Thames Tideway Tunnel
Thames Water Utilities Limited

Development Consent Order

Application Reference Number: WWO10001

Documents for Certification
September 2014

We, Lindsay Speed and Sarah Fairbrother hereby certify that this is a true copy of the environmental statement referred to in Article 61 (1) (f) of the Thames Water Utilities Limited (Thames Tideway Tunnel) Order 2014.

Lindsay Speed

Sarah Fairbrother

September 2014

Thames Tideway Tunnel

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

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Environmental Statement

Doc Ref: **6.2.14**

Volume 14: Kirtling Street appendices

APFP Regulations 2009: Regulation **5(2)(a)**

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Volume 14: Kirtling Street appendices

Appendix A: Introduction

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Appendix A: Introduction

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Appendix A: Introduction

A.1 Summary

A.1.1 This document presents the appendices that accompany the *Environmental Statement* Volume 14 Kirtling Street site assessment.

A.1.2 Figures associated with the appendices are provided within a separate volume of figures.

A.1.3 For consistency and ease of use Volumes 3 to 27 of the *Environmental Statement* all utilise the same appendices contents and labelling protocol. For these volumes the appendices are as follows:

a. Appendix A: Introduction
b. Appendix B: Air quality and odour
c. Appendix C: Ecology – aquatic
d. Appendix D: Ecology – terrestrial
e. Appendix E: Historic environment
f. Appendix F: Land quality
g. Appendix G: Noise and vibration
h. Appendix H: Socio-economics
i. Appendix I: Townscape and visual
j. Appendix J: Transport
k. Appendix K: Water resources – groundwater
l. Appendix L: Water resources – surface water
m. Appendix M: Water resources – flood risk
n. Appendix N: Development schedule.

A.1.4 Where a topic has not been assessed the associated appendix does not include any supporting information. Also, if a topic has been assessed but does not need to present any supporting information then the appendix is intentionally empty.

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Appendix B: Air quality and odour

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Appendix B: Air quality and odour

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Appendix B: Air quality and odour

B.1 Model verification

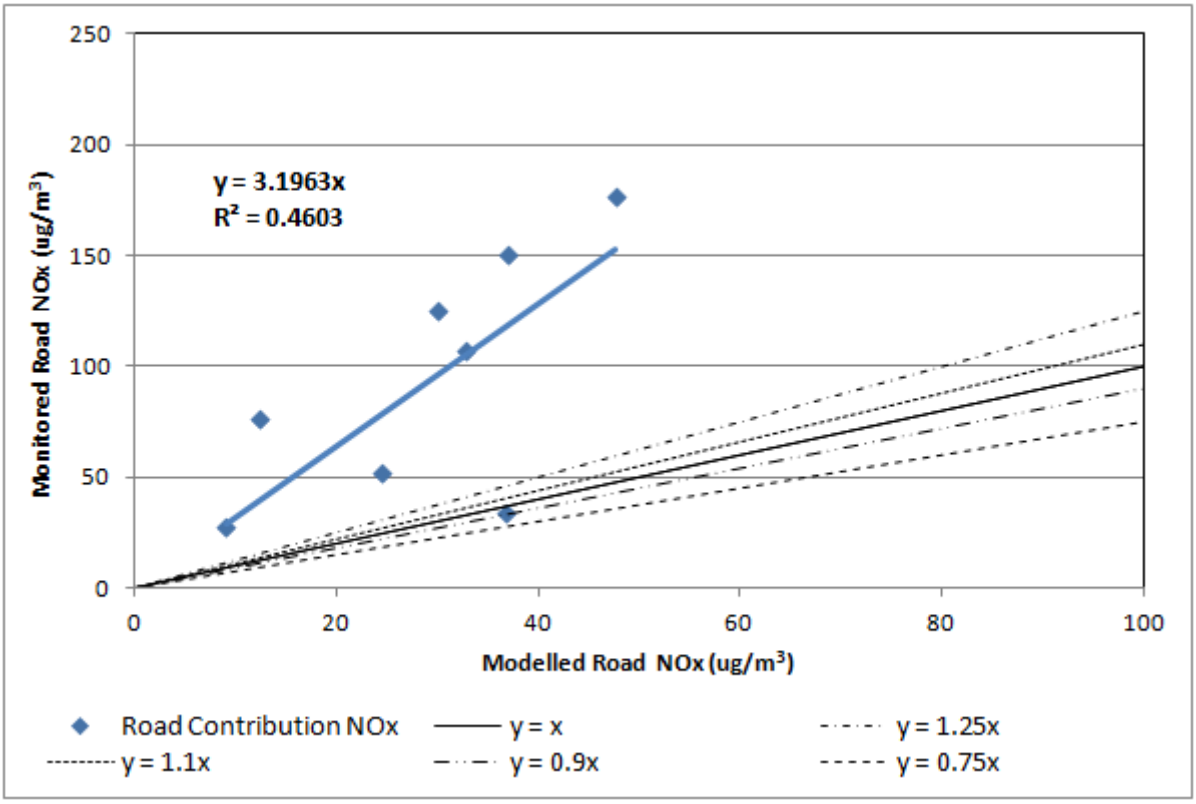
B.1.1 Modelled NO_2 concentrations have been plotted against monitored concentrations at the eight diffusion tube sites (KSTM1-KSTM5, HEAM1-HEAM2 and W3) shown in Vol 14 Figure 4.4.1 (see separate volume of figures).

B.1.2 This showed that the modelled results underestimated NO_2 concentrations by between -2% and 37%. As the model has been optimised and no further improvement of the model was considered feasible (such as reducing vehicle speeds or using different pollutant backgrounds, etc), a model adjustment factor was therefore deemed necessary.

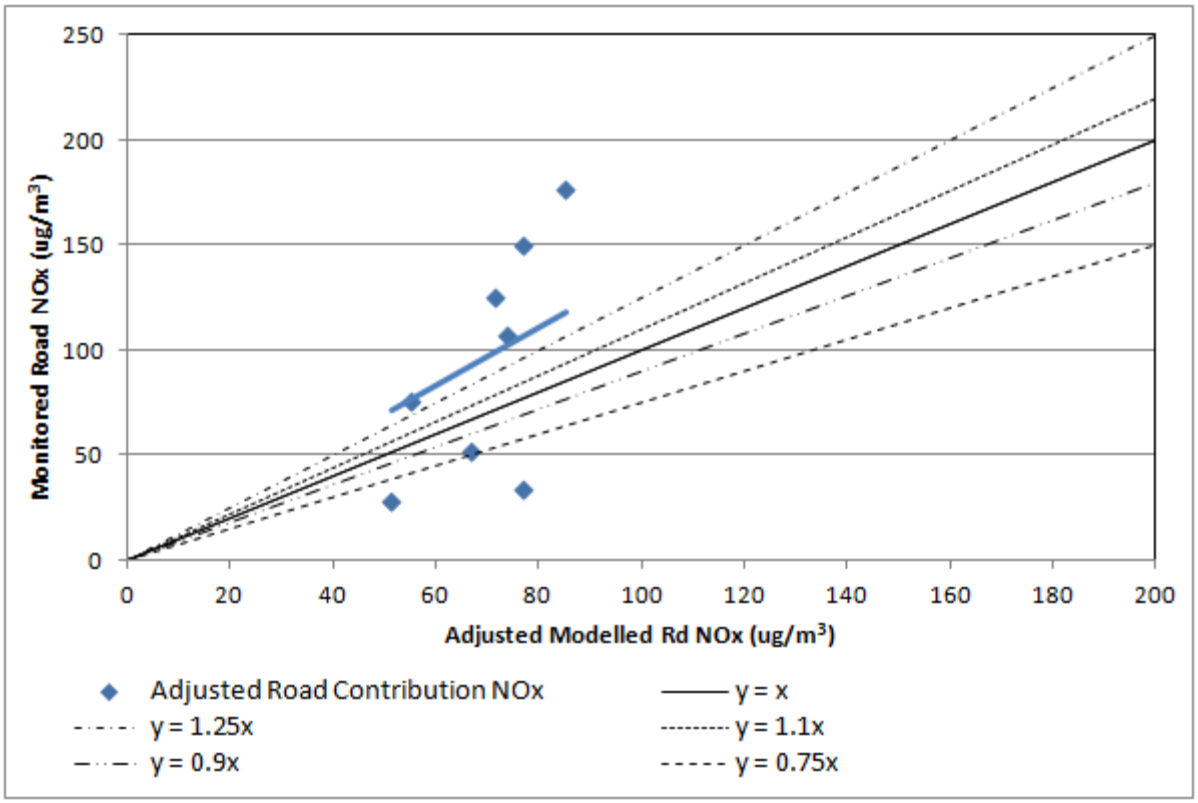
B.1.3 To derive the adjustment factor, modelled road NO_X concentrations were plotted against calculated monitored road NO_X concentrations - see Vol 14 Plate B.1 below. An adjustment factor of 3.20 was calculated to adjust modelled roadside NO_X concentrations, in accordance with LAQM.TG(09)[1] and was subsequently applied – see Vol 14 Plate B.1. This factor was also applied to the PM_{10} results as the PM_{10} monitoring sites were more than 1km away from the site and traffic data were not available, so model verification could not be carried out.

B.1.4 Applying the NO_X adjustment factor and then calculating NO_2 concentrations, as shown in Vol 14 Plate B.2, provides better overall agreement between actual and predicted data. The subsequent linear regression calculation for monitored versus modelled total NO_2, as shown in Vol 14 Plate B.3, indicated that five of the eight modelled concentrations were within 10% of the measured value and that two of the other three were within 25% of the modelled value.

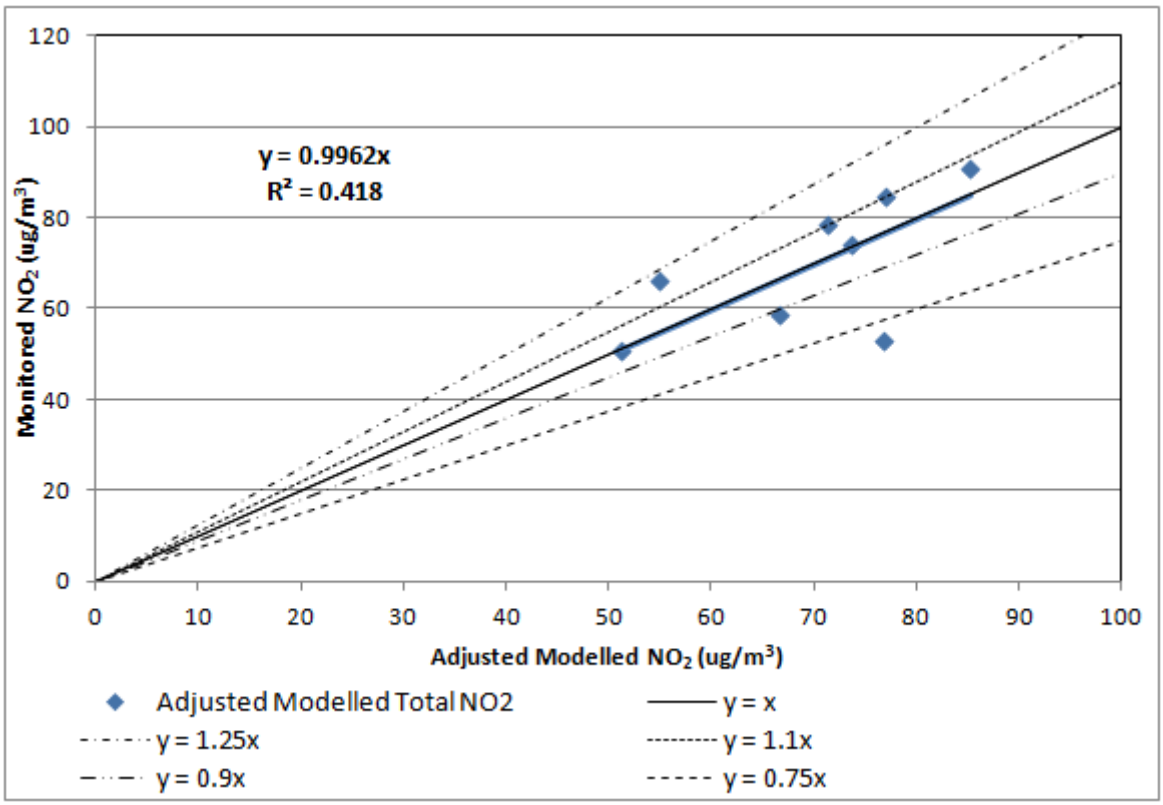
Vol 14 Plate B.1 Air quality - monitored road NO_X vs. modelled road NO_X



Vol 14 Plate B.2 Air quality – monitored road NO_X vs. adjusted modelled road NO_X



Vol 14 Plate B.3 Air quality – total monitored NO_2 vs. total adjusted modelled NO_2



B.2 Traffic data

B.2.1 The traffic data used in the air quality modelling for the Kirtling Street site are shown in Vol 14 Table B.1.

Vol 14 Table B.1 Air quality - traffic data model inputs

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak const-ruction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
ATC** 'Indirect'	Battersea Park Road	29180	9.7%	30	30.2	8.3%	31609	50	31672	9.8%
Speed Limit	Kirtling Street	994	19.4%	30	30.0	8.3%	1077	140	1217	28.6%
ATC 'Indirect'	Nine Elms Lane west of Cringle Street	27295	8.8%	30	30.2	8.3%	29568	118	29698	9.1%
Speed Limit	Cringle Street	1166	25.4%	30	30.0	8.3%	1263	140	1403	32.9%
ATC 'direct'	Nine Elms Lane east of Cringle Street	28140	18.6%	30	30.2	8.3%	30482	118	30613	18.9%

** AADT – annual average daily traffic. ** ATC – automatic traffic counter.*

B.3 River tug emission factors

B.3.1 Emissions of NO_X and PM_{10} from tugs pulling the barges were calculated using the data shown in Vol 14 Table B.2 for the Kirtling Street site.

Vol 14 Table B.2 Air quality - tug assessment model inputs

Parameter	Value	Units
Total tugs	730	Tugs/year
Time per tug*	25	minutes
NO_X base emission factor	10.2	g/kWhr
PM_{10} base emission factor	0.9	g/kWhr
Average tug engine size	984	kW
Manoeuvring and hotelling** load factor	0.2	No units
Total tug area***	19357	m^2
NO_X emissions per tug	2.9×10^{-05}	$g/s/m^2$
PM_{10} emissions per tug	2.5×10^{-06}	$g/s/m^2$

* Time that tug is at the site.
** Hotelling refers to when the tug is securely moored or anchored.
*** Area of the mooring and manoeuvring of tugs.

B.4 Construction plant emission factors

B.4.1 For the purpose of the assessment, the following listed equipment in Vol 14 Table B.3 has been modelled for the peak construction year at the Kirtling Street site.

