Environmental costs and benefits at the site of the London 2012 Olympics

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We protect and improve the quality of water, making sure there is enough for people, businesses, agriculture and the environment. Our work helps to ensure people can enjoy the water environment through angling and navigation.

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Executive summary

This project was designed to test the concept that it would be possible to obtain a reasonably good idea of the costs and benefits of the environmental improvements at a development site using only currently available techniques and valuation data.

The specific objective was to understand what value has been added to the environment in and around the Olympics site in East London through the Environment Agency's engagement with the planning system.

The project was commissioned by the Environment Agency's national Sustainable Places team in order to better understand the value of work to influence the shape of new development through the use of robust quantitative analysis. It was led by the Environment Agency's Economics and Social Science team, with support from the London Area team which worked with colleagues from other Areas to provide much of the data and 'institutional memory' required for the project.

To understand the value added through influencing the planning of the Olympics site, the appraisal focused on five important areas:

- flood risk
- surface water
- groundwater
- contaminated land
- recreation

Site-level data on key environmental indicators from before and after July 2005 – when it was announced that London had won the right to host the 2012 Olympics – were produced by the Environment Agency's London Area team. These were supplemented with further datasets and a variety of methods were then used to monetise these physical measurements.

The main conclusion of this report is that the Environment Agency used £1.5 million of resources to influence the spending of approximately £113 million, which achieved estimated benefits to people and the environment of £116 million. The central estimates of the costs and benefits are set out in the table below.

Because some environmental benefits cannot yet be monetised, the value of the environmental benefits from the work on the Olympics site calculated in this appraisal is very likely to be an underestimate, although it is not clear to what extent.

Estimated costs and environmental benefits of the work carried out in and around the Olympics site

Benefit category	Estimated costs	Estimated benefits
Flood risk	£50.5 million	£43.0 million
Surface water	£2.0 million	£2.0 million
Groundwater	£0	£0.5 million
Contaminated land	£0	£0
Recreation	£60.5 million	£70.5 million
TOTAL	£113.0 million	£116.0 million

It seems that it is possible to obtain a reasonably good idea of the costs and benefits of the environmental improvements at a development site using only currently available techniques and valuation data. But as expected, this project identified a number of improvements that could help to

make future appraisals such as this one more accurate and more robust. These improvements can be grouped as follows.

1. Appraisals of this nature should be built in from the start of relevant development projects. This would make it much easier to collate data on the costs of different measures and the physical impacts resulting from them.
2. More thought needs to be given to the method of integrating different appraisal methodologies designed for discrete policy areas so that they can be focused on a single development site. How to choose a relevant appraisal period, in particular, needs to be examined more closely.
3. Better valuation data are required for some ecosystem services such as surface water quality, and new valuation data are required for others such as pollination and cultural heritage value.
4. It was not possible to construct a robust methodology to assign 'credit' for environmental costs and benefits to a single organisation within a partnership approach to delivery such as that at the Olympics site. Further work is required to understand if it is possible to assign credit to single organisations under these circumstances.

Contents

1. Aim and objective of this appraisal

This project was designed to test the concept that it would be possible to obtain a reasonably good idea of the costs and benefits of the environmental improvements at a development site using only currently available techniques and valuation data.

The specific objective was to understand what value has been added to the environment in and around the Olympics site in East London through the Environment Agency's engagement with the planning system.

2. Background

This project was commissioned by the Environment Agency's national Sustainable Places team, which was keen to better understand the value of work to influence the shape of new developments through robust quantitative analysis. It was led by the Environment Agency's Economics and Social Science team, with support from the London Area team which worked with colleagues from other Areas to provide much of the data and 'institutional memory' required for the project. The project team was:

- Abdul Gaffar (Economic Development Specialist, Yorkshire Area)
- Andy Howe (Senior Advisor, national Sustainable Places team)
- Chris Saville (Senior Advisor, national Sustainable Places team)
- David Griggs (Advisor, Solent and South Downs Sustainable Places team)
- Matt Georges (Principal Economist, national Economics and Social Science team)
- Paula Wadsworth (Strategic Planning Officer, London Area)
- Rob McCarthy (previously Project Manager for the Environment Agency's input into the Olympics)

3. Location of the development

Much of the site of the 2012 Olympic Games in East London is now owned by the London Legacy Development Corporation (LLDC). The main water body running through the site is the Lower Lee from Tottenham Locks to Bow Locks/Three Mills Locks. In July 2005, when it was announced that London had been awarded the right to host the 2012 Olympics, this heavily modified urban waterway had multiple pollution problems.

4. Approach taken

The exercise did not use an orthodox Appraisal Summary Table. Instead, discussions at the kick-off meeting for the project established that the aim of the work was to understand the value added through influencing the planning of the Olympics site, focusing on the following 5 important areas:

- flood risk
- surface water
- groundwater
- contaminated land

- recreation

These categories were linked back to the relevant ecosystem services covered in the Environment Agency's Water Appraisal Guidance (Environment Agency 2013a).

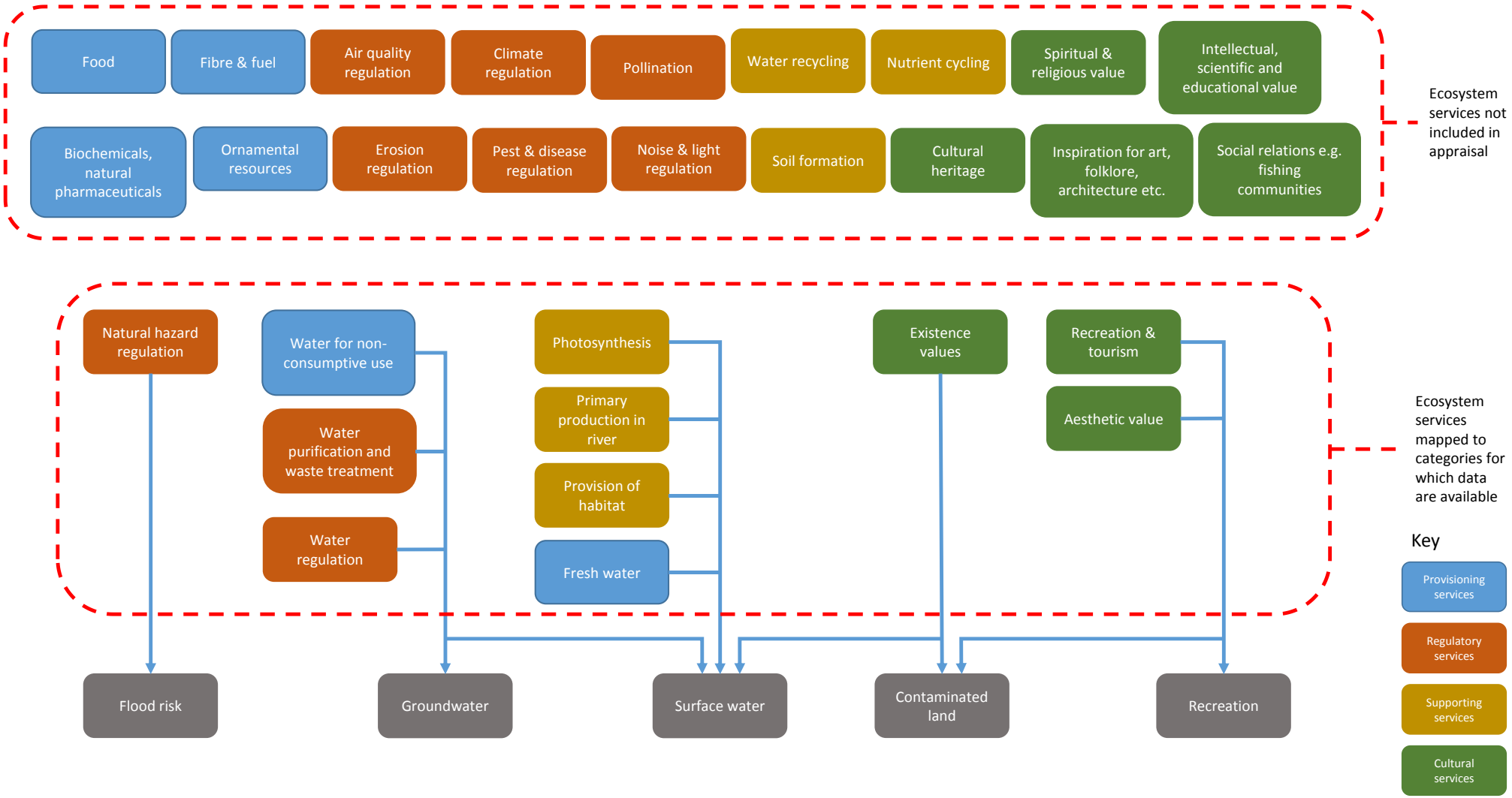
However, this left a number of ecosystem services not covered by the appraisal. Some will not have been affected by the Environment Agency's work to influence the construction of the Olympics site, while others will have been but could not be quantified. The latter are:

