of water content (the higher this amount, the more costly operations to transport and dispose of muck would become). Thus using an independent contractor for this operation created a tricky interface with the other tunnelling contractors, which Crossrail Ltd had to manage. Some therefore argued that it might be better to have each tunnelling contractor find their own transport solution, whilst ruling out road transport through central London.

Complicating matters around the problem of muck disposal was the fact that not many firms operated in the market equipped with special boats that could go down the river Thames; moreover, different parts of Thames require different boats to be used for example due to low bridges. Identifying a suitable site for disposing the muck was also not straightforward and thus it was a time-consuming process. Transporting muck along the river itself was a sensitive operation that unfolded under the eyes of third parties, and thus had to be carefully planned.

Challenges notwithstanding, the tunnelling projects were relatively low tech. Only the last building systems were expected to be technologically more complicated. For one, various mechanical and electrical works would have to be installed consistently. And this would then need to be followed up by installing a Supervisory Control and Data Acquisition (SCADA) system for monitoring and controlling operations and coordinating operations with associated infrastructure. All these systems were interdependent, and thus no part of the tunnel could become operational without completing all systems, ruling out staggered openings.

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Importantly, the Thames Tideway Tunnel needed to interface smoothly with the Thames Water infrastructure including sewage treatment plants and Lee Tunnel.

Another aspect not to be underestimated was the safety and security of the general public as well as the workers on site. With 24 construction sides, many right next to schools, homes or public infrastructure, great care needed to be taken. No unauthorized personnel should be able to enter sites and with many deliveries each day, safe, efficient and secure construction processes needed to be in place.

Building a massive tunnel under central London also created numerous institutional challenges. To gain legitimacy for the enterprise in the eyes of third parties, Thames Water was publicly announcing ambitious goals with regards to Health and Safety standards under the mantra of 'no life-changing injuries'. In addition, Thames Water was promising a broader legacy involving engagement with local communities during construction, work opportunities for local companies, landscaping visions post-construction, and opportunities for young people to receive training and pursue careers in the construction industry.

Thames Water was aware that boring a massive tunnel under central London would disrupt local businesses and households, while providing limited tangible benefits to these stakeholders. This made the scheme different from Crossrail which despite the disruptions it was creating had triggered property price raises, and would offer better connections to work and leisure activities and opportunities for new businesses. Thames Water in contrast had none of these tangible benefits to offer on its side, and thus could expect a more adverse stakeholder environment.

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Exhibit 7.2 – Renderings illustrating work sites in legacy (reprinted from Thames Tunnel Major Project report 2010. New Civil Engineering, September)

Barn Elms: Proposed TBM launch site

King Edward Memorial Park: Proposed site for North East Storm Relief CSO

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Exhibit 7.3 - Geology Times Tideway Tunnel (Presentation by Mike Gerrard, Managing Director TTT to Infrastructure Investment World 2013)

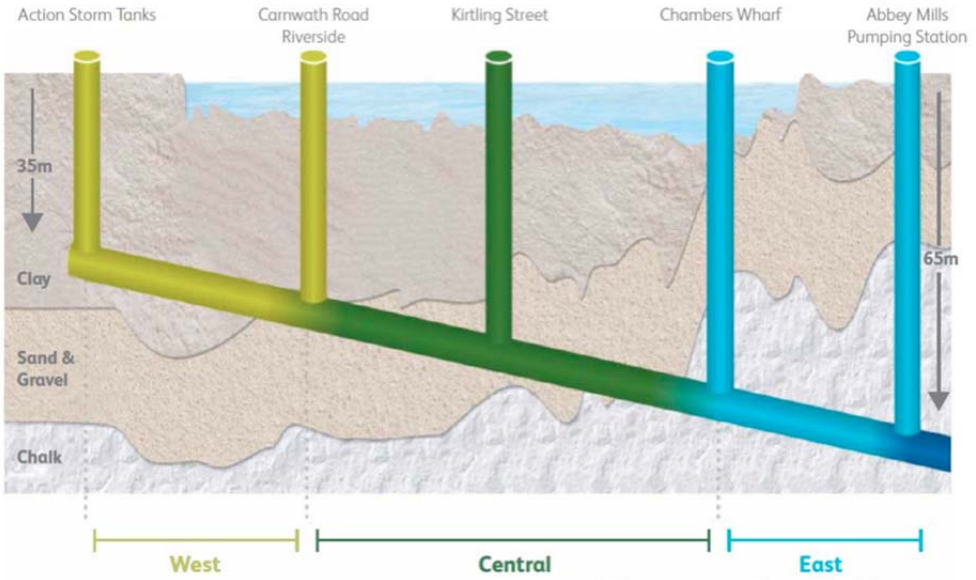

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Exhibit 8- Generic representation of the interception of the untreated sewage discharges from one of the 36 combined sewer overflows (CSOs) with the future Thames tunnel (reprinted from Thames Tunnel Major Project report 2010. New Civil Engineering, September)