Vol 14 Table B.3 Air quality - construction plant assessment model inputs

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NO_X emission rate ($g/s/m^2$)	PM_{10} emission rate ($g/s/m^2$)
Site set up and general site	Ground level behind hoarding	Compressor 250cfm*	1	50	104	6.6×10^{-08}	4.1×10^{-09}
	Ground level behind hoarding	Generator - 200kVA	1	100	160	2.0×10^{-07}	1.3×10^{-08}
	Ground level behind hoarding	JCB with hydraulic breaker	1	50	67	4.2×10^{-08}	2.6×10^{-09}
	Ground level behind hoarding	Cutting equipment (diamond saw)	2	10	2.3	1.5×10^{-09}	3.2×10^{-09}
	Ground level behind hoarding	Telescopic handler / FLT**	1	30	60	2.3×10^{-08}	1.4×10^{-09}
	Ground level behind hoarding	Hiab*** lorry/crane	1	5	56	3.5×10^{-09}	2.2×10^{-10}
	Ground level behind hoarding	Well drilling rig	1	50	403	2.5×10^{-07}	1.6×10^{-08}
Main Tunnel Drives - Kirtling Street to Carnwath Road Riverside & Kirtling	Ground level behind hoarding	150t crawler crane	1	50	240	1.5×10^{-07}	9.5×10^{-09}
	Ground level behind hoarding	250t mobile (TBM assembly only)	1	25	610	1.9×10^{-07}	1.2×10^{-08}

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NO_X emission rate ($g/s/m^2$)	PM_{10} emission rate ($g/s/m^2$)
Street to Chambers Wharf	Ground level behind hoarding	500t mobile (TBM assembly only)	1	25	610	1.9×10^{-07}	1.2×10^{-08}
	Ground level behind hoarding	Air compressor 600cfm	4	50	224	5.7×10^{-07}	3.5×10^{-08}
	Ground level behind hoarding	Dumper	2	25	81	5.1×10^{-08}	3.2×10^{-09}
	Ground level behind hoarding	Emergency generator - 400kW	1	5	400	2.5×10^{-08}	1.6×10^{-09}
	Ground level behind hoarding	Flatbed trucks for materials haulage	1	20	56	1.4×10^{-08}	8.8×10^{-10}
	Ground level behind hoarding	Flatbed trucks for segment haulage	1	20	56	1.4×10^{-08}	8.8×10^{-10}
	Ground level behind hoarding	Loading shovel	2	30	325	2.5×10^{-07}	1.5×10^{-08}
	Ground level behind hoarding	Telehandler 5t	2	80	60	1.2×10^{-07}	7.6×10^{-09}
	Within tunnel	Locomotives	8	100	180	6.7×10^{-05}	4.2×10^{-06}

Note: For the purposes of this assessment, the above listed equipment has been modelled for the peak construction year. The data assumes a 24 hour working day. This schedule provides an illustration of typical plant that could be used in the construction of the Thames Tideway Tunnel at this site. The appointed Contractor must comply with section 6 of the CoCP but may vary the method and plant to be used. This schedule therefore represents the most reasonable assumption for the assessment that can be made at this stage. cfm – cubic feet per minute. ** FLT – fork lift truck. ***Hiab – loader crane.*

References

[1] Defra, *Local Air Quality Management - Technical Guidance*, LAQM.TG(09) (2009).

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Appendix C: Ecology - aquatic

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Appendix C: Ecology – aquatic

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Appendix C: Ecology – aquatic

C.1 Introduction

C.1.1 Construction and operational effects assessments at this site for this topic do not require the provision of any supporting information, so this appendix is intentionally empty.

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Appendix D: Ecology - terrestrial

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Appendix D: Ecology – terrestrial

D.1 Notable species survey report

Introduction

D.1.1 A Phase 1 Habitat Survey was carried out on 7 December 2010 covering the majority of the site with an additional area also surveyed on 20 May 2011 at the Kirtling Street site, as shown in Vol 14 Figure 6.4.2 (see separate volume of figures). Based on this, surveys for the following species have been undertaken:

a. bats

b. wintering birds

c. black redstart *(Phoenicurus ochruros)* and

d. invasive plants.

D.1.2 The purpose of the surveys is to determine the presence or likely absence of these species at and around the site.

D.1.3 This report presents the survey findings. The survey area for each species is described with reference to the habitat types identified during the Phase 1 Habitat Survey as having potential for notable species (paras. D.1.5 to D.1.13). The results from the surveys are then presented (paras. D.1.14 to D.1.23). The final section provides an interpretation of the results (paras. D.1.24 to D.1.34). Figures referred to in this report are contained within Vol 14 Kirtling Street Figures.

D.1.4 Information on legislation, policy and methodology can be found in Vol 2 of the *Environmental Statement*. Information on site context can be found in Section 3 of this volume.

Survey area

Bats

D.1.5 Bats are associated with a diverse range of habitats, including woodland, scrub, riparian habitats and buildings. They roost in trees and buildings where suitable features are present, and they commute along linear features such as hedgerows, watercourses and tree lines, and forage around vegetation such as scrub, hedgerows, grassland, trees and river corridors.

D.1.6 A two stage bat survey was carried out. The first survey was a remote recording (bat triggering) survey using remote Anabat™ recording devices. Based on the habitat types identified during the Phase 1 Habitat Survey and their potential to support foraging, commuting or roosting bats, three locations were chosen for the installation of the remote recording devices shown on Vol 14 Figure 6.4.3 (see separate volume of figures).

D.1.7 At the time that remote recording surveys were undertaken access was not available to the Kirtling Street site. Therefore, data from the remote recording survey at Heathwall Pumping Station to the east (Location one)

was used to trigger the need for further dawn surveys at this location. Location one was selected to record activity associated with commuting and foraging along the River Thames corridor and activity of bats entering and leaving the Heathwall Pumping Station site. A remote recording survey was subsequently undertaken at location two and location three so that a full set of remote recording data has been obtained for the Kirtling Street site. The remote recording devices were installed along a fence line with an adjacent line of introduced shrubs. Location two and location three were selected to record possible activity associated with bats roosting in buildings on or in close proximity to this part of the site.

D.1.8 As high numbers of bats and a range of bat species were recorded, the remote recording surveys triggered the need for an additional dawn survey at the Kirtling Street site (see Vol 2 Methodology for bat triggering criteria). Therefore, a second stage of bat surveying was undertaken, comprising one dawn survey visit by two ecologists to assess the usage of the site and immediate surrounds by bats. The survey area for the bat activity (dawn) surveys, is shown in Vol 14 Figure 6.4.3 (see separate volume of figures).

Wintering birds

D.1.9 Wintering birds are mainly associated with aquatic habitats such as intertidal mudflats and marshes, marginal vegetation and wetlands, which they use for resting and foraging. Some wintering bird species are also associated with terrestrial habitats such as scrub and grassland, which they use for roosting at high tide or foraging. The survey area, as shown in Vol 14 Figure 6.4.4 (see separate volume of figures), comprises intertidal foreshore of the River Thames, jetties and moored house boats. The foreshore mainly consists of stones and silt.

D.1.10 The Heathwall Pumping Station (Vol 15) proposed development site is located nearby to Kirtling Street, and as such the foreshore survey area for the wintering bird surveys has been combined with the foreshore survey area for Heathwall Pumping Station wintering bird surveys, resulting in one large survey area and a combined set of results.

Black redstart

D.1.11 Black redstart nest on and within buildings and structures (mostly those that are derelict), and forage on sparsely-vegetated open areas. The survey area is shown in Vol 14 Figure 6.4.5 (see separate volume of figures), and includes those buildings, areas of hardstanding and other features which lie in the immediate vicinity of Kirtling Street and includes the section of foreshore and river which lie adjacent to the proposed development site.

Invasive plants

D.1.12 Invasive plants that are listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) occur in a wide range of habitats, although they are more often associated with watercourses or wet areas, or within areas of disturbed ground, where material contaminated with seeds and rhizomes (sections of root that can re-grow), may have been imported into the area.

D.1.13 The invasive plants survey area, as shown on Vol 14 Figure 6.4.6 (see separate volume of figures), comprises the proposed development site, and an area within 10m of the proposed development site boundary. The 10m zone beyond the site boundary was surveyed to record any invasive plants present adjacent to the site that could potentially spread onto the site, or that could have roots that extend into the site below ground (eg Japanese knotweed (*Fallopia japonica*)).

Results

D.1.14 In this section, the results of the desk study, notable species surveys and the invasive plant survey are presented. The results are then interpreted in paras D.1.24 and D.1.34.

Desk study

D.1.15 Species data recorded within 500m of the site from 2001 to 2011, as supplied by Greenspace Information for Greater London (GIGL), are summarised in Vol 14 Table D.1.

Vol 14 Table D.1 Terrestrial ecology – species recorded within 500m of the site from 2001 - 2011

Common name	Latin name	Record count
Mammals		
Leisler's/Lesser noctule	*Nyctalus leisleri*	4
Noctule bat	*Nyctalus noctula*	4
Common pipistrelle	*Pipistrellus pipistrellus*	42
Bats	*Vespertilionidae*	2
Birds		
Common tern	*Sterna hirundo*	2
Greater scaup	*Aythya marila*	4
Whimbrel	*Numenius phaeopus*	4
Herring gull	*Larus argentatus*	18
Black redstart	*Phoenicurus ochruros*	128
Peregrine falcon	*Falco peregrinus*	48
Common kingfisher	*Alcedo atthis*	8
Common linnet	*Carduelis cannabina*	4
Common redpoll	*Carduelis flammea*	4
Common starling	*Sturnus vulgaris*	14
European turtle dove	*Streptopelia turtur*	4
House sparrow	*Passer domesticus*	48
Storm petrel	*Oceanodroma leucorhoa*	4

Common name	Latin name	Record count
Hedge accentor	*Prunella modularis*	8
Northern lapwing	*Vanellus vanellus*	8
Invertebrates		
Stag beetle	*Lucanus cervus*	8
Plants		
Stinking goosefoot	*Chenopodium vulvaria*	4

Bat surveys

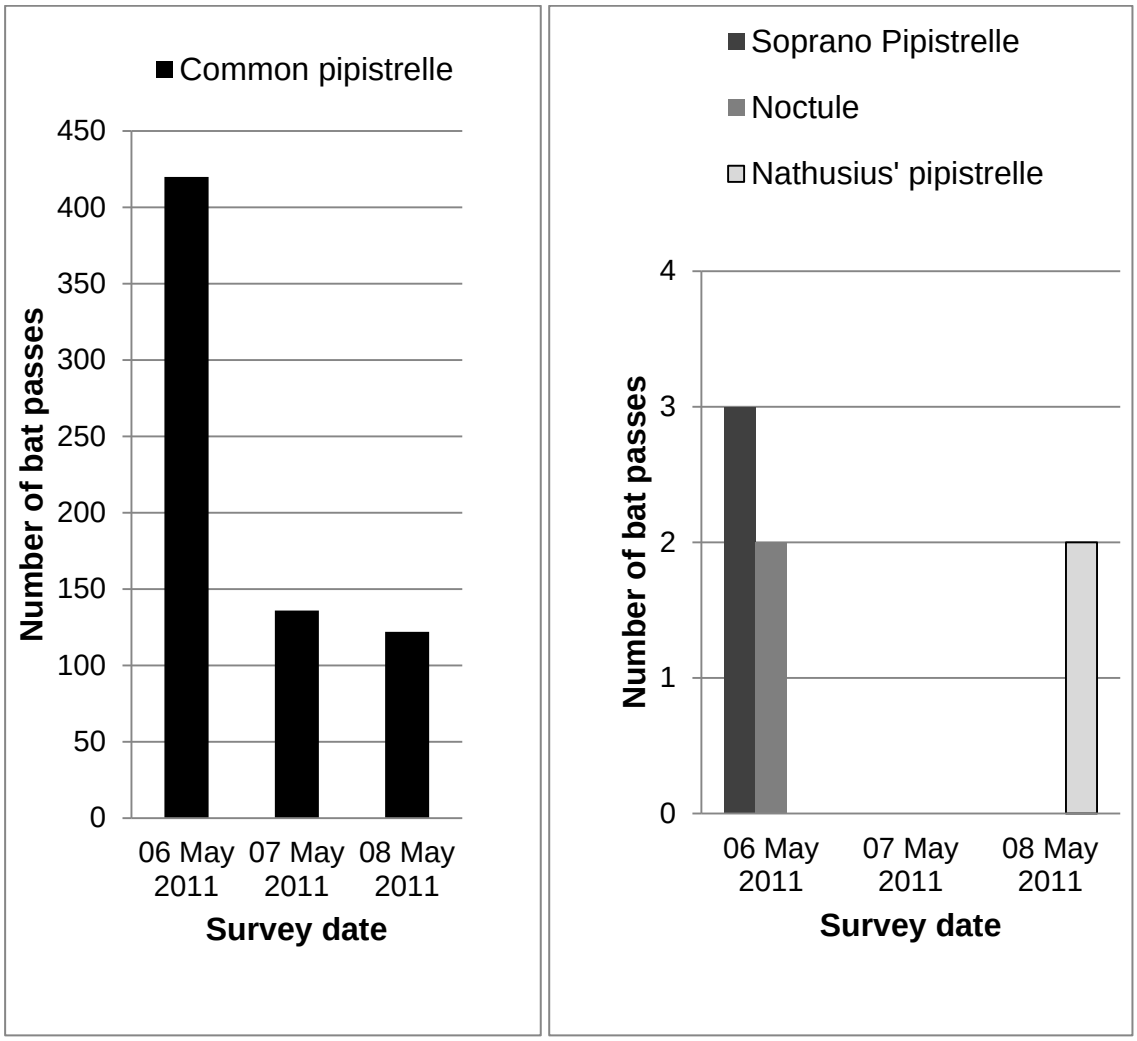
Bat triggering (remote recording) surveys

D.1.16 The bat triggering (remote recording) surveys were undertaken over three nights between 6 and 8 May 2011 adjacent to the River Thames (location one), and over three nights between 29 September and 1 October 2012, in suitable weather conditions (see Vol 14 Table D.1). The remote recording surveys undertaken on the 6 to 8 May 2011 at this site recorded four species of bats using the site, common pipistrelle (*Pipistrellus pipistrellus)*, soprano pipistrelle (*Pipistrellus pygmaeus),* Nathusius' pipistrelle (*Pipistrellus nathusii)* and noctule (*Nyctalus noctula)*. A high number of common pipistrelle was recorded. The peak count of common pipistrelle was 420, recorded on 6 May (see Vol 14 Plate D.1). Soprano pipistrelle, noctule and Nathusius' pipistrelle were recorded in low numbers, with each species only present on one survey night. No bat passes were recorded during the remote recording survey undertaken between 29 September and 1 November 2012.

Vol 14 Table D.1 Terrestrial ecology – bat survey weather conditions

Survey visit	Weather conditions
6 May 2011	10°C, gentle breeze, 0% cloud cover, dry
7 May 2011	16°C, calm, 25% cloud cover, dry
8 May 2011	15°C, gentle breeze, 25% cloud cover, dry
29 September 2012	10°C, gentle breeze, 75% cloud cover, dry
30 September 2012	8°C, gentle breeze, 75% cloud cover, dry
1 October 2012	14°C, moderate breeze, 25% cloud cover, dry

Vol 14 Plate D.1 Terrestrial ecology – bat passes recorded during remote recording surveys at one location at Kirtling Street



Bat activity (dawn) surveys

D.1.17 As there were high numbers of common pipistrelle recorded during the remote recording survey, this triggered the need for a bat activity (dawn) survey to be undertaken (based on bat triggering criteria in Vol 2 Section 6). The bat activity survey was undertaken on 28 June 2011 in suitable weather conditions (20^{o}C, gentle west north-westerly wind, 50% cloud cover, dry). No bat activity was identified during the dawn activity survey.

Wintering bird surveys

D.1.18 A total of six surveys were undertaken at monthly intervals during January and December 2011 by an experienced ornithologist (bird specialist). The survey visits were taken from an hour before low tide to at least one hour after low tide. The survey visits were undertaken in suitable weather conditions (see Vol 14 Table D.2). The main foraging and resting areas for wintering birds are indicated on Vol 14 Figure 6.4.4 (see separate volume of figures). The numbers of individuals of each species recorded in each month are provided in Vol 14 Table D.3.