- ornamental resources
- air quality regulation
- climate regulation
- pollination
- cultural heritage
- intellectual, scientific and educational value

This means that the value of the environmental benefits from the work on the Olympics site calculated in this appraisal is very likely to be an underestimate, although it is not clear by how much.

Figure 1 sets out the various ecosystem services and their connection to the valuation categories.

Figure 1: Ecosystem services included in the appraisal



5. Methods used to value the ecosystem services categories

All site-level data were made available by the Environment Agency's London Area team. The methods used to monetise these physical measurements are described below.

5.1. Flood risk

Reduced residential flood risk was monetised using the Weighted Annual Average Damages (WAAD) in Table 4.5 and the intangible benefits in Table 4.7 of the Multi-Coloured Manual (Penning-Rowsell et al. 2016).

Reduced non-residential flood risk was monetised using the WAAD in Table 5.3 of the Multi-Coloured Manual.

5.2. Surface water

The Environment Agency's Water Appraisal Guidance (Environment Agency 2013a) was used to value improvements to the surface waters flowing through the Olympics site. The values in this guidance come from the National Water Environment Benefit Survey (NWEBS). More information on NWEBS can be found in Environment Agency (2013b).

5.3. Groundwater

To avoid double-counting of benefits from measures taken to improve surface waters, NWEBS benefits should not be counted in the groundwater part of the appraisal The Water Appraisal Guidance (Environment Agency 2013a) gives a value for 'water and wastewater treatment savings from direct abstraction', which is relevant in this case. It is derived from the long run marginal costs for various water companies, and is around £0.44 per m^3 in prices for 2016 to 2017.

5.4. Contaminated land

Two methods for valuing the impact of contaminated land remediation were used. The first was a simple comparison of the cost of purchasing and remediating the land at the site, with the price that it was sold on for. The second is based on the fact there is some evidence for a 'ripple effect' on the value of properties near to formerly contaminated land (see, for example, Jenkins et al. 2006) which is theorised to come from an appreciation of the improved environment by homebuyers.

To investigate whether this ripple effect exists in the case of the Olympics, a time series analysis was carried out on house prices in the Medium Super Output Areas (MSOAs) surrounding the site, in comparison to house prices in MSOAs in the rest of London. The analysis used data obtained in April 2017 from the Greater London Authority's database of average house prices covering the period from 1 January 1995 to 31 December 2015 (https://data.london.gov.uk/dataset/average-house-prices).

5.5. Recreation

The ORVal (Outdoor Recreation Valuation) tool developed by the Land, Environment, Economics and Policy Institute at the University of Exeter (http://leep.exeter.ac.uk/orval/) was used to estimate the value of the recreational benefits produced by the Olympics site. Strictly speaking, this tool is designed for policy-level analysis and there are known to be problems when using it at the level of an individual site. But, given the early stage of development of this integrated assessment approach, it was felt that a rough estimate of this set of benefits, accompanied by a wide sensitivity analysis, would be more useful than nothing at all.

6. Methods used to combine estimates of the value of different benefits

Each of the valuation methods set out in Section 5 was developed to measure a specific benefit (or set of benefits) across multiple sites, rather than multiple benefits at a specific site. This creates problems when trying to combine them. These were resolved for this appraisal as follows.

6.1. Double-counting

Double-counting of benefits occurs when the same ecosystem service is counted under more than one appraisal category. For example ‘recreation and tourism’ will be picked up by the valuations of both ‘contaminated land’ and ‘recreation’, while ‘provision of habitat’ will be valued by the methodologies used to calculate the benefits to ‘surface water’, ‘contaminated land’ and ‘recreation’.

The analysis that attempted to value the remediation of contaminated land at the Olympics site (see Section 7.4) concluded that this action was cost neutral. As a result, it was assumed that:

- the ‘recreation and tourism’ and ‘aesthetic value’ ecosystem services were valued only through the ‘recreation’ category
- the ‘existence value’ ecosystem service was valued only through the ‘surface water’ category

The valuation methodology for groundwater in the Environment Agency's Water Appraisal Guidance explicitly excludes any impact on surface waters (Environment Agency 2013a). As a result, the only benefit of action in this area was taken to be the reduction in water treatment costs from two boreholes used by Thames Water for emergency water supplies.

6.2. Appraisal periods

In general, the length of the appraisal period used for a valuation reflects the estimated lifetime of the asset being valued. In the case of the long-lived natural and manmade assets involved in this appraisal, there is no right answer to the question of how long the appraisal period should be. The Water Appraisal Guidance uses 40 years and the Multi-Coloured Manual uses 100 years for residential properties and 75 years for non-residential properties, while ORVal gives annual values. To reduce the risk of over-inflating benefits, a 40-year appraisal period was chosen, although the effect of choosing a different period was also investigated.

6.3. Discounting

In line with Green Book guidance (HM Treasury 2011), the discount rate for appraisals of this nature is set at 3.5% for the first 30 years, falling to 3.0% up to year 75 and falling further after that. Crucially, risks to life and health are discounted at a lower rate of 1.5%. In this appraisal, costs are therefore discounted at the higher rate and benefits at the lower rate, except in the case of flood risk where most of the damages are related to property and infrastructure.