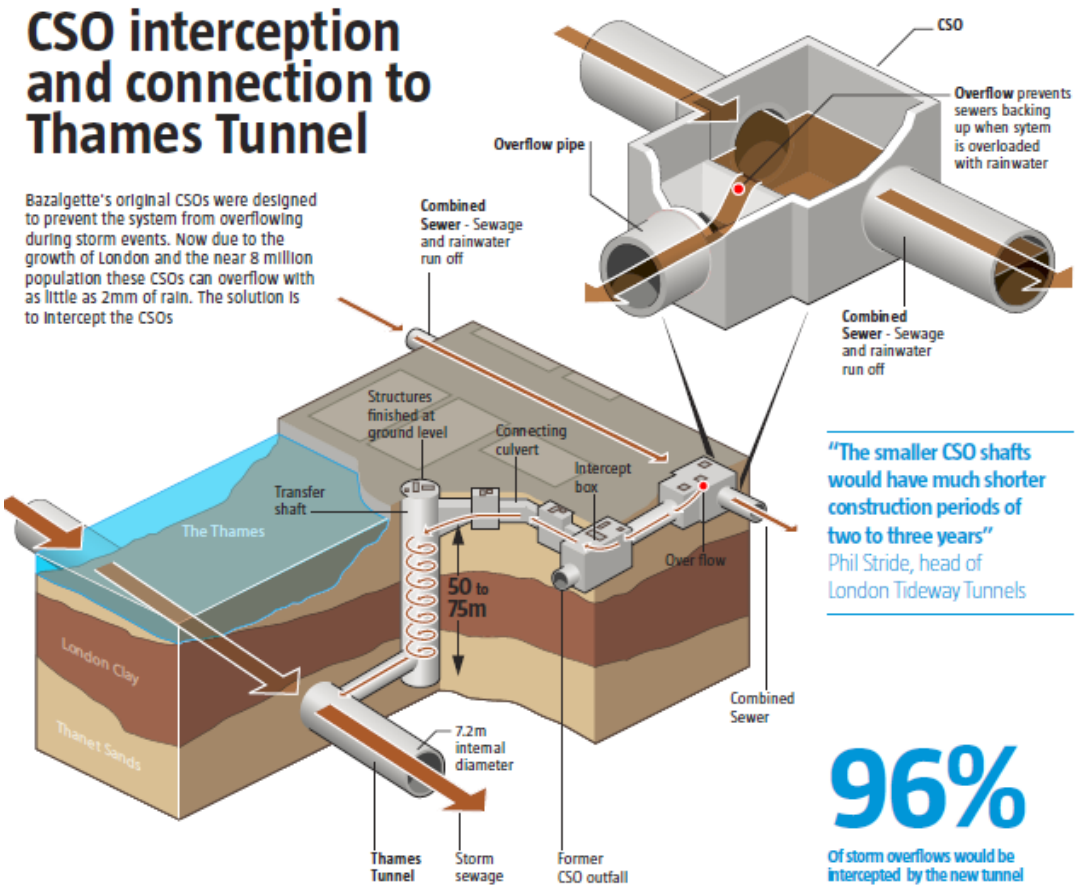

Exhibit 9 – Summary of the Timeline of the Development Process

2000	Thames Tideway Strategic Study starts
2005	Results of Thames Tideway Strategic Study published, recommending a single full length tunnel
2006	European Commission starts proceedings against the UK for non-compliance with the EU Urban Waste Water Treatment Directive
2007	Minister of State for Climate Change and Environment Agency announces support; Defra issues Regulatory Impact Assessment
2010	EU Court of Justice Rules that the UK is in breach with the EU Urban Waste Water Treatment Directive
September 2010 – January 2011	First round of public consultation (three tunnel options presented)
October 2011	Thames Tunnel Commission, sponsored by 5 of 14 London Councils affected, finds that alternative, mixed solutions instead of TTT should be revisited Prof. Chris Binnie, former chairman of the Thames Tideway Strategic

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	Study, raises concerns that the proposed TTT is not the most cost effective solution, casting doubt on future sewage levels
November 2011 – February 2012	Second round of public consultation

Exhibit 10- Alternative funding scenarios [NAO 2014]

Illustration of how the average and maximum annual costs to consumers of a £4.2 billion project may vary depending on the cost of capital and repayment period (£, nominal)

Benchmark: A maximum of £80 per household per year = £418 million annual revenue from residential customers

Cost of capital:		3.5%	4.5% (Current cost of capital)	5.5%
		Annual Cost (£m)	Annual Cost (£m)	Annual Cost (£m)
Repaid over 50 years	(highest)	229.5	271.1	312.7
	(average)	157.5	178.5	199.5
Repaid over 100 years	(highest)	188.2	230.1	271.8
	(average)	115.5	136.5	157.5
Interest paid in perpetuity	(highest)	147.0	189.0	231.0
	(average)	(constant)	(constant)	(constant)

Notes

1 This table indicates the possible maximum and average annual cost to Thames Water bill payers if a £4.2 billion project were to be regulated in line with other water sector infrastructure.

2 'Repaid over 50 years' and 'repaid over 100 years' assumes an initial ten-year construction period where interest is paid but there is no depreciation as the asset has not yet been completed. From 11 years, the asset depreciates evenly until the end of the repayment period (50 or 100 years).

3 Average annual cost is the average over the repayment period, excluding the ten-year construction period. The annual interest charge is calculated based on the value of the asset at the start of the year before depreciation. Depreciation is charged at the year end. The annual cost is the sum of the interest and depreciation charges for the year.