Vol 14 Table D.2 Terrestrial ecology – wintering bird survey weather conditions

Survey visit	Weather conditions
25 January 2011	3°C, calm, 100% cloud cover, dry
24 February 2011	10°C, light breeze, 75% cloud cover, dry
25 March 2011	5°C, light breeze, 100% cloud cover, dry
18 October 2011	14°C, south-westerly wind, 75% cloud cover, dry
29 November 2011	13°C, south-westerly wind, 100% cloud cover, dry
13 December 2011	11°C, south-westerly wind, 25% cloud cover, dry

D.1.19 A total of 12 waterbird[i] species were recorded on the foreshore on and adjacent to the site. Of these, six species are of nature conservation importance and are included on the Birds of Conservation Concern 3 (RSPB, 2009)[1] Red or Amber List[ii] and/or UK and London BAP as priority species.

D.1.20 The six species of nature conservation importance are gadwall *(Anas strepera)*, mallard (*Anas platyrhynchos)*, black-headed gull (*Larus ridibundus)*, common gull (*Larus* canus*)*, lesser black-backed gull (*Larus fuscus* ssp. *Graellsii)* and herring gull (*Larus argentatus* ssp. *argenteus*). Gadwall and mallard were recorded foraging on the muddy foreshore and along the water's edge as the tide receded. Four species of gull were recorded resting on the jetty and moored house boats adjacent to the site.

[i] A waterbird is a species which is listed in the Wetland Bird Survey (WeBS) methodology – British Trust for Ornithology, Royal Society for the Protection of Birds, Joint Nature Conservation Committee and Wildfowl and Wetlands Trust.

[ii] The conservation status of all regularly occurring British birds has been analysed in cooperation with the leading governmental and non-governmental conservation organisations, including the Royal Society for the Protection of Birds (RSPB), British Trust for Ornithology (BTO) and Birdlife International Birds of Conservation Concern 3 (RSPB, 2009). The basis of species ongoing population trends are assigned to one of three lists of Conservation Concern. These are the UK Red, Amber and Green lists. Although the lists confer no legal status in themselves, they are useful in evaluating the conservation significance of bird assemblages, and for assessing the potential significance of impacts and informing appropriate levels of mitigation with respect to bird populations.

Birds of Conservation Concern (BoCC) Red List criteria for breeding birds are those which have experienced a severe decline of more than 50% of population and / or range over the last 25 years, as measured by the number of 10km squares occupied by breeding birds of the species concerned. Species listed as globally threatened by Birdlife International and those with a historical decline in the UK between 1800 and 1995 (without evidence of recovery) are also included. BoCC Amber List criteria for breeding birds are those which have experienced a moderate decline of between 25% and 49% of population and / or range over the last 25 years. Species of European conservation concern and those with a historical decline but which are currently recovering are also included.

Vol 14 Table D.3 Terrestrial ecology – species and numbers of wintering waterbirds recorded during monthly wintering bird surveys

Species name	Latin name	Conservation designation[iii]	Monthly wintering waterbird counts					
			January 2011	February 2011	March 2011	October 2011	November 2011	December 2011
Cormorant	*Phalacrocorax carbo*	None	6	22	2	-	4	TBU[iv]
Grey heron	*Ardea cinerea*	None	1	1	-	-	2	TBU
Canada goose	*Branta canadensis*	None	7	3	4	-	-	TBU
Mandarin	*Aix galericulata*	None	-	-	1	-	-	TBU
Gadwall	*Anas strepera*	Amber List	4	-	-	-	-	TBU
Mallard	*Anas platyrhynchos*	Amber List	1	7	7	4	6	TBU
Moorhen	*Gallinula chloropus*	None	2	3	3	-	-	TBU
Coot	*Fulica atra*	None	2	1	3	-	1	TBU
Black-headed gull	*Chroicocephalus ridibundus*	Amber List	83	78	8	20	68	TBU
Common gull	*Larus canus*	Amber List	4	5	2	6	14	TBU
Lesser black-backed gull	*Larus fuscus*	Amber List	-	5	4	3	1	TBU

[iii] A species that is listed in the following publications:

Batten, L.A., Bibby, C.J., Clement, P., Elliot, G.D. & Porter, R.F. (1990). *Red Data Birds in Britain*. T. & A.D. Poyser, London.

Commission of the European Communities (1979). Council Directive 79/409/EEC on the Conservation of Wild Birds. *Official Journal of European Communities, L103*.

Holliday, M & Rare Breeding Bird Panel (2011). Rare Breeding Birds in the United Kingdom in 2009. *British Birds*, 104, 9, 476-537.

Royal Society for the Protection Birds (2009). *Birds of Conservation Concern 3*. RSPB, Sandy.

United Kingdom Biodiversity Action Plan Steering Group (2011). *United Kingdom Biodiversity Action Plan* http://jncc.defra.gov.uk/page-5163 [10.11].

[iv] TBU = survey visit to be undertaken.

Species name	Latin name	Conservation designation[iii]	Monthly wintering waterbird counts					
			January 2011	February 2011	March 2011	October 2011	November 2011	December 2011
Herring gull	*Larus argentatus*	Red List UK BAP Priority List	3	4	2	35	16	TBU

Black redstart surveys

D.1.21 A total of five back redstart surveys were undertaken between 20 May and 12 July 2011 by an experienced ornithologist, for a minimum of three hours each during the early morning period and when weather conditions were suitable, as detailed below in Vol 14 Table D.4.

Vol 14 Table D.4 Terrestrial ecology – weather conditions for black redstart surveys

Date	Weather conditions
20 May 2011	11°C, light breeze, 25% cloud cover, dry
10 June 2011	9°C, light breeze, 100% cloud cover, dry
21 June 2011	15°C, south–westerly wind, 100% cloud cover, dry
28 June 2011	20°C, light breeze, 50% cloud cover, dry
12 July 2011	27°C, east-north-easterly wind, 75% cloud cover, dry

D.1.22 Black redstart was not recorded within the proposed works area during the five survey visits. However, a single black redstart was recorded on 21 June 2011 at the end of Cringle Street (approximately 350m west of the proposed works area) near Battersea Power Station, which is indicated on Vol 14 Figure 6.4.5 (see separate volume of figures).

Invasive plants survey

D.1.23 The invasive plant survey was undertaken on the 2 August 2011 by an experienced ecologist. The results of the survey are shown on Vol 14 Figure 6.4.6 (see separate volume of figures). No invasive plant species were recorded during the survey.

Interpretation

Bats

D.1.24 The survey area is used by a large number of common pipistrelle as a foraging and commuting site. Other bat species are also using the site although much more infrequently.

D.1.25 Peak activity of common pipistrelle was observed on 6 May with 420 bat passes recorded. The majority of calls occurred later in the night between midnight and dawn, with only a small number of calls within an hour of dawn. The number bat passes recorded over the three survey nights indicated that habitats in this area may be important to local populations of common pipistrelle.

D.1.26 Soprano pipistrelle was recorded on three occasions, noctule on two occasions and Nathusius' pipistrelle also on two occasions. Each of the three species was only recorded on one survey night. None of the records were close to sunrise or sunset, and therefore it is considered unlikely that any of these species are roosting close to the survey area. It is considered that due to the low numbers of bat passes recorded, that this

was the result of an individual bat foraging and/or commuting through the survey area.

D.1.27 There was a noticeable difference in the level of activity on the first survey night and the two subsequent survey nights. The most noticeable difference is seen with common pipistrelle with a peak activity count of 420 on 6 May and 122 on 8 May. This variability between survey nights is likely due to variations in weather conditions, variability in the invertebrate foraging resource and local roost usage.

D.1.28 At location two and three no bats were recorded. The buildings in this part of the site are sub-optimal for roosting bats and the area lacks vegetation that would support invertebrates that would be used for foraging. The buildings are also set back from the River Thames where activity associated with the use of the river as a corridor for commuting bats was recorded.

D.1.29 From the number of bat passes recorded within an hour of sunrise and sunset, in addition to the lack of bat activity recorded during the dawn bat activity survey, it is considered unlikely that bats are roosting close to the survey area.

Wintering birds

D.1.30 Of the 12 waterbird species recorded within the survey area, six are of nature conservation importance and are included in the Birds of Conservation Concern Red or Amber List and/or UK BAP Priority Species: gadwall, mallard, black-headed gull, common gull, lesser black-backed gull and herring gull.

D.1.31 Within the survey area, the foreshore was used for foraging by gadwall, mallard, black-headed gull, common gull, lesser black-backed gull and herring gull. The jetties and moored house boats were used as resting sites by gulls and cormorants.

Black redstart

D.1.32 Black redstart was not recorded within the proposed works area during five survey visits that were undertaken during the species breeding season.

D.1.33 A male black redstart was located singing 100m west of the proposed works area near Battersea Power Station on 21 June 2011. It is likely that this was a breeding bird from Battersea Power Station where this species is known to regularly nest, including a pair reported from the Power Station on 5 June 2007 (London Natural History Society, 2007)[2], (Battersea Power Station, 2009)[3].

Invasive plants

D.1.34 No invasive plant species were recorded within or in the immediate vicinity of the proposed development site.

References

[1] Royal Society for the Protection Birds. *Birds of Conservation Concern 3*. RSPB, Sandy (2009).

[2] London Natural History Society. *London Bird report.* London Natural History Society (2007).

[3] Battersea Power Station. *Battersea Power Station – A new energy for London: Environmental Statement for Outline Planning Application.* Battersea Power Station (July 2009).

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.14**

Volume 14: Kirtling Street appendices

Appendix E: Historic environment

APFP Regulations 2009: Regulation **5(2)(a)**

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Thames Tideway Tunnel

Environmental Statement

Volume 23 Kirtling Street appendices

Appendix E: Historic environment

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Appendix E: Historic environment

E.1 Gazetteer of known heritage assets

E.1.1 Details of known heritage assets within the assessment area are provided in Vol 14 Table E.1 below, with their location shown on the historic environment features map (Vol 14 Figure 7.4.1, see separate volume of figures).

E.1.2 All known heritage assets within the assessment area are referred to by a historic environment assessment (HEA) number. Assets within the site are referred to (and labelled in the historic environment features map) with the prefix 1, e.g., **HEA 1A**, **1B**, **1C**. References to assets outside the site but within the assessment area begin with 2 and continue onwards, e.g., **HEA 3**, **4**, **5**.

Vol 14 Table E.1 Heritage environment – gazetteer of known heritage assets within the site and assessment area

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
1A	The location of a 17th century windmill or post mill, recorded as demolished by 1828.	MLO12012 031474
1B	The location of T. & W. Farmiloe's Nine Elms Lead Works, established in 1886 which became paint works in the early 20th century.	MLO64086 800014
1C	Thames Foreshore. The location of a pontoon with navigation light, in the northern part of the site between Middle Wharf and Cringle Wharf.	SZID 4860000061 47117
1D	North–south brick wall with buttresses on the eastern façade, probable surviving 19th century and wall of part of Farmiloe complex of buildings.	---
1E	Thames Channel, the approximate findspot, probably in the early 20th century, of a Neolithic flint axe.	MLO14603 100063
1F	Battersea Borough Council (1900-1965) electricity supply box with a decorative panel and finial.	---
1G	Thames foreshore jetty: late 20th century raised concrete deck above foreshore with mainly steel and concrete piled foundations and fenders and dolphins. Linked to riverside by a concrete and metal walkway and conveyor belt. Used for the transportation of building industry materials such as cement and aggregates.	529500 177645

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
2	The former Southwark and Vauxhall Water Works Company pumping station (Battersea Water Works), Cringle Street, SW8. Standing building recording carried out here by CgMs Consulting in 2003 on buildings dating from 1839–40 to 1856, with additions to c. 1930. The engine house (**HEA 17**) is Grade II Listed. See also **HEA 9**.	BWK03
3	Battersea Power Station and South Lambeth Goods Yard. Archaeological evaluation of 37 test pits and 4 archaeological test pits, and monitoring of geotechnical work, by Sutton Archaeological Services in 1997. Construction of the former reservoirs and subsequent power station had removed archaeological remains in most areas, but significant exceptions lay to the south and southeast of the power station where the natural gravel terraces were found to have survived up to 103m above tunnel datum (ATD), the equivalent of 3m above Ordnance Datum (OD). The eastern test pits revealed worked alluvial soils probably derived from the pre-1862 market gardens of the area. Boreholes produced evidence for a possible ancient river channel running west-east parallel to the Thames that silted up and allowed peat formation, or the maximum southern extent of the River Thames at this point. Environmental evidence of the prehistoric to late-Saxon period was recovered.	KTS97
4	Battersea Power Station and Wharf. Standing building recording of the Grade II* listed Battersea Power Station (**HEA 16**) was carried out by CgMs Consulting in 2005.	BPX05
5	Post Office Way, Ponton Road, Nine Elms Lane. Archaeological watching brief by Pre Construct Archaeology (PCA) on a geotechnical investigation in 2008. Alluvium above natural gravels or, in the south of the site, brickearth, was overlain by 16th/17th century agricultural soil. Towards the centre of the site the foundations and a basement or cellar, probably part of the 19th century brewery that was situated in the area, were recorded above the earlier deposits. On the northeast edge of the site was an undated structure cut into the natural gravel and sealed by a layer of 18th/19th century made ground, whilst towards the north side an 18th/19th century well or cesspit was recorded. Modern made-ground sealed the site.	PNO08 MLO100457 MLO100463

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
6	Former burial ground and site of St. George's Church, Nine Elms Lane. The church was built in 1828, altered and extended in 1874 and seriously damaged during World War II. It was closed in 1953 following bomb damage in 1940 and destroyed by fire in 1960. The burial ground of the church was noted in Mrs Basil Holmes's 1896 survey of London's Burial Grounds as closed, and very neglected, with few gravestones (Holmes, 1896)[1].	---
7	Late 19th/early 20th century four storey warehouse, brick wall and entrance with brick gate posts.	---
8	A building known as Manor House is shown on the Ordnance Survey 1st edition map of 1874, and the site of 'Manor House Wharf' is shown on subsequent Ordnance Survey maps and noted in the GLHER: no further details are given, and no medieval house has been identified from other sources.	MLO3284 020779
9	Battersea Water Pumping Station (Southwark and Vauxhall Water Works). Operational c. 1839–1925. The boiler house, stores and workshops, standpipe tower and chimney stood to the rear of the pumping station. The reservoir and filter beds of the waterworks were sold by the Metropolitan Water Board for Battersea Power Station.	MLO65779–83 MLO 19935 800111
10	Battersea Power Station (west side). A Bronze Age socketed spearhead was found here by chance in 1865 during construction of the filter beds.	MLO13093 031272
11	Battersea Water Works. A possibly Mesolithic or Neolithic stone axe was found here by chance in 1889.	MLO10454 031183
12	Thames Channel, off Pimlico. The remains of a Mesolithic axe were discovered by chance on the foreshore, to the north of the site.	MLO26771 112010
13	Thames Channel, off Pimlico. The remains of a Mesolithic axe were discovered by chance on the foreshore, to the northeast of the site.	MLO14575 100018
14	Thames Foreshore, Nine Elms. Metal detector findspot at William Henry Wharf, Battersea, of an undated finger ring recorded by the Portable Antiquities Scheme (PAS).	MLO100036