7. Benefits

7.1. Flood risk

7.1.1. Site data

Impact of the development as first proposed		Impact of the development as approved by the Local Planning Authority, or as built		Site information	Metric	
Qualitative description	**Standard of Protection for 'Do nothing' baseline (years)**	**Qualitative description**	**Standard of Protection resulting from the scheme(s) (years)**	**Type of development**	**Number of units**	**Average floor area**
	50	4,000 homes taken out of floodplain as result of works and Environment Agency influence	100	Residential	4,000	
				Recreational schemes	100ha	
				Mixed use	250	360m^2

7.1.2. Monetisation

WAAD per residential property as first proposed	WAAD per residential property as built	Residential WAAD avoided	Intangible benefits	Total benefits per residential property	Present Value (PV) of benefits per residential property
£302	£75	£227	£165	£392	£8,793

WAAD per non-residential building as first proposed	WAAD per non-residential building as built	Non-residential WAAD avoided	PV of benefits per non-residential building
£5.32	£1.33	£3.99	£89.50

To avoid double-counting, the recreational schemes were left out of this part of the analysis.

Multiplying the PVs calculated above by 4,000 for residential properties, and 250 then 360 for non-residential buildings, gives total PVs of the reduction in flood risk for these 2 types of buildings of £35,172,000 and £8,055,000 respectively. To reflect the estimated nature of these calculations, the figures have been rounded to the nearest £0.5 million, that is, £35 million and £8 million.

The total estimated flood risk benefit of the Environment Agency's intervention in the Olympics planning process is therefore **approximately £43 million**.

7.2. Surface water

7.2.1. Site data

Impact of the development as first proposed			Impact of the development as approved by the Local Planning Authority, or as built			Site information	Metric
Qualitative description	**Estimate of probability of the impact occurring**	**Significance of change from existing state of the site**	**Qualitative description**	**Estimate of probability of the impact occurring**	**Significance of change from development as first proposed**	**Name of affected water body**	**Estimate of length of water body affected**
Benefits from increased permeable surfaces, proposals to use sustainable drainage systems (SUDS) and separation of foul and surface water drainage	Extremely likely	Somewhat improved	Further benefits derived from: • increasing culvert sizing as requested by the Environment Agency • improved and more extensive application of SUDS	Virtually certain	Much improved	Lower Lee	8km

The data on changes to the water quality in the Lower Lee from Tottenham Locks to Bow Locks/Three Mills Locks are summarised in Table 1. The headline ecological, chemical and overall water body statuses are defined by their worst subcategory score and so are a little misleading. Focusing on the subcategories, only one has worsened between 2009 and 2015, while all the rest have either stayed the same or improved. Unfortunately the subcategory that has worsened is ‘biological water quality elements’, which links to several ecosystem services categories.

Table 1: Changes to water quality in the Lower Lee

	2009 Cycle 1	2015 Cycle 2
Overall water body	Moderate	Bad
Ecological	Moderate	Bad
Biological quality elements	Poor	Bad
Hydromorphological supporting elements	Supports good	Supports good
Other substances	–	–
Physicochemical quality elements	Moderate	Moderate
Specific pollutants	Moderate	High
Supporting elements (surface water)	Moderate	Moderate
Chemical	Fail	Good
Other pollutants	Good	Good
Priority hazardous substances	Fail	Good
Priority substances	Good	Good

Notes: Based on cycles 1 and 2 of river basin planning under the Water Framework Directive

Source: Catchment Data Explorer (Environment Agency 2017)

7.2.2. Monetisation

The Environment Agency's Stage 1 Valuation Spreadsheet version 9 (available internally to Environment Agency staff) was used to monetise the data above. This has six categories of benefits, which are linked to the NWEBS survey data. They are:

- fish
- plants
- other animals such as invertebrates
- water clarity
- condition of the river channel and flow of water
- suitability for recreational contact

Because of the decrease in the biological quality elements, it was felt to be inappropriate to use the 'fish', 'plants' and 'other animals' valuations from NWEBS. Instead, only the valuations of 'water clarity', 'river channel condition' and 'recreational contact' were used.

7.2.3. Additionality

Further information on the work done to improve surface water quality in preparation for the Olympics was obtained to better understand how much of the benefits above could be attributed to the actions of the Environment Agency.

The judgement of Environment Agency Area staff was that the following occurred as a result of the Olympics.

Phosphate stripping at Deephams Sewage Treatment Works was prioritised to start in 2012 because of the Olympics.

Combined sewer overflow (CSO) prevention projects were only allowed to go ahead in the AMP5 (Asset Management Plan) period because of the Olympics. These were supposed to have been completed in AMP4 but the River Lee CSOs hadn't made it onto that list because the area wasn't a priority before the Olympics announcement.

Improvement schemes dealing with misconnections were highlighted in the Lower Lee so that the majority were completed by 2012.

A lot of partnership work occurred during the Olympics in order to ensure that any sewage discharges were minimised.

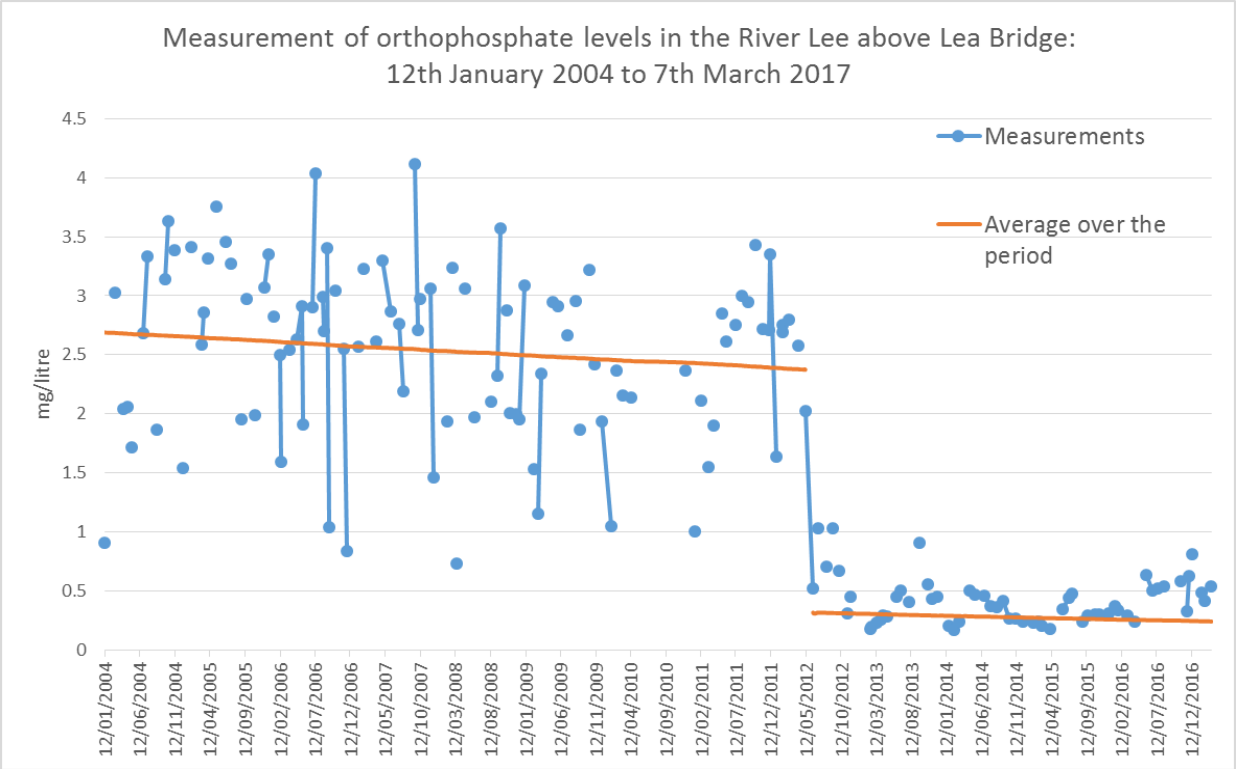
The Environment Agency installed both fixed aeration points and barges for deployment during Games time, which used hydrogen peroxide. Peroxide dosing was part of the agreement made between the Environment Agency and Thames Water to undertake improvements to Deephams as part of the preparations for the Olympics.