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
15	Chance find of a medieval token recorded by the PAS.	LON-D97713
16	Battersea Power Station. Grade II* listed building.	1357620
17	Battersea Water Pumping Station. Grade II listed. Now disused. Extended two bays in 1846, and lower west end 1856 by John Aird, for the Southwark and Vauxhall Water Company.	1226087
18	Railway Bridge (Southern Region). Grade II listed.	1065548
19	A pontoon with navigation light located on the Thames foreshore, to the east of the site.	SZID 4860000061 47423
20	Three pontoons/boats on the Thames foreshore, within the site of the former Nine Elms Tide Mill Dock, to the east of the site.	SZID 4860000061 48599/9006/ 6424
21	A pontoon, adjacent to the riverbank on the Thames foreshore, to the east of the site. The Battersea Barge, an early 20th century ship, converted into a bar and restaurant, is moored against it.	SZID 4860000061 47284
22	A pontoon adjacent to the northern (Pimlico) riverbank on the Thames foreshore, to the northeast of the site.	SZID 4860000061 48962
23	Two pontoons moored in the Thames channel, adjacent to Nine Elms riverbank, near Vauxhall to the northeast of the site.	SZID 4860000061 48257/7747
24	An unspecified obstruction on the Thames foreshore, Nine Elms riverbank, near Vauxhall.	SZID 6370000011 35744
25	Thames Foreshore, Pimlico riverbank. A post-medieval artefact scatter, including nails, staples and crucible fragments.	FWM01 A112
26	Three post-medieval mooring posts on the Thames foreshore, Pimlico riverbank.	FWM01 A113
27	Thames foreshore, Pimlico riverbank: a post-medieval dock entrance, sealed with large square stone blocks.	FWM01 A114

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
28	Thames foreshore, Pimlico riverbank: a possible riverfront defence or cofferdam consisting of a line of large, squared, close-set piles which appear to predate the 19th century river wall. May be associated with the construction of the embankment.	FWM01 A116
29	Thames foreshore, Pimlico riverbank: a post-medieval dock entrance.	FWM01 A115
30	Thames foreshore, Pimlico riverbank: a possible post-medieval tide gauge (a metal marker on a timber and concrete platform) and a possible barge bed consisting of a double line of small stakes, high on the foreshore.	FWM01 A117
31	Thames foreshore, Pimlico riverbank: 19th century brick landing steps contemporary with the river wall.	FWM02 A101
32	Thames foreshore, Pimlico riverbank: a possible barge bed, consisting of a large squared timber lying horizontal and almost parallel to the river wall.	FWM02 A102
33	Thames Foreshore, Pimlico riverbank. Covered dock entrance. A packed timber raft forms the bottom of the dock entrance.	FWM02 A103
34	Thames foreshore, Pimlico riverbank: a brick-built flood defence with a straight joint visible between two phases of building.	FWM02 A105
35	Thames foreshore, Pimlico riverbank: a possible causeway of timber and concrete with no associated stairs.	FWM02 A106
36	Thames foreshore, Pimlico riverbank: a possible barge bed consisting of a rubble surface and mooring chain.	FWM02 A107
37	Thames foreshore, Pimlico riverbank: a hard, possibly a barge bed, consisting of close set, vertical planks at an angle to the river wall, with one large squared pile adjacent.	FWM03 A101
38	Thames foreshore, Pimlico riverbank: a possible barge bed, consisting of a line of small vertical piles and stone rubble.	FWM03 A102
39	Thames foreshore, Nine Elms riverbank to the east of the site: a possible crane base or mooring feature consisting of a timber shuttered box with concrete.	FWW17 A107
40	Thames foreshore, Nine Elms riverbank, to the east of the site. A possible crane base or mooring feature. A timber shuttered box with concrete and stone slabs.	FWW17 A108

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
41	Thames foreshore, Nine Elms riverbank, to the east of the site: a possible consolidation deposit of cobble-sized rocks.	FWW17 A109
42	Thames Foreshore, Nine Elms riverbank, to the east of the site: a post-medieval dock with a sheet-piled entrance.	FWW17 A110
43	Thames foreshore, Nine Elms riverbank, to the east of the site: a post-medieval mooring block of two joined vertical posts.	FWW17 A111
44	Thames foreshore, Nine Elms riverbank, to the east of the site: two post-medieval riverfront defences, one brick-built with buttresses and the other consisting of a line of vertical timbers, reused to form shuttering for concrete.	FWW17 A112 & A113
45	Thames foreshore, Nine Elms riverbank, to the east of the site: a post-medieval outfall drain.	FWW17 A114
46	Thames foreshore, Nine Elms riverbank, to the east of the site: a post-medieval drain of stone rubble and wire.	FWW17 A115
47	Thames foreshore, Nine Elms riverbank, to the east of the site: a post-medieval sheet-piled dock entrance.	FWW17 A116
48	Thames foreshore, Nine Elms riverbank, to the east of the site: a layer of sand.	FWW17 A117
49	Thames foreshore, Nine Elms riverbank, to the east of the site: small exposures of peat/clay deposit.	FWW17 A118
50	Thames foreshore, Nine Elms riverbank, to the east of the site: a post-medieval consolidation layer of concreted gravel.	FWW17 A119
51	Thames foreshore, Nine Elms riverbank, to the east of the site: a stone mooring block.	FWW17 A120
52	Thames foreshore, Nine Elms riverbank, to the east of the site: a post-medieval timber flood defence below concrete.	FWW17 A121
53	Thames foreshore, Nine Elms riverbank, to the east of the site: small exposures of a peat/clay deposit.	FWW17 A122
54	Thames foreshore, Nine Elms riverbank, to the east of the site: a consolidation layer of compacted chalk.	FWW17 A124
55	Thames foreshore, Nine Elms riverbank, to the east of the site: a Thames Discovery Programme survey carried out in 2010 recorded a fish trap on the foreshore, which has been radio-carbon dated to the (Early) Saxon period.	---
56	Line of the Bazalgette Southern Low Level Sewer, constructed c. 1865–68.	---

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
57	The chance find of a post-medieval potsherd recorded by the PAS.	LON-80E617
58	The chance find of a medieval coin recorded by the PAS.	LON-004B64
59	The chance find of a post-medieval vessel recorded by the PAS.	LON-460412
60	The chance find of a post-medieval mould recorded by the PAS.	LON-D23BF7
61	The chance find of two Roman coins recorded by the PAS.	LON-E96487 LON-004E96
62	The chance find of a Roman coin recorded by the PAS.	LON-720153
63	The chance find of a post-medieval coin and a medieval coin weight recorded by the PAS.	LON-E13B96 SUR-EED5C4
64	The chance find of a Roman coin recorded by the PAS.	LON-FC5155
65	Jetty, comprising a rough concrete base on the Thames foreshore with a suspended concrete deck on timber and steel piled foundations with concrete and metal walkways extending further out over the Thames channel. Built between 1947 and 1952. Used to facilitate the transportation of bulk building materials.	529565 177650
66	Nine Elms Pier: Built between 1947 and 1952. Concrete deck suspended above Thames foreshore with piled foundations of steel and concrete and similar materials with boats moored against it.	529400 177640

E.2 Site location, topography and geology

Site location

E.2.1 The northern part of the site is bounded to the south by Cringle Street, to the east by cleared land, and to the west by the Cringle Dock Refuse Transfer Station: it extends out over the Thames foreshore and into the channel. The southern part of the site extends to the south of Cringle Street and is bounded to the west by Kirtling Street, and to the east and south by Nine Elms Lane. The site is located in the northeastern corner of

the London Borough of Wandsworth: it was previously part of the county of Surrey within the parish of St. Mary Battersea.

Topography

E.2.2 The ground on which the majority of the site is situated, on the south bank of the Thames, slopes gently downwards from north to south. Street level is at c. 105.0–105.2m ATD at the northern end of Kirtling Street in the centre of the site, c. 104.2–104.4m ATD to the south at the junction with Cringle Street, and c. 103.9m ATD at the southern end of the site on Nine Elms Lane at the junction with Battersea Park Road. The northern part of the site, situated on the foreshore and within the Thames channel lies at approximately 101.0m ATD, dropping down to 98.0m ATD at the level of low tide. Further north, into the river, the riverbed falls to just above 95m ATD in Cringle Wharf (in the northwestern part of the site) and has been dredged more deeply, to around 94m ATD in Middle Wharf (to the north east).

Geology

E.2.3 All but the southwestern edge of the site is geologically located on alluvium. The southwestern edge, making up approximately 10% of the total site area, lies on a remnant of river terrace that survived erosion within the floodplain at the end of the last cold stage, and is one of two outcrops of Kempton Park Gravels that lie within the floodplain of the Thames in this area, which together form the 'Battersea Eyot' on which Battersea Park is situated. This large 'island' of high gravel is dissected by former channels of the Thames, carved out at the end of the last cold stage of the most recent glacial period (Vol 14 Plate E.15). The site lies between two of these channels, the largest of which to the east of the site is known as the Battersea Channel. Alluvium infills the valleys of both channels which are aligned from southwest to northeast.

E.2.4 The site is located between the confluence of these two channels and the Thames. In the confluence area the mouths of the channels and their alluvial-filled valleys are wide and merge into one another and into the Thames floodplain. The course of a third channel or 'lost river' crossing the terrace to the east joins the floodplain of the Thames in the extreme eastern part of the mouth of the Battersea Channel, approximately 700m to the east of the site. This is the River Effra, a major tributary of the Thames, now culverted but once comparable in size to the Fleet in the City of London (Barton, 1992) [2].

E.2.5 The alluvium and the river terrace represent distinctly different geological areas, where contrasting deposit sequences are likely to exist (Vol 14 Plate E.16). The alluvium, deposited (and periodically eroded) by the Thames over the last 5000 years, is potentially 3.0–4.0m thick on the site. Its lowest part might relate to the Late Glacial and Early Holocene river, preserving archaeological remains and environmental evidence for the Late Upper Palaeolithic and very early Mesolithic when pools, streams and marginal wetland might have existed on the site. Peats recorded at c. 98.7m ATD within the Battersea channel at a site 900m to the south (Vol 14 Plate E.15) have been dated to the early Mesolithic and represent

the development of marshland across the former pools and channels, which silted up as river levels and flow decreased in the Early Holocene (Morley , 2010)[3].

E.2.6 The area in which the site is located would have provided rich natural resources for prehistoric people. With the river channels nearby, the high ground of the gravel terrace is likely to have been attractive as a base for activity. From the Mesolithic until the Bronze Age this area would have remained largely dry although increasingly throughout the late prehistoric and historic period it would have become wet and marshy and subject to periodical flooding until more organized land reclamation was carried out in the later medieval and post-medieval periods.

E.2.7 Although the valley floor would have become dry between a mosaic of pools and stream channels during the Mesolithic and Earlier Neolithic, a combination of human activity, changing climate and rising river levels during prehistory led to the expansion of wetlands in the later prehistoric period. This created areas of thick alluvium and in particular peat deposits, with high potential for palaeo-environmental preservation.

E.2.8 The floodplain became progressively wetter in the area of the site from the Neolithic to the Iron Age, changing from a freshwater to brackish and tidal environment as a result of rising relative sea level (RSL). In contrast, the higher river terrace gravel on which the southwestern part of the site lies probably remained largely dry throughout the Holocene, from the Mesolithic to the modern day. It could well have formed a significant landmark, a peninsula of high, dry ground, protruding into the floodplain and wetlands, which was likely to have been recognised and perhaps exploited by prehistoric people.

E.2.9 British Geological Survey digital data notes a strip of made ground in the northern half of the site, behind the river wall. This probably relates to infill of two 19th century docks at this location, although the docks do not occupy the entire footprint of the area shown as made ground. Either the extent of made ground has been generalised and is not entirely accurate, or there has been additional ground consolidation, perhaps as part of the flood defences.

E.2.10 The only borehole record for the overland part of the site itself (borehole no. TQ27NE531) is antiquated and contradictory and therefore not considered reliable. A cluster of boreholes some 50m to the east of the site over alluvium are, however, modern and detailed and provide useful information as they are in a similar topographic area to that of the site. Where present, alluvium lies between c. 101.1m ATD and 102.4m ATD under c. 4.9m of made ground. The alluvium is described as organic silty clay with pockets of fibrous organic material (peat). In places no alluvium was recorded, which is probably the result of localised dredging or truncation from other human activity. The top of the floodplain Shepperton gravels, which underlie the alluvium undulates between 99.1m ATD and 100.4m ATD.

E.2.11 On the foreshore, next to Cringle Wharf a vibro core (VC6032) records peat from c. 97m ATD and alluvial clays from c. 98.6m ATD. The thickness of the peat is not known but at least c. 1.6m of alluvial deposits exist and

are overlain by 0.4m of foreshore gravels. It would imply that while deposits of archaeological interest might not survive to north of Cringle Wharf and in the deeper parts of the channel they do survive to the south of Cringle Wharf under Historic foreshore deposits. Additionally, no deposits of interest are likely to survive on the northern sides of the Cemex compound jetty (HEA1G) and Nine Elms Pier (HEA66), where dredging has removed deposits to below 96m ATD.

E.2.12 The boreholes drilled within the former Battersea Channel to the south of the site found the gravel surface at c. 97m ATD. This suggests that the Late Glacial and Mesolithic topography, which followed the surface of these gravels, is likely to lie above 99.0m ATD on the river terrace or eyot in the southwest of the site, dipping to below 97m ATD below the floodplain alluvium. This topography forms the approximate lower level at which deposits of archaeological interest might be encountered on the overland part of the site. From the late prehistoric period onwards, RSL rose and the Thames became wider and the floodplain wetter. The alluvial deposits, organic silty clays, could contain abandoned boats and fish traps, as well as palaeo-environmental evidence. Post-medieval features such as barge beds could lie directly upon this alluvium. As the site stretches from the gravel terrace to the Thames there is potential where there has been no dredging for remains from all periods to be recovered.

E.2.13 From the late prehistoric period onwards, RSL rose and the Thames became wider and the floodplain wetter. The alluvial deposits, organic silty clays, could contain abandoned boats and fish traps, as well as palaeo-environmental evidence. Post-medieval features such as barge beds could lie directly upon this alluvium. As the site stretches from the gravel terrace to the Thames there is potential where there has been no dredging for remains from all periods to be recovered.

E.3 Past archaeological investigations within the assessment area

E.3.1 No past archaeological investigations have been carried out within the site itself. In the 1990s, the Thames Archaeological Survey (TAS) carried out walkover surveys (‘Alpha’ surveys), on the foreshore to the east of the site. These recorded post-medieval remains, including flood defences, barge beds, former dock entrances and foreshore consolidation deposits, reflecting the commercial use of the foreshore in the vicinity of the site in the 19th century. Further survey work has been carried out recently on the foreshore by the Thames Discovery Programme (TDP).

E.3.2 Understanding of the site and its surroundings in the prehistoric, Roman and medieval periods is limited in comparison to the post-medieval period, although the historic landscape and survival potential for remains of earlier periods may be better understood in the context of available geoarchaeological information. The number of archaeological excavations or watching briefs carried out in the assessment area is relatively small, and other than environmental evidence only post-medieval remains have been recorded. An archaeological evaluation comprising test pits and boreholes at Battersea Power Station (**HEA 3**), approximately 200m to the

west of the site, revealed that the majority of archaeological remains had been removed by the construction of reservoirs and filtering beds by the Southwark and Vauxhall Water Works in the 19th and 20th centuries. A watching brief on geotechnical boreholes at Post Office Way on Ponton Road (**HEA 5**), c. 340m to the east of the site, recorded evidence of 16th–17th century soils, a 18th–19th century well or cess pit and a basement or cellar which probably belonged to a 19th century brewery.

E.3.3 Standing building surveys have also been carried out within the assessment area. These were in 2003 (**HEA 2**) at the Southwark and Vauxhall Water Works c. 85m to the west of the site, and in 2005 at Battersea Power Station (**HEA 4**), c. 260m to the northwest of the site.

E.3.4 The results of these investigations, along with other known sites and finds within the assessment area, are discussed by period, below.

E.4 Archaeological and historical background of the site

E.4.1 The following section provides a detailed archaeological and historical background for the site. It should be read alongside the research framework presented in Appendix C to Vol 2 Appendix E2, which sets the overall Thames Tideway Tunnel project, and the individual site-specific assessments, within a broader historic environment context (i.e. past landscapes and human activity within such landscapes). It identifies the main route-wide heritage themes, of which the built and buried heritage assets identified within this assessment form a part.

Prehistoric period (700,000 BC–AD 43)

E.4.2 A Neolithic flint axe (**HEA 1E**) was recovered by chance redeposited within the Thames channel, close to the present foreshore, within the northern boundary of the site. This suggests activity on the dry land which would have existed immediately to the north of the site in the Mesolithic and Neolithic periods. There have been no other prehistoric remains recorded within the site.

E.4.3 The majority of the site may have remained dry throughout the earlier prehistoric period (Mesolithic to Bronze Age) and its location, at the confluence of the Thames and the Battersea Channel and on the edge of the Battersea Eyot (Vol 14 Plate E.15) would have provided plentiful fresh water and resources such as fish, eels and reeds, making it an ideal location for hunting, fishing and for gathering building materials. The southwestern part of the site, lying on the Battersea Eyot would have been dryer land, possibly suitable for pasture or occupation throughout this period and may preserve archaeological evidence of activity in the form of residual artefact scatters; *in situ* remains located within buried soil horizons, or as features cut into the natural underlying gravel.

E.4.4 Environmental remains dating to the prehistoric period onwards were recorded in alluvial deposits during archaeological investigations to the west of the site in the vicinity of Battersea Power Station (**HEA 3**). A Mesolithic or Neolithic stone axe was found in 1889 c. 350m to the west of

the site at the Battersea Water Works (**HEA 11**), and a socketed spearhead (**HEA 10**) dating to the late Bronze Age was discovered approximately 360m to the west of the site in 1865 during construction work. Within the wider assessment area two Mesolithic axes (**HEA 12** and **13**) were recovered by chance from the Thames channel, approximately 95m and 115m to the north and northeast of the site respectively.

E.4.5 Rising water levels in the Bronze Age may have made conditions less suitable for settlement, although it is likely that the marshes continued to be utilised for hunting, fishing, and gathering materials (Rippon, 2000)[4]. It is possible that wooden trackways or platforms, as found in other parts of the Lower Thames Estuary, may have been constructed out into the marshes to facilitate access from drier settled islands, or to connect areas of higher ground, although it is difficult to predict the exact positions of such features for the first time. Outside of the assessment area, c. 890m northeast of the site, recording and monitoring of erosion on the Thames foreshore in 1993 revealed a wooden structure together with a sequence of sediments being actively eroded out of the bank at low water. The structure comprised the bases of substantial timber piles set in two irregular rows extending down the foreshore: the timbers were radiocarbon-dated to approximately 1770–1260 BC. Two copper alloy side-looped spearheads of Middle Bronze Age date, and several pieces of worked red deer antler, were also found between two of the piles, which may have been part of a jetty or platform for ceremonial offerings (Sidell et al., 2002)[5].

Roman period (AD 43–410)

E.4.6 The town of *Londinium* was established within a decade of the arrival of the Romans in AD 43, on the north bank of the Thames, approximately 4.2km to the northeast of the site, with a river crossing to the settlement at Southwark, approximately 3.9km to the northeast. The nearest known Roman road to the site lay approximately 1.4km to the southeast. The only known remains dating to the Roman period from the assessment area are chance finds of coins recovered from the river or foreshore and recorded on the Portable Antiquities Scheme (PAS) database. One was found c. 290m to the northeast (**HEA 62**), two were found c. 300m to the northeast (**HEA 61**), and one c. 510m to the northeast (**HEA 64**). It is not known how far these might have moved from their original place of deposition. During this period, the southern part of the site would have lain on dry land suitable for settlement, whilst the rest of the site, following a rise in relative sea levels, would have been marshy, prone to flooding, and unlikely to have been inhabited.

E.4.7 In Battersea Fields, outside the assessment area c. 1km to the southwest of the site, a Roman coffin was found in the late 18th century. A possible Roman anchor, iron spearhead, javelin head or dart, the soles of several shoes, and a sword sheath were also found during the construction of Chelsea Bridge, approximately 550m to the west of the site. The general lack of finds within the immediate assessment area, however, and its unsuitability for occupation suggests that it was not close to Roman settlement. The intertidal marshes could have been exploited for a range

of purposes, although there is currently no evidence for this in the area of the site.

Early medieval (Saxon) period (AD 410–1066)

E.4.8 During this period the southern part of the site would have lain on the higher dry gravel terrace, whilst the northern part lay within low-lying floodplain, and, as in the Roman period, prone to flooding. Although the majority of the land would not have been suitable for settlement, the marshes would have continued to be a source of food and building materials. In 2010, a walkover foreshore survey by the TDP identified a series of parallel stakes c. 145m to the east of the site, interpreted as the remains of a fish trap (**HEA 55**). Three of these timbers have been radiocarbon-dated to the Saxon period with a two-sigma probability range of between AD 550 and 670. Other fish traps could potentially survive along this stretch of the foreshore obscured by the foreshore silts and mud.

E.4.9 Battersea, or 'Patrick-sey', is said to have taken its name from St. Patrick or St. Peter, having formerly belonged to the Abbey of St. Peter at Westminster. St. Mary's Church at Battersea, approximately 2.4km to the west of the site, is known to have existed by the beginning of the 9th century, and archaeological evidence of settlement c. AD 750–800 has been found near the church (Cowie and Blackmore, 2008)[6]. There was also possible Saxon settlement centred on Vauxhall, approximately 1.3km to the northeast of the site. The site therefore lay outside the areas of likely occupation in this period, and was probably marshland that may have been used for pasture.

Later medieval period (AD 1066–1485)

E.4.10 The only known remains dated to this period within the assessment area are recorded on the PAS database. They comprise a coin (**HEA 58**) found in the river c. 450m to the northwest, a coin and coin weight (**HEA 63**) recovered from the river c. 450m to the northeast and a medieval metal token (**HEA 15**) found c. 575m to the northeast. The marshes on which the majority of the site was situated probably began to be reclaimed in stages in this period with the construction of successive river walls (earthen banks) and drainage ditches, enabling the fertile land to be used for pasture and cultivation. Activity associated with the river, boats and fishing would gradually have spread along the riverfront. The site probably continued to lie within open, undeveloped land, but may have been used for access to the river.

E.4.11 The manor (estate) of Battersea, sometimes known as the Manor of Battersea and Wandsworth, had been acquired by the abbey of Westminster by the time of Domesday Book (1086)[7], and in 1225, Battersea was assigned to the monks of Westminster for their maintenance in bread and ale. From an account of the steward of the manor in 1303, it appears that the land was directly farmed by the monks (Victoria County History, 1912)[8].

E.4.12 The site of a manor house of possible medieval date (**HEA 8**) is noted in the GLHER: no further details are given, and the location may be derived

from Ordnance Survey maps from the 1870s onwards, which show a building called 'Manor House' and later mark the site of a manor house. No medieval documentary sources make reference to it. Rocque's map of 1746 (Fig 6), shows several large buildings at what was then the western end of Nine Elms Lane, but does not identify them.

Post-medieval period (AD 1485–present)

E.4.13 In the 16th and 17th centuries, the land northeast of the main settlement of Battersea was a well-known cultivation area due to its fertile soils. Corn mills were established in Battersea Fields by the late 17th century (Victoria County History, 1912)[9], and the GLHER notes the site of a 17th century windmill or post mill (**HEA 1A**) in the northern part of the site, approximately 10m south of the present foreshore. It is recorded as having been demolished by 1828. There were several mills lining the river bank, which was fringed by fields and osier beds.

E.4.14 The earliest map consulted was Rocque's map of 1746 (Vol 14 Plate E.1). It indicates areas of settlement, isolated farms and main roads. The site lay within Battersea Common Field at its northeastern corner; a large area of drained and reclaimed open land which may have been used for pasture. The area to the north of Nine Elms Lane, lying to the east of the site, contained several buildings alongside the river, and may by this time have comprised reclaimed ground raised above the level of the foreshore. The land to the south of Nine Elms Lane was fields used for market gardens, supplying produce to the rapidly growing urban population of London. Lysons, writing in 1792, commented that 'above 300 acres of land in Battersea is occupied by market gardeners' (Lysons, 1792)[10].

E.4.15 In 1771–1772, a wooden bridge which became known as Old Battersea Bridge was constructed approximately 510m to the west of the site (outside of the assessment area). This replaced a ferry between Chelsea and Battersea, and helped to stimulate development in the area during the late 18th and 19th centuries. The area between Vauxhall and Nine Elms to the east and the town of Battersea to the west became a centre of industry and trade (Weinreb et al., 2008)[11].

E.4.16 Greenwood's map of 1824–1826 (Vol 14 Plate E.2) shows the southern part of the site as still lying within open land in Battersea Fields, crossed by footpaths: the fields in c. 1830 consisted of 'an entirely open space, a good deal of it given up to corn and the rest grazing fields' (Victoria County History, 1912)[12]. The northern part of the site includes a series of timber docks, constructed for the transportation of local grain and timber, and the inlet giving access to the Nine Elms Mill Pond constructed in the 1820s on the southeast side of Nine Elms Lane, approximately 150m to the east of the site, south of a tidal mill on the riverfront. A single building with a yard or garden is shown in the site just south of one of the docks, and may have been a house or office. Battersea New Town, which began to be constructed in the 1790s for the housing of the expanding labour force in the area, is shown as a scatter of houses aligned along a small street network, approximately 150m to the southwest of the site.

E.4.17 The mill pond to the southeast of the site was gradually filled in during the 19th century, with part of it converted into a dock for the London Gas Works, constructed by the Gas Light and Coke Company in 1833, approximately 160m to the east of the site. The Southwark and Vauxhall Water Works (**HEA 9**), approximately 75m to the west of the site, were built in 1839 and its filter beds and reservoirs occupied the majority of the western part of the assessment area at this date. Battersea Water Pumping Station (**HEA 17**) formed part of the water works and was located approximately 100m to the west of the site. It was operational between 1839 and 1925 and is now disused.

E.4.18 Stanford's map of 1862 (Vol 14 Plate E.3) shows the southern part of the site as lying within an area of market gardens, with the Battersea Park New Road running across the southwestern end of the site. The low-lying ground of the old Battersea Fields had been artificially raised to allow the Park to be created, and it had opened in 1853. A road (now Prince of Wales Drive) was laid out along its southern edge to a circus at its southeastern corner, from where the Stanford map shows it continuing east across the site to join Nine Elms Lane near the bridge over the mill pond inlet. The road is not shown on later maps and it is possible that it was never completed, or was quickly obliterated by the subsequent development of the new Southwark and Vauxhall Water Works to the west of the site. The timber docks in the northern part of the site had almost all been filled in by this time and wharf buildings now occupied the area, beside the riverfront: one on the eastern edge of the site is named as The Haven. The northwestern part of the site on the Thames frontage continues to be a dock opening off the Thames. To the east of the site is a gas holder of the London Gas Light Company, established in 1833. To the southwest of the site, small streets branching off from Battersea Road are now lined with rows of houses, small buildings with yards, and garden plots. The Church of St. George and its graveyard (**HEA 6**), built in 1828, was located approximately 40m to the southeast of the site.

E.4.19 Bazalgette's Southern Low Level Sewer (**HEA 56**) was constructed beneath Nine Elms Lane outside the southeastern edge of the site in c. 1865–68.

E.4.20 The Ordnance Survey (OS) 1st edition 25":mile map of 1874 (Vol 14 Plate E.4) shows the majority of the site as open ground, with an access road from Nine Elms Lane to The Haven running into the centre of the site, where two relatively small buildings are shown. The former dock in the northwestern part of the site has been infilled. Just outside the eastern edge of the site are the Crown and Victoria Wharfs, and outside the site to the southeast is an additional gas holder of what was by this date the London Gas Works. Also on the south side of Nine Elms Lane, streets of terraced houses had been built around St George's Church (**HEA 6**). To the east of the site, along the riverbank, are works which illustrate the types of industry which in addition to the Gas Works characterised the area, such as the Whiting and Lime Works c. 100m to the east of the site.

E.4.21 Remains related to 19th century commercial docks to the east of the site were recorded by the TAS in the 1990s, including dock entrances (**HEA**

42) c. 350m to the east of the site, on the site of the former Nine Elms Coal Wharf, marked on the OS map of 1874 (Vol 14 Plate E.4), and c. 175m to the east (**HEA 47**). Two post-medieval riverfront flood defences, one of brick, and the other consisting of a line of vertical timber posts (**HEA 44**) were observed c. 160m to the east of the site, adjacent to the former Palace Wharf, also shown on the OS map of 1874. Consolidation layers and possible barge beds (**HEA 50** and **HEA 54**), of uncertain post-medieval date, were also noted along the foreshore, c. 185m and 340m to the east of the site respectively.

E.4.22 By the time of the OS 2nd edition 25":mile map of 1894–1896 (Vol 14 Plate E.5), Kirtling and Cringle Streets had been laid out in the southern part of the site, with what were probably industrial or storage buildings on the street frontages in the centre of the site. The northern part of the site continued as the undeveloped Thames foreshore, with industrial or storage buildings on the wharfside. These included the Nine Elms Lead Works (**HEA 1B**), later known as the Paint and Colour Works. The works were established by T. and W. Farmiloe Ltd at 86–88 Nine Elms Lane (now the northern arm of Kirtling Street), in 1886 and extended across the site to the river wall. Vol 14 Plate E.9 shows part of a brick building which may be one of the earliest surviving parts of the complex, and Vol 14 Plate E.10 shows the distinctive entrance to the Farmiloe complex on Cringle Street. Vol 14 Plate E.11, Vol 14 Plate E.12 and Vol 14 Plate E.13 show parts of the wall of the complex.

E.4.23 The northwestern part of the site is occupied by warehouses to the south, and in the area of the former dock, by tracks or gantries used to move goods. The southern part of the site to the south of Cringle Street was an empty plot of land, with one building in the extreme southern corner of the site.

E.4.24 The OS 3rd edition 25":mile map of 1916 (Vol 14 Plate E.6) shows the northernmost part of the site as open foreshore. Much of the central part of the site is the Farmiloe Paint and Colour Works with additional warehouses to the west. To the south of Cringle Street an engineering works and a public baths have been constructed, with the extreme southern end of the site remaining open with the same building shown on the 1894–1896 map.

E.4.25 The London County Council's Bomb Damage Maps 1939–1945 (not reproduced) show irreparable damage to the northernmost buildings of the Paint and Colour Works within the northern part of the site, as well as less serious damage to the buildings immediately adjacent to the east, to the engineering works within the northwestern part of the site, and to a building in the southern part of the site, next to the public baths.