Figure 2 shows the combined effect on the River Lee of the implementation of the phosphate stripping, CSO projects and improvements to misconnections. For various reasons, the Environment Agency's London Team felt that the phosphate stripping was responsible for the majority of the improvement in surface water quality.

It is not clear when the phosphate stripping project would have been carried out in the absence of the Olympics, but a major upgrade of the Deephams site began in 2015 and is due to be completed in 2018. It therefore seems reasonable to assume that the phosphate stripping was commissioned a maximum of six years before it otherwise would have been.

While the reduction in orthophosphate levels is clearly visible in Figure 2, this does not yet seem to have translated into improvements in the status of the Lower Lee's biological quality elements. However, if it is assumed, that the benefits were actually only available six years before they would have been in any case, the resulting improvement in water quality is valued at £2,094,980 or **approximately £2 million**. Feedback from national water quality colleagues suggests that the Environment Agency is entitled to claim some credit for this early improvement of the water environment at the Olympics site.

Figure 2: Measurement of orthophosphate levels in the River Lee above Lea Bridge, 12 January 2004 to 7 March 2017



7.2.4. Sensitivity

There was some surprise within the project team that the clear improvements in chemical water quality had not lead to an improvement in the biological elements of the Lower Lee. The project team wondered if biological improvement was simply lagging behind the other improvements and that as such it might be possible to include the 'fish', 'plants' and 'other animals' valuations from NWEBS at some point in the future. To understand how much of a difference this might make to the appraisal results, the analysis was re-run with six years' worth of improvements across all the NWEBS benefits categories. The result was an improvement valued at £3,594,405 or approximately £3.5 million. This is substantially more than the estimate without the biological quality elements included, but is not huge in terms of the overall benefits figure.

7.3. Groundwater

7.3.1. Site data

Unfortunately, data on the amount of groundwater treated as part of the Olympics remediation work are contained in a large number of paper reports. To collate these data would not have been an effective use of time and so a different approach was adopted.

First, a qualitative assessment of the Environment Agency's influence on the groundwater remediation work carried out as part of the Olympics was obtained from the London Area team. This read as follows:

> *If the Environment Agency hadn't been involved in this development, the groundwater quality in the River Terrace Gravels and the Chalk aquifer would be extremely poor quality because the efforts to clean up the park would have just been focused on human health criteria. These are not necessarily protective of controlled waters. While groundwater remediation has not achieved a reduction in pollutant concentrations down to the expected baseline groundwater quality (that is, natural/clean background*

quality) in either the River Terrace Gravels or the Chalk aquifer, betterment has been achieved in some areas of the site while some areas are still under review.

Next, information on the abstraction points on the site was obtained. There are two boreholes within the site that can be used by Thames Water to abstract groundwater should it be required. The first is Stratford Box. This is actually a dewatering scheme designed to prevent structural problems with buildings in the area. If the water is not needed then it is discharged to the River Lee, but Thames Water can choose to use it if necessary. The second abstraction point is called Old Ford. Thames Water is licensed to abstract groundwater at this site, but generally does not do so because the water quality is not good and the costs of treatment are consequently higher than other sources. More information on the two sites was obtained from Thames Water (2013).

Old Ford is a groundwater source in East London which abstracts from the Chalk aquifer. The licence allows for the abstraction of 4.5 megalitres per day (Ml/d) average and 4.5Ml/d peak to meet peak demands and demand during drought conditions. Trigger event: Drought Event Level 1 and naturalised Teddington flows below 3,000Ml/d for 10 days.

Stratford Box is a groundwater abstraction source and is licensed for 8Ml/d peak and 8Ml/d average. This source is only operated during drought periods in conjunction with the Old Ford licence. The implementation time for this supply side measure is a minimum of 7–14 days but may take longer depending on water quality testing.

7.3.2. Monetisation

The data above give a figure for the amount of water to be multiplied by the value of £0.44 per m^3 identified as applicable in this case. The fact that Thames Water only uses this water during periods of quite severe drought complicates the calculation, but it is possible to make some reasonable assumptions to simplify things. The sort of event that would trigger the use of these boreholes has roughly a 1 in 20 chance of occurring in any particular year (Thames Water 2013). Previous droughts of this type have required the use of emergency boreholes for around two months in such a year (Thames Water 2013), and so over a 40-year appraisal period, an abstraction of 12,500m^3 per day for about 120 days could reasonably be expected. This is a total amount of 1,500,000m^3, which has a value of £660,000.

It is impossible, however, to know when the benefit of being able to access this water will occur. It could be in the first two years of the appraisal period (a 1 in 20 chance does not mean that there is a 20-year wait after one drought before another one occurs), it could be in the last two years, it could be somewhere in between, or a drought might not happen at all. This matters because benefits that accrue near to the beginning of the appraisal period are worth more than those near to the end. To resolve this problem the value of £660,000 was divided by 40 and entered into each year in the appraisal so that it could be discounted. The result is an estimated value of the improvement to groundwater as a result of the Environment Agency's input to the planning process for the Olympics of £510,111, which has been rounded to **£0.5 million**.

7.4. Contaminated land

7.4.1. Site data

Accurate data on the cost of the work to prepare for the Olympics is harder to locate than might be expected. The anticipated final cost of preparation and infrastructure was £1.8 billion (DCMS 2012), £766 million of which was spent purchasing land (Public Accounts Committee 2012) with £243m spent on remediation (London Assembly 2010). The East Village was purchased for £557 million and some of the Athletes' Village properties were sold for £268 million (The Guardian 2011).

According to the LLDC, the first homes in the Chobham Manor development were occupied from late 2015 and 'in 2015/16 the Legacy Corporation recognised £3.1 million of capital receipts arising from its share of proceeds from sales of homes on the Chobham Manor site' (LLDC 2016, p.30). The difference between the cost of purchasing and remediating the Olympics site and the sale price of the land therefore currently stands at around £180 million.

However, given that the LLDC appears to be pursuing a strategy of taking a share of the sales of homes built on its land and that many more homes in this and other developments remain to be built, it is likely to be at least a decade before the amount of money received back by the state is fully known. This means that it is currently impossible to calculate whether the price that the formerly contaminated land at the Olympic site sold for is higher than the cost of acquiring and remediating it, and thus to work out the value added by this activity. This leaves the second option of using a time series analysis to see whether there was any ripple effect from the remediation of the Olympic site to the surrounding land.

Figure 3 shows an index of average house prices in Greater London from 1995 to 2015. There does seem to be some sort of effect associated with the announcement that London had been awarded the Olympic Games, although it appears to be temporary and has to be set against the backdrop of the events leading up to the financial crisis of 2008, which had an impact on house prices across London.