E.4.26 The OS 25":mile map of 1947 (Vol 14 Plate E.7) shows no major changes to the northeastern and eastern parts of the site, although parts of the paint works may have been rebuilt. The northwestern part of the site was now entirely occupied by a large engineering works. The engineering works to the south of Cringle Street had been demolished, and further buildings have been constructed within the southern part of the site, including what may be a petrol filling station and garage. Outside the site

c. 300m to the west a major development had taken place in the construction of 'Station A' of the Battersea Power Station (**HEA 16**), marked 'Electricity Works' on the map: Station B, located to the southeast of Station A, was not completed until 1953. The power station is now a Grade II* listed building and was fuelled using cranes on a jetty on the Thames bank to unload coal from barges into a large underground store.

E.4.27 The OS 1:1250 scale map of 1952 (Vol 14 Plate E.8) shows a new, possibly rebuilt, warehouse in the location of the previously bomb-damaged building in the northern part of the site, with no major changes to the layout of the works. In the southern part of the site, the baths and works buildings have been demolished and a car park, garage and transport depot constructed. Outside the site to the southeast the gas works had been demolished.

E.4.28 Post-1950s OS maps (not reproduced) show no major changes to the site itself, although the area of the paint works in the northeastern part of the site was eventually redeveloped for light industrial units. The present cement works in the northwestern part of the site were built following the demolition of the engineering works warehouse in the 1950s. Over the last 60 years several of the original 1950s warehouse buildings and tanks in the northeastern part of the cement works have been demolished. In the early 1970s New Covent Garden Market, to which the fruit and vegetable market in central London transferred, was established c. 340m to the southeast of the site. The gas works was replaced by a Royal Mail depot. Battersea Power Station had increased to its current size and layout by the end of the 1960s but Station A was shut down in 1975 and Station B in 1983, leaving the complex disused, as it remains today.

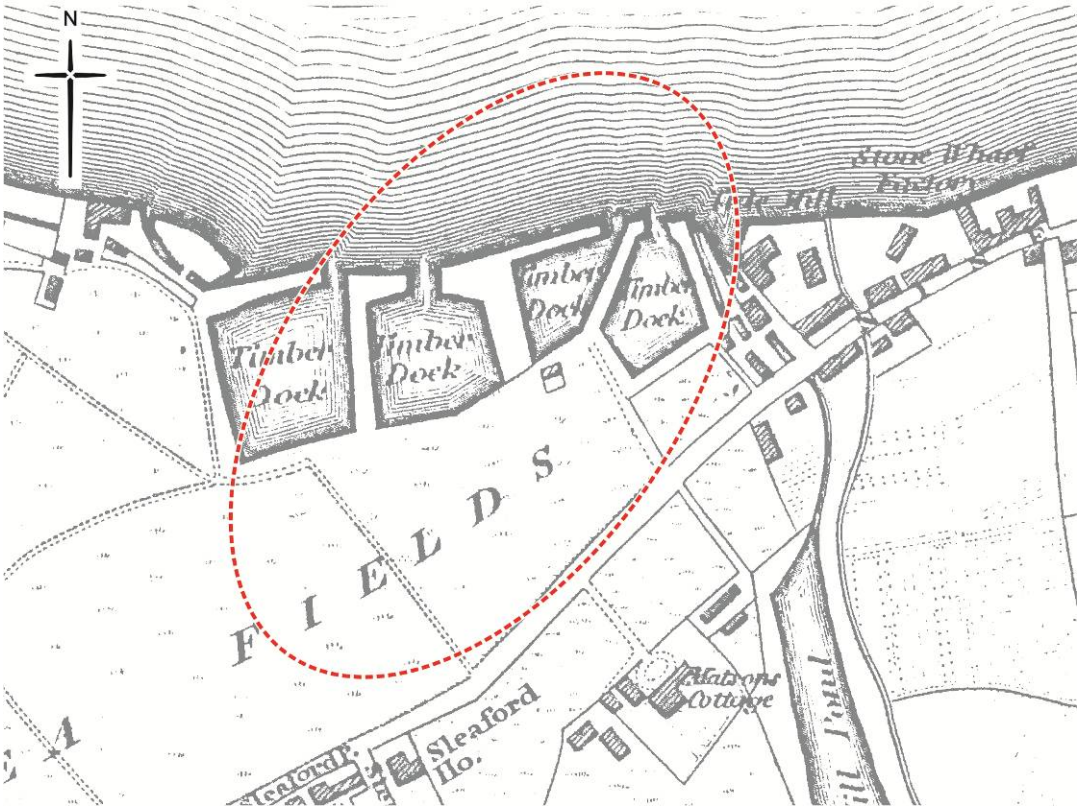
The current site

E.4.29 The northern part of the site, lying within the Thames channel and on the foreshore, contains mooring posts used for tethering barges which are located approximately 10m to the north of the site. A pontoon (**HEA 1C**) lies within the site, adjacent to the river wall, c. 55m to the east of Cringle Wharf. The foreshore to the east and west of the site includes a number of piers and wharves. The riverbank is occupied by a mix of light industrial and residential buildings. Within the site on the riverside above the foreshore there are currently a number of works and warehouse buildings to the north of Cringle Street. The western part of the site is occupied by an aggregates wharf containing an open yard and buildings forming a concrete batching works. To the east, at 88 Kirtling Street, there is a large modern warehouse building. The Securicor Site, occupied by offices and warehouses, lies to the south of Kirtling Street, whilst the southern part of the site contains depot buildings, yards, offices, shops and residential properties fronting the junction of Nine Elms Lane and the approach to Battersea Power Station. In the extreme southern corner of the site (**HEA 1F**: Vol 14 Plate E.14) is an electricity supply box with a decorative panel and finial of the Battersea Borough Council (1900-1965).

E.5 Plates

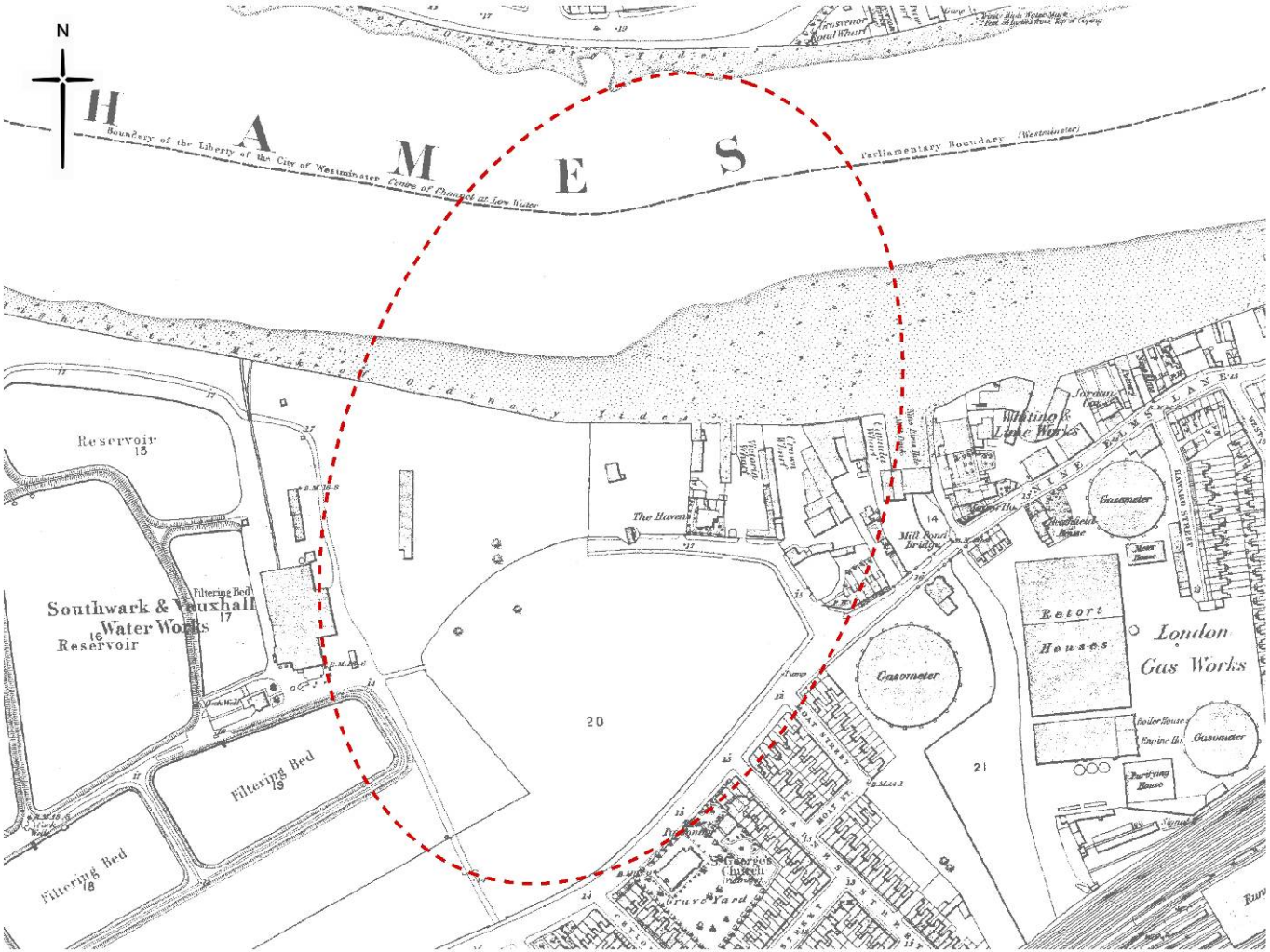
Vol 14 Plate E.1 Historic environment – Rocque's map of 1746

Vol 14 Plate E.2 : Historic environment – Greenwood's map of 1824–1826



Vol 14 Plate E.3 Historic environment – Stanford's map of 1862

Vol 14 Plate E.4 Historic environment – OS 1st edition 25":mile map of 1874 (not to scale)



Vol 14 Plate E.5 Historic environment - OS 2nd edition 25":mile map of 1894–1896 (not to scale)

Vol 14 Plate E.6 Historic environment – OS 3rd edition 25”:mile map of 1916 (not to scale)

Vol 14 Plate E.7 Historic environment – OS 25":mile map of 1947 (not to scale)

Vol 14 Plate E.8 Historic environment – OS 1:1250 scale map of 1952 (not to scale)

Vol 14 Plate E.9 Historic environment – brick built complex of T. & W. Farmiloe Ltd, Est. 1886 on Kirtling Street, this may be one of the earliest surviving parts of the complex; standard lens, looking southwest

Vol 14 Plate E.10 Historic environment – distinctive entrance to the Farmiloe complex; standard lens, from Cringle Street looking north-east

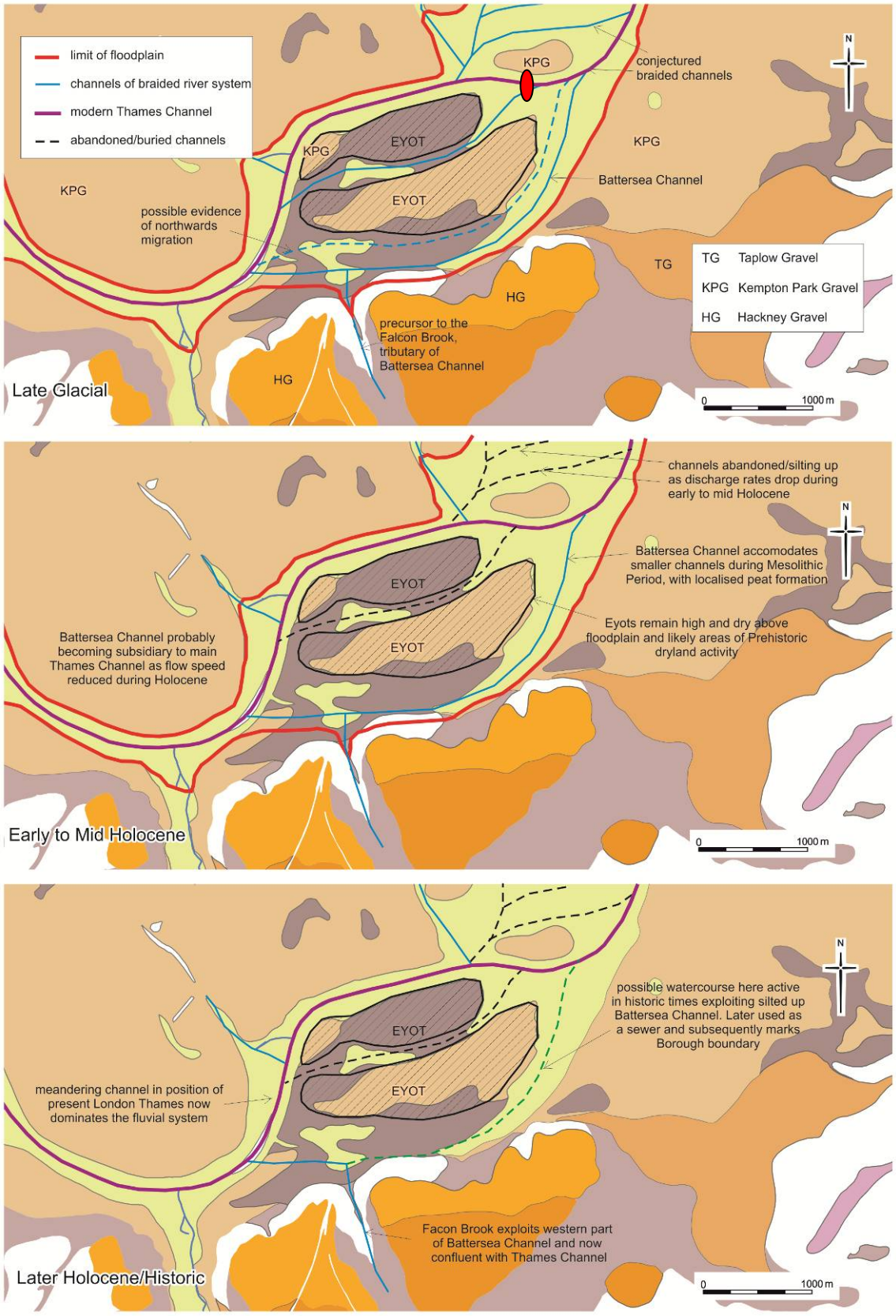
Vol 14 Plate E.11 Historic environment – blocked entrances to the Farmiloe complex (south wall); standard lens, from Cringle Street looking east

Vol 14 Plate E.12 Historic environment - blocked windows/doorway of the Farmiloe complex east wall; standard lens, from the corner of Cringle Street and Kirtling Street looking north

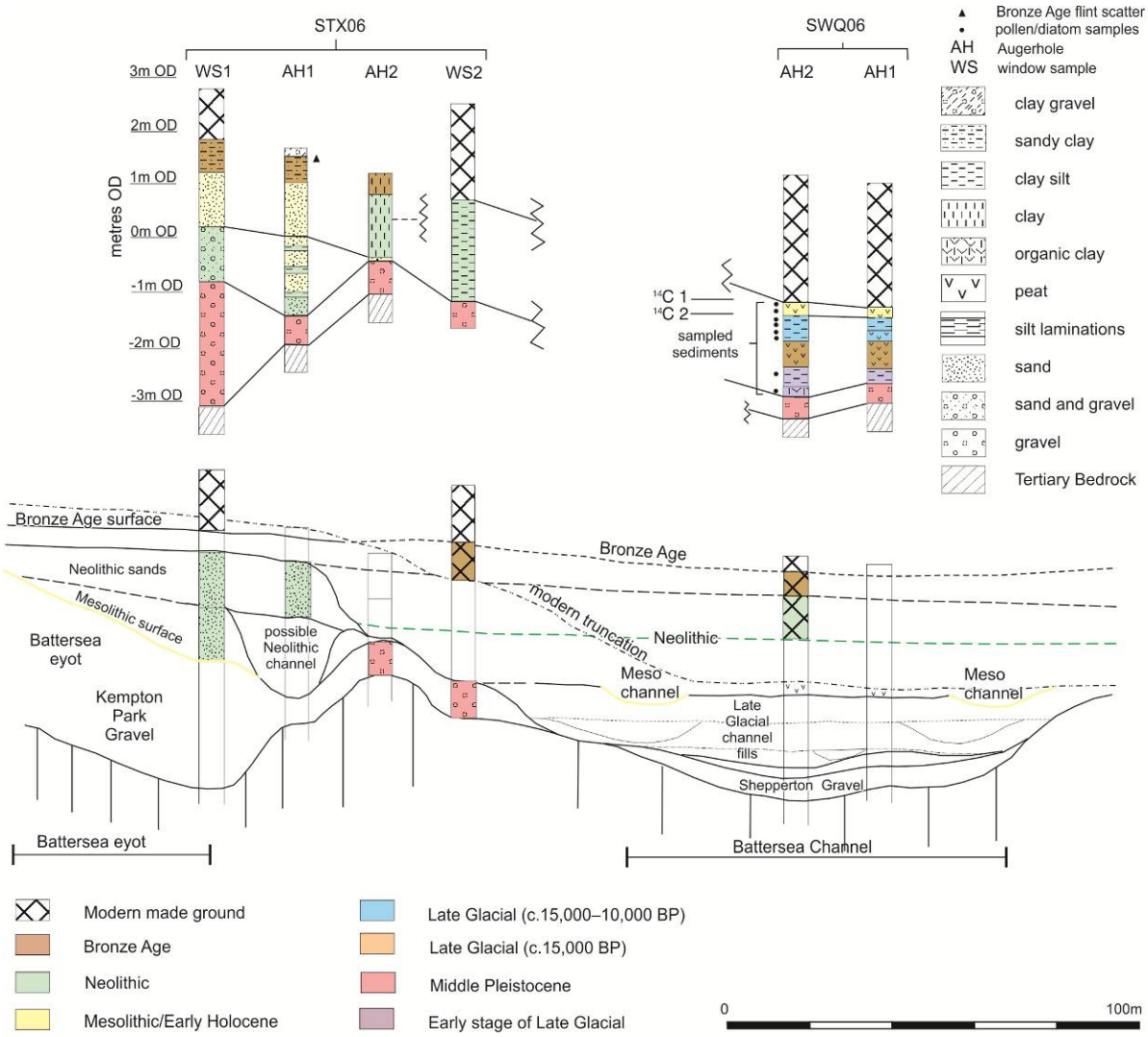
Vol 14 Plate E.13 Historic environment – east façade of the former warehouse wall close to the river likely to be associated with the Farmiloe complex; standard lens, looking south

Vol 14 Plate E.14 Historic environment – Early electricity supply box with decorative panel and finial (HEA 1F); standard lens, looking north-west on the corner of the junction between Kirtling Street, Nine Elms Lane and Battersea Park Road

Vol 14 Plate E.15 Historic environment – The distribution of former channels of the Thames and eyots of higher ground in the vicinity of the site (Fig 5 from Morley 2009/10[13]). The site is located roughly in the position of the red oval.



Vol 14 Plate E.16 Historic environment – indicative section through the deposits likely to exist on the site from the river terrace remnant in the southwest (similar to site 'STX06') and the floodplain alluvium (similar to site'SWQ06'), as found 100m south of the site (Figure 4 in Morley 2009/10[14])



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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.14**

Volume 14: Kirtling Street appendices

Appendix F: Land quality

APFP Regulations 2009: Regulation **5(2)(a)**

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Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 14 Kirtling Street site appendices

Appendix F: Land quality

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Appendix F: Land quality

F.1 Baseline report

F.1.1 Baseline data is sourced from:

a. walkover survey

b. the Landmark Information Group database, including historic maps and environmental records

c. stakeholder consultation

d. the initial results from a preliminary intrusive ground investigation.

Site walkover

F.1.1 A site walkover survey of Kirtling Street was undertaken on 25th May 2011.

F.1.2 The aim of the walkover survey was to inspect the condition of the site and surrounding areas in order to identify evidence of historical or ongoing contamination sources, as well as any nearby sensitive receptors.

F.1.3 The site comprises four parcels of land as well as an area extending into the River Thames foreshore within the northern part of the site. The areas are developed with industrial/commercial buildings of varying ages. These include an electrical substation and switch gear facilities, areas for loading/unloading, site parking and an aggregates storage yard associated with the existing ready mixed concrete plant.

F.1.4 A former fuel filling station is located in the southern part of the overall site.

F.1.5 The surrounding area is predominantly industrial/commercial and this type of land-use is present beyond each of the site boundaries. Adjacent sites include Cringle Dock Refuse Transfer Station, a Thames Water Pumping Station, part of the disused Battersea Power Station and Tideway Walk Industrial Estate.

F.1.6 Detailed site walkover notes are provided in Vol 14 Table F.1 below.

Vol 14 Table F.1 Land quality – site walkover report

Item Site Ref (PWH9X, Kirtling Street)		Details
Date of walkover	25th May 2011	
Site location and access	Cringle Street/Nine Elms Lane, London Borough of Wandsworth	
Size and topography of site and surroundings	Record elevation in relation to surroundings, any hummocks, breaks of slope etc.	Site is flat in relation to the surrounding areas. The northern section of the site is located in the foreshore of the River Thames.

Item Site Ref (PWH9X, Kirtling Street)		Details
Neighbouring site use (in particular note any potentially contaminative activities or sensitive receptors)	North	River Thames. There are house boats moored adjacent to the river.
	South	Residential properties are located immediately south of the site, along Kirtling Street. Battersea Service Station is located approximately 200m south of the site. The surrounding area in a southwesterly direction is residential and in a southeasterly direction commercial/industrial.
	East	Tideway Industrial Estate which houses storage sheds.
	West	Cringle Dock Solid Waste Transfer Station. Battersea Power Station and an electrical substation are located immediately adjacent to the western boundary of the site.
Site buildings	Record extent, size, type and usage. Any boiler rooms, electrical switchgear?	The site is presently occupied by four parcels of industrial/commercial land. The north-western block is a concrete batching works which, apart from aggregate transfer structures, is largely free from significant buildings. Adjacent to this is a three storey block with a secure compound at its eastern end. Between Cringle Street and Kirtling Street is a large walled block of buildings with a central yard (no access). The block south of Cringle Street comprises various buildings of different ages; the majority associated with the Cringle Lock Refuse Transfer Station and also includes some warehousing. Electrical switchgear noted.
Surfacing	Record type and condition	Hardstanding
Vegetation	Any evidence of distress, unusual growth or invasive species such as Japanese	No vegetation observed

Item Site Ref (PWH9X, Kirtling Street)		Details
	Knotweed?	
Services	Evidence of buried services?	None observed
Fuels or chemicals on-site	Types/ quantities?	None observed
	Tanks (above ground or below ground)	None observed
	Containment systems (eg, bund, drainage interceptors). Record condition and standing liquids	None observed
	Refill points located inside bunds or on impermeable surfaces etc?	None observed
Vehicle servicing or refuelling onsite	Record locations, tanks and inspection pits etc.	Within the proposed work site area there is a small, general purpose area for loading/unloading and site parking. No evidence of refuelling or servicing was observed across the area however detailed observation was not possible due to access restrictions.
Waste generated/stored onsite	Adequate storage and security? Fly tipping?	None observed
Surface water	Record on-site or nearby standing water	River Thames and associated foreshore.
Site drainage	Is the site drained, if so to where? Evidence of flooding?	None observed
Evidence of previous site investigations	eg trial pits, borehole covers.	None observed.
Evidence of land contamination	Evidence of discoloured ground, seepage of liquids, strong	No obvious indicators of pre-existing or ongoing contamination were identified during the survey.

Item Site Ref (PWH9X, Kirtling Street)		Details
	odours?	
Summary of potential contamination sources		On-site: concrete batching works, various depots and warehousing and possible works buildings and refuse transfer station. Surrounding industrial area including a refuse transfer station, former power station and pumping station.
Any other comments	Eg access restrictions/ limitations	Site access restricted, site observation restricted due to hoarding, site observed from the Thames Path. Site vacant, evidence of recent demolition and stockpiled demolition waste. Other evidence of clearance at adjacent site to the south.

Review of historical contamination sources

F.1.7 Historical mapping (dating between 1875 and 1990) has been reviewed in order to identify potentially contaminating land-uses at the site and within the 250m assessment area.

F.1.8 Vol 14 Table F.2 tabulates the potentially contaminating land-uses, inferred dates of operation and typical contaminants associated with the land-uses in question. Potential contaminants are sourced from CLR8: *Potential contaminants for the assessment of land* (Defra and EA, 2002)[1] and former Department of the Environment industry profiles (Department of the Environment, 2011)[2].

F.1.9 All dates are approximate, where no other information is available the dates relate to when the items first appeared and disappeared from the mapping rather than actual dates of construction, operation or demolition.

F.1.10 Items listed in Vol 14 Table F.2 below are also shown on Vol 14 Figure F.1.1 (see separate volume of figures). In addition, figures illustrating the historical environment of the site and surrounding area are provided in Vol 14 Appendix E.

Vol 14 Table F.2 Land quality – potentially contaminating land-uses

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
On-site			
1	(a) Unspecified industrial/commercial buildings	c1896-c1916	Heavy metals, sulphate, sulphur, asbestos, phenol, aromatic hydrocarbons, poly aromatic hydrocarbons (PAHs), chlorinated aliphatic hydrocarbons, solvents (eg benzene, toluene, ethylbenzene and xylene (BTEX)), oil and fuel hydrocarbons
	(b) Paint and colour works	c1916-c1952	
	(c) Various works and depots	c1952-present	
2	(a) Unspecified industrial/commercial buildings	c1896-c1916	
	(b) Paint and colour works	c1916-c1952	
	(c) Various works and depots	c1952-present	
3	Tank (possibly associated with public baths)	c1916-c1961	Unknown but could have contained chlorine
4	Engineering works	c1916-c1951	Heavy metals, arsenic, boron, free cyanide, nitrates, sulphates, sulphur-, asbestos, aromatic hydrocarbons, PAHs, polychlorinated biphenyls (PCBs), chlorinated aliphatic hydrocarbons
5	Electrical substation	c1951-c1990	Oils, PCBs
6	(a) Garage	c1951-c1961	Heavy metals, oil and fuel hydrocarbons (total petroleum hydrocarbons [TPH], PAHs), degreasers, cutting oils, paints, solvents (chlorinated hydrocarbons and other volatile organic
	(b) Transport depot	c1961-c1990	
7	Garage	c1976-c1990	

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
			compounds (VOCs)
20	Cement works	c1976-c1999	Heavy metals, arsenic, boron, nitrates, sulphates, sulphur, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons, alkali materials, magnesium, paints and dyes
Off-site			
8	(a) Various wharves including Imperial wharf and a Jam Factory (adjacent east)	prior to c1875-c1975	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
	(b) North Thames Gas Board offices (adjacent east)	c1975-c1987	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
	(c) Nine Elms/Tideway Industrial Estate and depot (adjacent east)	c1987-present	Heavy metals, sulphate, sulphur, asbestos, phenol, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, solvents

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
9	Dock including lock and brine mill pond (40m south)	prior to c1875-c1986	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PCBs, PAHs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
10	(a) Lime works (60m southeast)	prior to c1875-c1896	Heavy metals, sulphate, sulphur, asbestos, phenol, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, solvents
	(b) Sewage pumping station (60m southeast)	c1916	Heavy metals, arsenic, free cyanide, nitrates, ammonium, phosphates, sulphates, sulphides, asbestos, oil/fuel hydrocarbons, chlorinated aliphatic hydrocarbons, chlorinated aromatic hydrocarbons, PCBs, pathogens
11	Manor House Wharf and associated wharves (115m southeast)	c1896-c1975	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
12	(a) London Gas Works (15m east)	Prior to c1875-c1976	Benzene, toluene, ethylbenzene and xylenes, phenols,

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
			PAH, cyanide, ammonia, sulphur compounds, arsenic, chromium
	(b) Sorting offices and warehouse (15m east)	c1976-onwards	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
13	New Covent Garden Market (15m southeast)	c1976-present	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
14	Mixed industrial-depot and engineering works (30m south)	c1976-present	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds, heavy metals and asbestos
15	Southwark and Vauxhall Waterworks (including pumping station) (adjacent west)	Prior to c1875-c1938	Heavy metals, arsenic, free cyanide, nitrates, ammonium, phosphates, sulphates, sulphides, asbestos, oil/fuel hydrocarbons, chlorinated aliphatic hydrocarbons, chlorinated aromatic hydrocarbons, PCBs

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
16	Goods depot (10m west)	c1920-c1987	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds, heavy metals and asbestos
17	Various works/engineering works (adjacent south/southwest)	c1920	Heavy metals, sulphate, sulphur, asbestos, phenol, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, solvents
18	Power station (including coal storage area) (135m west)	c1929-c1983 (cease of generation)	Heavy metals, oil/fuel hydrocarbons, ashes, greases, oils, sulphate, sulphur, PAHs, PCBs, dioxins and furans
19	Waste transfer station (adjacent west)	c1986-present	Heavy metals, arsenic, sulphur, asbestos, oil/fuel hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, chlorinated aromatic hydrocarbons, PCBs, dioxins and furans
21	Wharf areas including embarkation shed (132m north)	c1875-c1950	Heavy metals, sulphate, sulphur, asbestos, phenol, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, solvents
22	Engine works including dock (142m north)	c1875-c1950	Phenol, acetone, oil and fuel hydrocarbons,

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
			aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PAHs, metals, semi-metals
23	Garage (156m northeast)	c1952-c1986	Oil and fuel hydrocarbons, paints, solvents, metals
24	(a)Three Bank Distillery and dock (205m northwest)	c1875-c1896	Metals, arsenic, sulphates, sulphur, phenols, oil and fuel hydrocarbons
	(b) Garage (205m northwest)	c1916-c1953	Heavy metals, oil and fuel hydrocarbons (TPH, PAHs), degreasers, cutting oils, paints, solvents
25	Electrical engineering works (191m northwest)	c1951-c1953	Aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs, metals, semi-metals, nitrate, sulphate, sulphur, asbestos
26	Railway (200m southeast)	c1874-present	Asbestos, metals, sulphate, PAHs, chlorinated aliphatic hydrocarbons, PCBs

On-site

F.1.11 The historical mapping has identified a number of previous uses that could be regarded as potentially contaminating, notably two paint and colour works, located at the site between c1916 and c1952, as well as various unidentified works, depots, warehousing, a garage (former fuel filling station) and the existing cement works.

F.1.12 In addition to the above, the historic environment research (see Section 7 and Appendix E of this volume) has identified that item 1 in the above table was also a lead works operated by T.W. Familioe in 1886.

Off-site

F.1.13 Within the 250m assessment area, the historical mapping show numerous industrial and commercial activities, most notably an adjacent refuse transfer station, a former power station to the west and the extensive gas works to the southeast. .

Geology

Data from the Thames Tideway Tunnel project ground investigation indicates the anticipated geological succession, as summarised below.