Figure 4 gives a better idea of the difference between the index of average house prices in the areas around the Olympics site and those in the rest of London. The areas around the Olympics site certainly performed better than the rest of London in the period after the announcement of the location of the 2012 Games, but this could easily be interpreted as a continuation of the pattern that began in mid-2004. The sudden increase relative to the rest of London in 2008, followed by a worse drop in prices than the rest of the city could well be as much to do with characteristics of the local housing market as anything else. For example, the areas around the Olympics site tend to have a higher percentage of flats than other parts of London.

In conclusion, it appears that it is not possible to identify any ripple effect from the remediation of the contaminated land on the site of the Olympics, or indeed any effect from the Olympics on house prices at all. The result is an estimated value of the improvement to contaminated land as a result of the Environment Agency’s input to the planning process for the Olympics of **zero**.

Figure 3: Index of average house prices in Greater London, 1995 to 2015

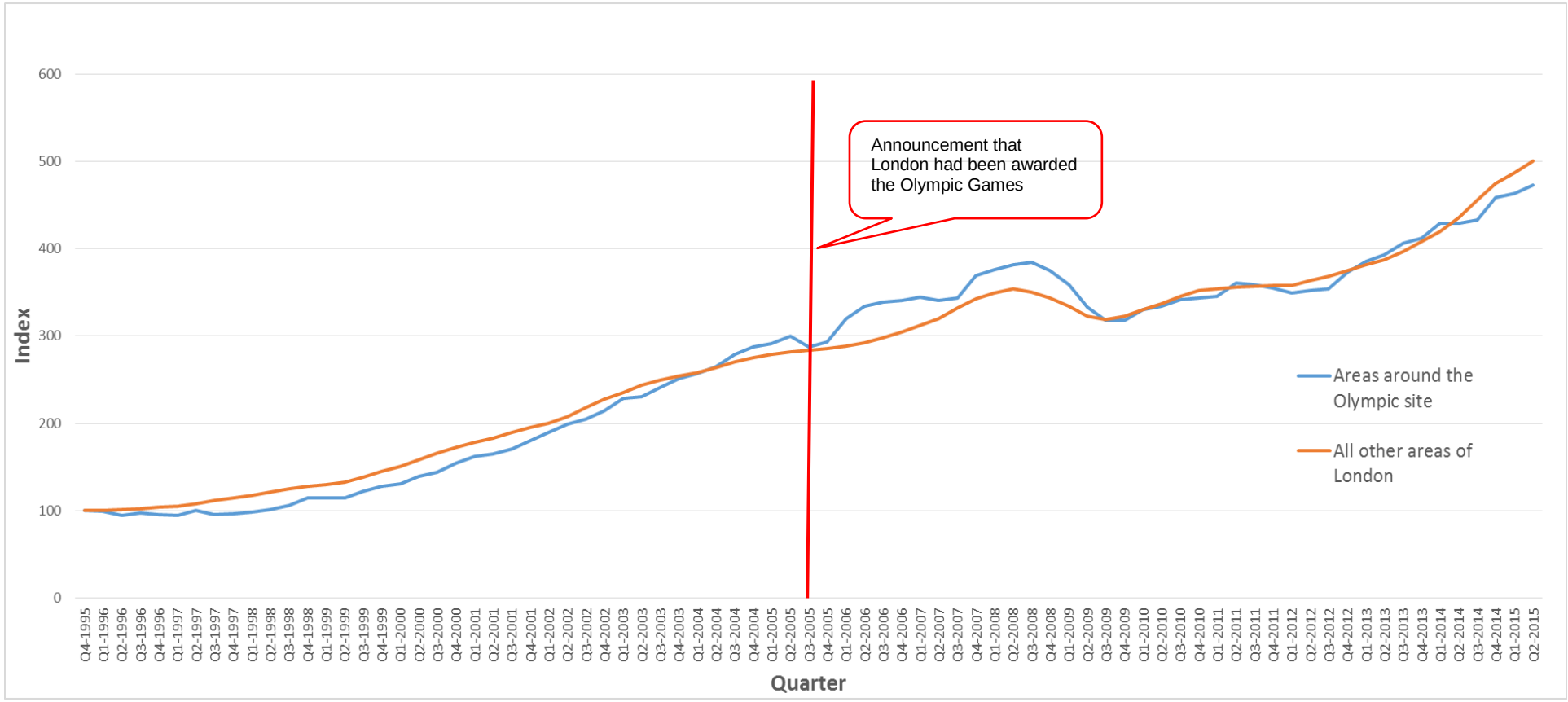
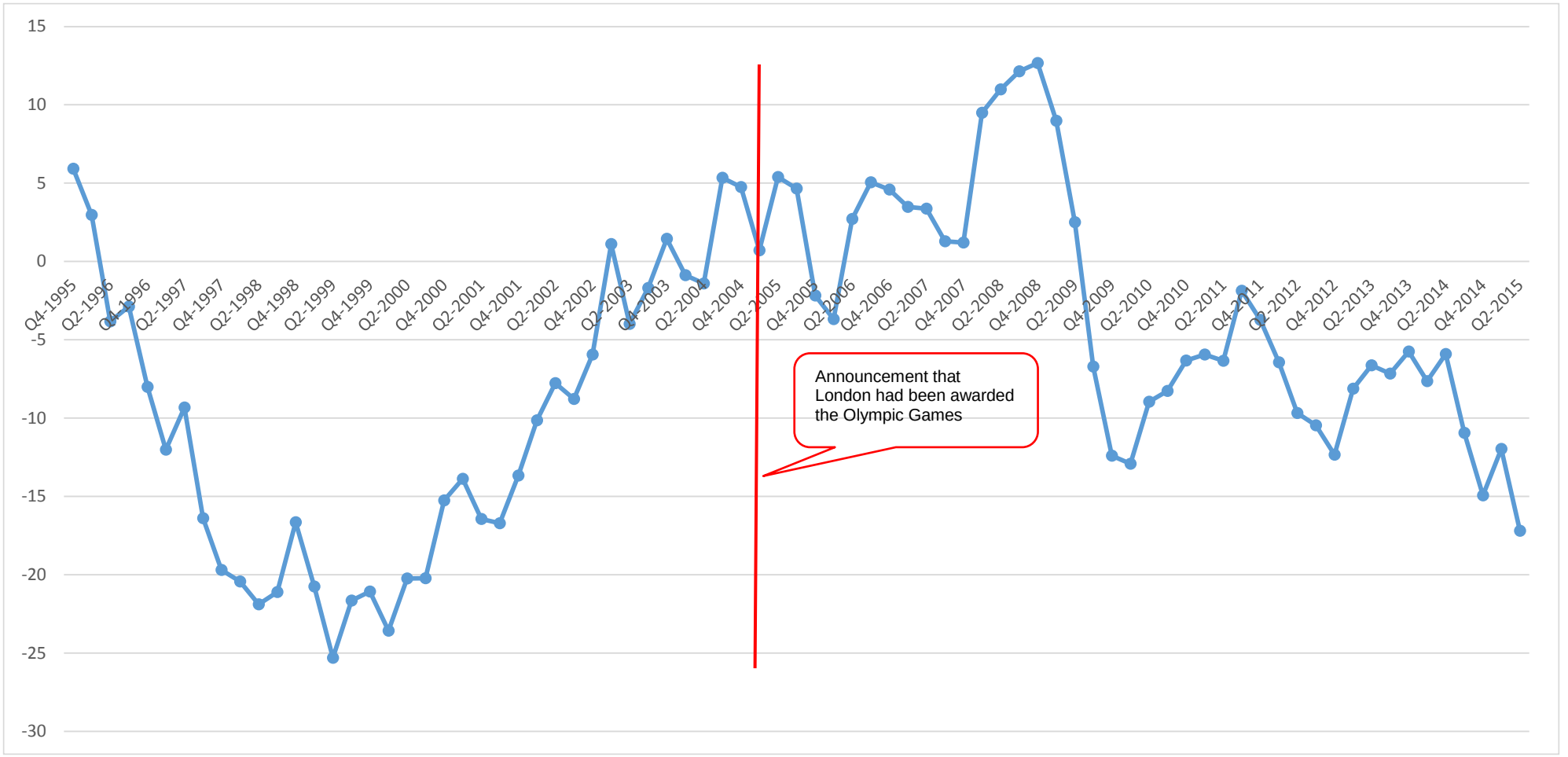


Figure 4: Differences between the Olympic area house price index and the rest of London house price index



7.5. Recreation

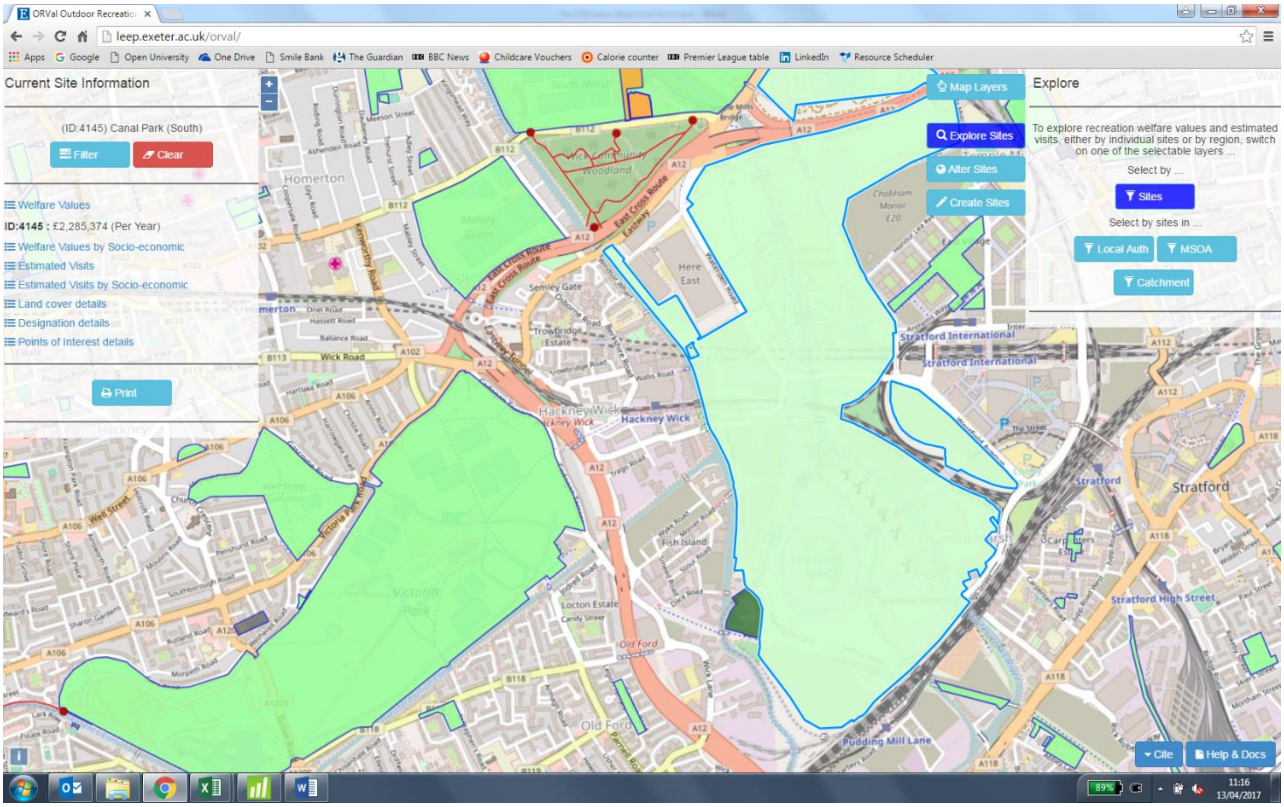
7.5.1. Site data

Impact of the development as first proposed			Impact of the development as approved by the Local Planning Authority, or as built			Site information	Metric
Qualitative description	**Estimate of probability of the impact occurring**	**Significance of change from existing state of the site**	**Qualitative description**	**Estimate of probability of the impact occurring**	**Significance of change from development as first proposed**	**Land use of new recreational site or area around new path**	**Estimate of length of new path or area of new recreational site**
No plans to enhance the water environment for recreational purposes	Extremely likely	Somewhat improved	Environment Agency influenced the developer to: • plant reeds • improve riverside access • separate industrial discharges to foul sewer • create wet woodland • undertake habitat translocation of Biodiversity Action Plan species	Virtually certain	Much improved	Managed grass: 30% Natural grass:30% River/canal: 10% Sports pitch: 30%	150ha

7.5.2. Monetisation

The ORVal tool was used to estimate the value of the recreational benefits produced by the Olympics site. Figure 5 shows a screenshot from the tool.

Figure 5: Screenshot from the ORVal tool showing the Olympics site



ORVal estimates that the annual benefit of recreation at the Olympics site is £2,285,374. If this value is entered for each year of the 40-year period of the appraisal, then discounted and summed it gives an estimated value of £70,654,269. This figure has been rounded to **£70.5 million**. Note that this is not the value added by the Environment Agency's intervention, but instead an estimate of the total recreational value of the Olympics site. However, the Environment Agency was instrumental in producing much of this value and so using this figure seems reasonable.

7.6. Total benefits

Summarising all these benefits gives total benefits of £116 million (Table 2).

Table 2: Estimated value of environmental benefits of work carried out in and around the Olympics site

Benefit category	Estimated benefit
Flood risk	£43.0 million
Surface water	£2.0 million
Groundwater	£0.5 million
Contaminated land	£0
Recreation	£70.5 million
TOTAL BENEFITS	£116.0 million

8. Costs

The following 3 categories of costs need to be considered in this appraisal:

- direct costs to the Environment Agency for providing the advice and support that led to the improvement in the environmental benefits from the redevelopment of the Olympics site
- capital costs paid by the organisations that actually implemented the Environment Agency's advice on the ground
- ongoing operation and maintenance (O&M) costs of keeping these environmental benefits available

The direct costs to the Environment Agency were £1.5 million over 5 years. This figure covers the salaries of a range of staff such as a project manager and flood risk advisor, as well as services such as legal support. However, this cost was recovered from the Olympic Development Authority and so from a financial point of view, the Environment Agency did not pay to influence the Olympics, rather it was paid to provide advice and support.

It is extremely difficult to disentangle the direct capital costs and O&M costs to the Environment Agency and other organisations of implementing the Environment Agency's advice on a project as large and complicated as this one. However, this is attempted below.

8.1. Flood risk

An assessment by the Olympic Park Legacy Company (2011, p. 5) states that:

> *During recent years, a number of measures have been taken by the Olympic Delivery Authority (ODA) to ensure that Planning Delivery Zones (PDZs) 1 to 7 within the Olympic Park are adequately defended against flood risk both during and after the London 2012 Olympic and Paralympic Games. Measures taken include:*
>
> *Three Mills Lock – a navigation structure that facilitates enhanced delivery of freight along the Olympic waterways and also provides the benefit of increased flow capacity through Prescott Channel;*
>
> *Henniker's Ditch culvert – provides an alternative flow path for overland flow approaching the site from the north, thus significantly reducing downstream flood risk;*
>
> *Increased flood water storage in the northern half of the Olympic Park and along Waterworks River;*
>
> *A new surface water drainage network which has been designed in accordance with current regulations and*
>
> *New / upgraded river wall structures in zone 1.*

According to the Canal and River Trust, the cost of this work, all of which had some impact on flood risk at or downstream of the Olympics site, was 'more than £50 million' (Canal and River Trust 2014a, p.13). For the purposes of this appraisal this has been rounded down to £50 million.

Three Mills Lock was designed partly to improve water quality by preventing water polluted by the CSO at Abbey Mills flowing into the Lee at high tide. This also acts to reduce fluvial flood risk, and to provide a non-tidal waterway that enables greater biodiversity and improves navigation. The Canal

and River Trust hopes that this last improvement will lead to an increase in freight as well as leisure traffic (Canal and River Trust 2014b), although maintenance to allow access for larger freight craft is more expensive. The Canal and River Trust estimates that the extra dredging required would cost about £2,000 per km per year on top of the cost of maintenance for leisure craft. Given the wide range of other benefits provided by the scheme, only the £2,000 figure has been used in this appraisal. It has not been uplifted to 2017 prices because of the minimal effect this would have on the results.

The costs of maintaining the other flood risk assets in and around the Olympics site were not available within the timeframe of this project, but an earlier Environment Agency report provides estimates of these costs for different types of assets. Concrete wall maintenance costs £0 to £855 per km per year while steel wall maintenance costs £0 to £530 per km per year (Environment Agency 2015). The following assumptions were made.

- The flood water storage, surface drainage network and Henniker's Ditch culvert were all assumed to have similar maintenance costs to flood defence walls. This is likely to overestimate those costs.
- An average maintenance cost of half of £855 for concrete walls was used. Again this is likely to overestimate these costs.
- The total cost per km per year was multiplied by eight, which is the length of the water body used for calculations in the surface water section of this appraisal.

The result was an annual maintenance cost of £19,420, which adds only about £0.5 million to the flood risk PV costs, making them **£50.5 million.**

8.2. Surface water

Phosphate stripping at the Deephams Sewage Treatment Works was part of a £27 million project (Water-technology.net, undated). The Environment Agency's London Area team estimated the cost of the phosphate stripping element of this work at £10 million. However, this is money that would have been spent a few years later in any case and so it is only the difference due to discounting that needs to be considered. The difference between an investment of £10 million made in 2012 and the same investment made in 2018 is £1.8 million. This has been rounded to **£2.0 million**. O&M costs would similarly have had to be paid under both these scenarios, but the rounding up of the capital costs should cover this.

8.3. Groundwater

Given the difficulty in obtaining the relevant data, the cost of groundwater treatment has been assumed to be subsumed within the total cost of remediating contaminated land on the Olympics site.

8.4. Contaminated land

The estimated total cost of land remediation was £243 million (see Section 7.4.1). However, much of this cost has been, or will eventually be, recovered through sales of land and buildings. The costs and benefits of the remediation of contaminated land have therefore been treated as though they cancel each other out.

8.5. Recreation

The process of turning the Olympic Park from a venue for the Games into a permanent part of London connected to the areas surrounding it was called 'Clear, Connect and Complete'. Examples of the type of work carried out include:

- removal of temporary venues such as the athletes' training centre at Eton Manor
- building new footways and cycle paths
- putting in new parkland, planting trees and meadows, and building allotments
- converting some Games-time buildings for more permanent use

- building new venues such as the Lee Valley VeloPark and the Lee Valley Tennis Centre

The contract for this work was worth £76 million (LLDC 2012), though some of this money was spent on venues that charge for entry. In this case, people's willingness to pay (provided they can afford to do so) is measured fairly well by the market, but this is not the value being measured by ORVal, which focuses on free-to-use green spaces. Assuming conservatively that 50% of the Clear, Connect and Complete project was spent on work that improved the green space available for free at the Olympics site, the capital cost of providing the recreational benefits set out above was £38 million.

A very rough estimate of O&M costs for the recreational space at the Olympics site is provided by Dunnett et al. (2002). They found that, of the 15 local authorities surveyed, there was a range in costs from £1,740 to £8,360 per hectare. In the absence of any evidence to the contrary, it was thought best to use the mean value of £5,050 and to multiply this by the figure of 15ha provided by the Environment Agency's London Area team. The result is an annual O&M cost of £757,500, which is discounted at 3.5% and produces a PV of approximately £22.5 million, resulting in a total PV of **£60.5 million** when the capital costs are also included.

8.6. Total costs

The PV of the total costs – as far as they can be discerned – of providing the environmental benefits identified in this appraisal are summarised in Table 3.

Table 3: Estimated costs of producing environmental benefits in and around the Olympics site

Benefit category	Estimated costs
Flood risk	£50.5 million
Surface water	£2.0 million
Groundwater	£0
Contaminated land	£0
Recreation	£60.5 million
TOTAL COSTS	£113.0 million

9. Sensitivity analysis

Bringing the costs and benefits together makes it clear that the vast majority of the costs and benefits accrue from just 2 categories – flood risk and recreation (Table 4).

The nature of the benefit valuation methodologies used for these categories is such that the intermediate values in the calculations do not lend themselves well to being altered as part of a sensitivity analysis. Net Present Values (NPVs) and benefit–cost ratios (BCRs) have not been calculated for the individual benefit categories because, as the example of Three Mills Lock shows, there is likely to be a degree of overlap in the contribution of costs accrued under one benefit category to other categories.

Table 4: Estimated costs and environmental benefits of the work carried out in and around the Olympics site

Benefit category	Estimated costs	Estimated benefits
Flood risk	£50.5 million	£43.0 million
Surface water	£2.0 million	£2.0 million
Groundwater	£0	£0.5 million
Contaminated land	£0	£0
Recreation	£60.5 million	£70.5 million
TOTAL	£113.0 million	£116.0 million

9.1. Clear, Connect and Complete

On the costs side, the major assumption is the percentage of the Clear, Connect and Complete project spent on free-to-use recreational assets. It is clear from the description of the project above that 100% of the cost of this project cannot be allocated to the creation of free-to-use green space, and so 75% and 25% were treated as the upper end and lower ends respectively of the possible range. The result of doing so is shown in Table 5; BCRs of <1 show that the costs outweigh the benefits.

To summarise, depending on the percentage of the Clear, Connect and Complete project assumed to be put towards the expansion and improvement of free-to-use recreational space, the NPV of the investments to improve the environment in and around the Olympics site ranges from -£16.0 million to £22.5 million.

Although BCRs have the disadvantage that they do not capture the magnitude of the costs and benefits, they have the advantage of making it easier to compare different scenarios. Roughly it seems that for every pound spent on environmental improvements in and around the Olympics site, between £0.90 and £1.20 of value was created.

Table 5: Sensitivity analysis of the effect of altering the costs of the Clear, Connect and Complete project

Clear, Connect and Complete cost	Total cost *
High: £57 million	£132.0 million
Central: £38 million	£113.0 million
Low: £19 million	£94.0 million
	NPV *
High: £57 million	-£16.0 million
Central: £38 million	£3.0 million
Low: £19 million	£22.5 million
	BCR **
High: £57 million	0.87:1
Central: £38 million	1.03:1
Low: £19 million	1.24:1

Notes: * Rounded to the nearest £0.5 million; ** Rounded to 2 decimal places

9.2. The appraisal period

A further crucial uncertainty is the appropriate length of the appraisal period. A period of 40 years was felt to be reasonable, but there is no right answer to this question. As such, the central analysis above was extended to look at 75-year and 100-year appraisal periods (Table 6).

Table 6: Sensitivity analysis of the effect of altering the length of the appraisal period

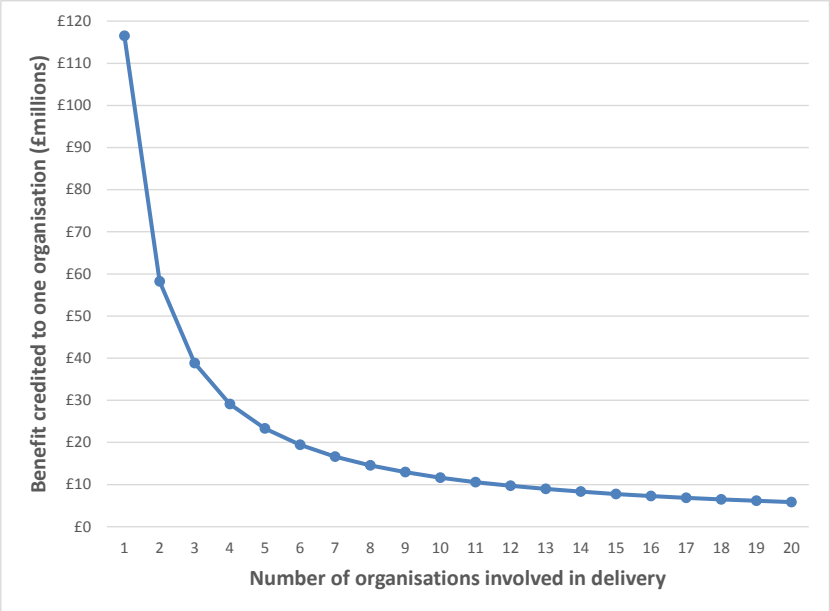
	Appraisal period		
	40 years	**75 years**	**100 years**
Estimated PV costs	£113.0 million	£124.0 million	£129.5 million
Estimated PV benefits	£116.0 million	£161.0 million	£180.0 million
NPV	£3.0 million	£37.0 million	£50.5 million
BCR	1.03:1	1.30:1	1.39:1

10. Claiming credit for environmental improvements

This project was commissioned by the Environment Agency's national Sustainable Places team to better understand the value of work to influence the shape of new developments through robust quantitative analysis. As such, it is of interest to know the extent to which the environmental benefits that have come about through the Olympics is down to the actions of the Environment Agency. Unfortunately this has not been possible for the Olympics site.

The value of the benefits credited to a single organisation decreases exponentially as the number of organisations increases additively (Figure 6). This means that the assumption of the number of organisations involved in a project can make a major difference to the 'credit' given to any single organisation. Furthermore, there is the problem that this approach fails to acknowledge the synergies between organisations and between different teams within organisations. It is like claiming that frogs contribute 10% to the functioning of a pond's ecosystem. They could not contribute anything without the presence of other flora and fauna, nor would the ecosystem collapse without them, although it is clearly more desirable to have them present.

Figure 6: Relationship between the value of benefits credited to a single organisation as the number of organisations involved increases



A related approach that was considered was to give individual percentages of credit for different categories of benefits. For example, the Environment Agency might reasonably claim more credit with regard to flood risk than, say, recreation. However, this would have introduced much more complexity – still based on a set of subjective assumptions – without necessarily producing a very different result.

11. Conclusions

The Environment Agency used £1.5 million of resources to influence the spending of approximately £113 million. This achieved estimated benefits to people and the environment of £116 million.

Because some environmental benefits cannot yet be monetised, the value of the environmental benefits from the work on the Olympics site calculated in this appraisal is very likely to be an underestimate, although it is not clear by how much.

There are also further sources of uncertainty that make it difficult to draw any more nuanced conclusion than this: it is probable that the benefits of improving the environment for people and wildlife at the Olympics site were slightly higher than the costs of doing so.

This may seem an underwhelming result, but it should be viewed in the context of the costs of staging the Olympics. The most comprehensive study in this area to date (Flyvberg et al. 2016, p. 1) states:

> *…at 156 percent in real terms, the Olympics have the highest average cost overrun of any type of megaproject. Moreover, cost overrun is found in all Games, without exception; for no other type of megaproject is this the case.*

Whether the costs – including the overruns – justify the benefits is a separate question, but a simple thought experiment is as follows. If the representatives of a host country were satisfied that the benefits of hosting the Games were worth the original costs presented to the International Olympic Committee, would they have felt the same if they had presented the final costs? In the case of the London Olympics, considered 'the most expensive Summer Games to date' (Flyvberg et al. 2016, p. 8), the original costs were USD 8.5 billion (2016 dollars) (this allows comparison with other Olympics) while the final costs were USD 15 billion. At least in the case of the environmental improvements to the area in and around the Olympics site, it is possible to be fairly sure that the benefits more than justify the costs.

12. Reflections

This project was designed to test the concept that it would be possible to obtain a reasonably good idea of the costs and benefits of the environmental improvements at a development site using only currently available techniques and valuation data. It seems that it is possible to do so. But as expected, the project also threw up a list of improvements that could help to make future appraisals of this nature more accurate and more robust. These improvements can be grouped as follows.

1. Appraisals of this nature should be built in from the start of relevant development projects. This would make it much easier to collate data on the costs of different measures and the physical impacts resulting from them.
2. More thought needs to be given to the method of integrating different appraisal methodologies designed for discrete policy areas so that they can be focused on a single development site. How to choose a relevant appraisal period, in particular, needs to be examined more closely.
3. Better valuation data are required for some ecosystem services such as surface water quality, and new valuation data are required for others such as pollination and cultural heritage value.

4. It was not possible to construct a robust methodology to assign 'credit' for environmental costs and benefits to a single organisation within a partnership approach to delivery such as that at the Olympics site. Further work is required to understand if it is possible to assign credit to single organisations under these circumstances.

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List of abbreviations

BCR	benefit–cost ratio
CSO	combined sewer overflow
LLDC	London Legacy Development Corporation
Ml/d	megalitres per day
MSOA	Middle Layer Super Output Area
NMEBS	National Water Environment Benefit Survey
NPV	Net Present Value
O&M	operation and maintenance
ORVal	Outdoor Recreation Valuation [tool]
PV	Present Value
SUDS	sustainable drainage system
WAAD	Weighted Annual Average Damages

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