Vol 14 Table F.3 Land quality – anticipated site geology

Geological unit / strata	Description	Approximate depth below ground level (m)
Made Ground	Granular fill comprising sand and gravel or brick with some fragments of timber. Locally clay soils predominate.	0-4.5
Alluvium	Very soft dark grey mottled black silty clay with many fine to medium gravel sized pockets of black organic clay and silt. Sand can be fine to coarse	4.5-6.0
River Terrace Deposits	Medium dense to dense to dense sand and gravel (predominantly quartz sand and flint gravel).	6.0-7.8
London Clay Formation	Slightly sandy clay.	7.80-39.17
Harwich Formation	Multicoloured slightly calcareous clast supported conglomerate.	39.17-39.82
Lambeth Group (Upper Shelly Beds)	The Lower and Upper Mottled Beds comprise mottled or multicoloured, stiff or very stiff fissured clay, compact silt, and dense or very dense sand. The Upnor Formation is a fine grained glauconitic sand.	39.82-41.02
Lambeth Group (Upper Mottled Beds)		41.02-44.42
Lambeth Group (Laminated Beds/Lower Shelly Beds)		44.42-47.02
Lambeth Group (Lower Mottled Beds)		47.02-53.12
Lambeth Group		53.12-54.12

Geological unit / strata	Description	Approximate depth below ground level (m)
(Lower Mottled Beds-gravel)		
Lambeth Group (Upnor Formation)		54.12-57.01
Thanet Sand Formation	Generally dense glauconitic silty fine sand with occasional rounded flint gravel. The Bullhead Beds which mark the base of the formation comprise green stained gravel and cobbles of flint.	57.01-66.5
Chalk Group	Weak fine grained limestone with nodular and tabular flints.	66.5 – unproven

Unexploded ordnance

F.1.14 During both World War I and II, the London area was subject to bombing and in some cases bombs failed to detonate on impact. During construction works unexploded ordnance (UXO) are sometimes encountered and require safe disposal.

F.1.15 A desk based assessment for UXO threat was undertaken by 6 Alpha Associates Limited at the Kirtling Street site[3]. The assessment covered two areas within the Kirtling Street site (Area A – land aspect of the main work area and Area B – foreshore and river of main work area). The report reviews information sources such as the Ministry of Defence (MoD), Public Records Office and the Port of London Authority (PLA).

F.1.16 Taking into account the findings of this study and the known extent of the proposed works at the Kirtling Street site, it was considered that within Area A there is an overall medium/high threat from UXO and within Area B there is a high threat from UXO.

Thames Tideway Tunnel ground investigation data

2009 investigation

F.1.17 This section summarises the portion of the project wide ground investigation undertaken in the Kirtling Street area by the Thames Tideway Tunnel project in 2009 [4].

F.1.18 Although the investigation was primarily for geotechnical purposes, samples from the boreholes were tested for the presence of common contaminants to obtain preliminary information on the contamination status of soils and groundwater in the area.

F.1.19 The nearest boreholes drilled as part of the investigation (borehole references PR1081, SA1084 and SR1083) were undertaken approximately 50m to the east of the proposed development site, as shown on Vol 14 Figure F.1.2 (see separate volume of figures).

F.1.20 The boreholes were tested for the presence of contaminants in soils and groundwater. The results are summarised in paras. F.1.21 to F.1.22 below.

F.1.21 Vol 14 Figure F.1.2 (see separate volume of figures) also identifies a number of other boreholes excavated in the vicinity of the site, these are not considered relevant to the contamination status of the site, either due to their distance from the proposed shaft location or because certain boreholes were excavated purely for geotechnical purposes.

Soil contamination testing

F.1.22 Laboratory soil contamination testing was undertaken on: one sample of Made Ground and two samples of Alluvium from borehole PR108; two samples of Made Ground and one sample of Alluvium from borehole SR1083; and two samples of Made Ground from SA1084.

F.1.23 The Made Ground in the boreholes was recorded to contain a proportion of ash and clinker which is commonly a source of PAHs.

F.1.24 The contamination testing suite included the following contaminants: heavy metals and metalloids, PAHs, TPH, VOCs, phenols, cyanide, ammoniacal nitrogen, pH and soil organic matter content.

F.1.25 The testing recorded concentrations of the potential contaminants that were typical of soils in an older urban setting (eg, some detectable PAHs and TPH). The testing did not however record contaminants above generic human health screening values[5,6] for light industrial land-use. These screening values consider risks to workers in the long term assuming that some open amenity space is provided.

F.1.26 See Volume 2 Environmental assessment methodology for full guidance on the benchmarks used.

Soil gas testing

F.1.27 No soil gas testing has been undertaken for the Kirtling Street site and no soil gas testing has been undertaken on boreholes located to the east of the site.

Sediment quality testing

F.1.28 No sediment quality testing has been undertaken on the foreshore of the River Thames at the Kirtling Street site.

Groundwater contamination testing

F.1.29 Samples of groundwater were taken from PR1081, SA1084 and SR1083, respectively.

F.1.30 The testing showed groundwater in the vicinity of the site has been impacted by metals, PAHs and hydrocarbons, notably, benzene and nickel in borehole PR1081 and benzene, arsenic and benzo(a)pyrene in borehole SA1084 and PAHs within borehole SR1083.

F.1.31 Refer to Section 13 Water resources – groundwater of this volume for further information.

2012 investigation

F.1.32 An additional investigation was undertaken on behalf of the project by Structural Soils in 2012 [7].

F.1.33 The investigation covered the area on-site to the south and east of Kirtling Street (in the approximate areas of polygons 2 and 3 as shown on Vol 14 Figure F.1.1 (see separate volume of figures)).

F.1.34 The investigation comprised the drilling of five boreholes by cable percussive techniques and four boreholes by window sampler techniques. The maximum depth of the investigation was 10.5mbgl (terminating in the London Clay Formation).

Soil contamination testing

F.1.35 Five soil samples were analysed for arsenic, cadmium, total chromium, lead, mercury, selenium, boron (water soluble), copper, nickel, zinc, PAHs, volatile petroleum hydrocarbons/extractable petroleum hydrocarbons (VPH/EPH) including BTEX, speciated phenols, total cyanide, sulphide (acid soluble), sulphate (water soluble) and pH.

F.1.36 Six soil samples were analysed for arsenic, cadmium, total chromium, lead, mercury, selenium, boron (water soluble), copper, nickel, zinc, polyaromatic hydrocarbons (total), hexavelent chromium, free cyanide, total sulphate, sulphide, total sulphur, pH and phenols.

F.1.37 Five soil samples were analysed for arsenic, cadmium, total chromium, lead, mercury, selenium, boron (water soluble), copper, nickel, zinc, PAHs, hexavalent chromium, free cyanide, total sulphate, sulphide, total sulphur, pH, phenols and thiocyanate.

F.1.38 The following additional tests were carried out on selected soil samples:

a. 6 for TPH including BTEX
b. 2 for speciated PCBs (World Health Organisation 12 compounds).
c. 2 for total phenols
d. 2 for free cyanide, 1 for total cyanide and 5 for complex cyanide
e. 6 for VOCs.

F.1.39 The testing recorded that the individual results for the above contaminants were all below the generic assessment criteria (GAC)/contaminated land exposure assessment soil guideline values (CLEA SGV) for a commercial end-use, with the exception of the following:

a. 2 lead results exceeded the guideline of 750mg/kg. These are 942mg/kg in BH1at 2.5m (possible Made Ground) and 990mg/kg in BH4 at 1.2m (Made Ground).
b. 2 benzo(a)pyrene results exceeded the guideline of 14mg/kg. These are 45.3mg/kg in BH4 at 1.2m (Made Ground) and 299mg/kg in WS4 at 0.5m (Made Ground).
c. 3 other PAHs also exceeded the SGV's: Benzo(a)anthracene, Dibenzo(ah)anthracene and Indeno(123-cd)pyrene in WS4 at 0.5m (Made Ground).

F.1.40 All VOC and PCB results were below detection limits.

F.1.41 The report advises that given the proposed work/usage for the site these results are not considered significant.

F.1.42 No fibres indicating potential asbestos presence were identified in the one sample subjected to detailed inspection. Furthermore, the laboratory did not report finding any potential asbestos containing material (ACM) during the preparation of all other samples for other contamination testing. The site works and logging of the exploratory holes showed no evidence of ACM .

Soil gas testing

F.1.43 Gas monitoring visits were carried out on six occasions, the 22nd, 24th and 28th February and the 6th, 13th and 20th March 2012.

F.1.44 The following ground gas parameters have been recorded over these six gas monitoring rounds:

a. maximum initial methane concentration of 0.1% by v/v in air (BH1, well response zone in made ground)

b. a maximum initial flow rate of 0.0 l/hr

c. maximum steady state concentration of carbon dioxide 4.4% v/v in air (BH2)

d. a maximum steady state flow rate of +/- 0.1 l/hr (but zero in most holes on most visits).

F.1.45 The report advises that the results indicate characteristic situation CS1 which requires no gas protection to new buildings on the site.

Groundwater contamination testing

F.1.46 Very low concentrations of PAH compounds were recorded in comparison with the assessment criteria used (GAC derived by RSK Group). The groundwater testing did not record any other notable contamination.

Third party ground investigation data

F.1.47 No third party ground investigation data was available for review for the Kirtling Street site.

Other environmental records

F.1.48 Details of environmental records (hazard and waste sites) in the vicinity of the site held by the Environment Agency (EA) and other bodies have been obtained from the Landmark Information Group and are presented in Vol 14 Table F.4. Pertinent records are discussed in further detail below.

F.1.49 The location of these records is shown on Vol 14 Figure F.1.3 (see separate volume of figures).

Vol 14 Table F.4 Land quality – hazard and waste sites

Item	On-site	Within 250m of site boundary
Active integrated pollution prevention and control	0	0
Control of major accident hazard sites	0	0
Historical landfill site	0	1
LA pollution prevention and control	1	3
Licensed waste management facility	0	1
Notification of installations handling hazardous substances	0	0
Past potential contaminated industrial uses	Areas of past potential contaminated industrial uses are present on-site and within 250m.	
Pollution incident to controlled water*	0	3
Registered waste transfer site	0	2
Registered waste treatment or disposal site	0	0

**Does not include regular combined sewer overflow (CSO) discharges*

F.1.50 Inspection of the data has identified one local authority pollution control registerentry within the Kirtling Street site which relates to the former Esso fuel filling station on Nine Elms Lane. A further three local authority pollution prevention and control records have been identified within the wider assessment area.

F.1.51 Within 250m of the Kirtling Street site, inspection of the data identified one historical landfill site, one licensed waste management facility and two registered waste transfer sites, which are all recorded as being situated adjacent to the western site boundary. All of the entries appear to be associated with the Cringle Dock refuse transfer station.

F.1.52 The EA do not hold details of landfill classification and details of licence type and landfill closure. It must therefore be considered to represent a contamination risk (via gas migration and/or leachate generation) until proven otherwise.

F.1.53 A number of past potential contaminating industrial uses have been identified within the site and the surrounding 250m. From an analysis of the historical mapping data, the past industrial uses can be attributed to various industries including paints, varnishes, printing inks, mastics and sealants manufacture, transport support and cargo handling, road haulage and unspecified factories, as highlighted on Vol 14 Figure F.1.1 (see

separate volume of figures). Common contaminants associated with these land-uses are identified within Vol 14 Table F.2.

F.1.54 Within the 250m assessment area, inspection of the data has identified three pollution incidents to controlled waters; each is located in the River Thames, the closest located approximately 50m east of the site.

Land quality data from local authority

F.1.55 The London Borough (LB) of Wandsworth was consulted with respect to land quality information for this area. The full response is presented in Section. F.2

F.1.56 The Council confirmed that the site is located in an industrial/commercial area and the land-use in the surrounding area is as described above. The response concluded that there may be soil and groundwater impacted by contaminants in the area of the proposed development, as a result of the historical industrial land-uses and infill materials.

F.1.57 The LB of Wandsworth provided ground investigation data (Buro Happold 2009) in relation to Battersea Power Station which is due to be redeveloped for a mix of uses.

F.1.58 Whilst the investigation cannot provide information on the soil quality within the shaft site, it does provide some indication of the soil quality in the area as well as the potential for mobile contamination. The pertinent elements of the investigation to the present assessment are summarised below:

a. the Battersea Power Station site was found to be underlain by Made Ground material of variable composition, generally described as clayey sandy gravel, but varying to a sandy gravelly clay. The gravel and cobbles are composed of flint, brick and concrete with occasional ash, clinker, metal and timber

b. the Made Ground is underlain by Alluvium and River Terrace Deposits which in turn rest upon the London Clay Formation. A scour filled hollow is present in the near surface deposits within the footprint of the Power Station

c. soil samples from Made Ground recorded average concentrations of cadmium exceeding residential screening criteria, and individual concentrations of naphthalene, benzo(a)pyrene, arsenic, chromium, lead, mercury, nickel and total cyanide exceeding the residential screening criteria. Occasional exceedances of commercial/industrial criteria were noted for benzo(a)pyrene and lead. Soil contamination is generally restricted to the Made Ground. The soil gas regime is characterised by slightly elevated concentrations of methane and carbon dioxide (although gas flow rates are generally low)

d. groundwater (secondary aquifer in River Terrace Deposits) recorded slightly elevated contaminant concentrations, particularly ammoniacal nitrogen.

Summary of contamination sources

F.1.59 Following the review of the baseline data, the following on-site sources of contamination which may impact on construction of the proposed development have been identified:

a. potential ongoing contamination of underlying soil and groundwater from current industrial land-uses including the concrete batching works, warehousing, electrical substations and other works. The main potential contaminants of concern are likely to be, but not limited to, heavy metals (e.g. lead and zinc), PAHs, TPH, VOCs, cresols and phenols

b. potential soil and groundwater contamination associated with historical land-use, for example various works, a paint and colour works, tanks, depot and former fuel filling station. Contaminants may include metals, hydrocarbons, VOCs, PAHs, PCBs, cyanide and phenols. Locally elevated concentrations of lead and PAH compounds (benzo(a)pyrene, benzo(a)anthracene, dibenzo(ah)anthracene and ideno(123-cd)pyrene) were recorded in comparison with widely used soil assessment criteria for commercial and light industrial use

c. potentially elevated ground gases or vapours from Made Ground from past development or alluvial deposits

d. potential UXO.

F.1.60 Off-site sources which may impact on the construction of the proposed development could arise from shallow groundwater contamination associated with historic and existing industries including the concrete depot, power station, and gas works. The main potential contaminants of concern are likely to be, but not limited to: hydrocarbons, phenols, PAHs, PCBs and heavy metals.

F.2 Local authority consultation

WANDSWORTH COUNCIL
Technical Services Department
Environmental Services & Community Safety Division
PO Box 47095
London SW18 9AQ

Please ask for/reply to: Roy Fox
Telephone: 020 8871 7874
Fax: 020 8871 7661
Email:rfox@wandsworth.gov.uk
Minicom: 020 8871 8403

Our Ref: SR155939
Your ref:
Date: 19 May 2011

Lorna Brooks
Mott MacDonald Ltd
8-10 Sydenham Road
Croydon, CR0 2EE

Dear Ms Brooks

Re: Kirtling Street Site, London, SW8

I refer to your e-mail enquiry regarding the potential for land contamination at the above site. In order to respond to you I have examined our environmental data for the area, including historical mapping, aerial photographs, geological, hydrogeological and other environmental data, our premises database, the London Fire Brigade petroleum records and the Planning Register. The following points summarise our information relating to the site.

- The site is located within a current commercial/ industrial area. To the east is a business park comprising warehousing and other commercial uses. On the adjoining land to the west is a cement batching works and immediately west of this a waste transfer station, both with operating wharves. The whole area is subject to considerable planned changes through redevelopment. The business park to the east has planning permission for redevelopment as housing and mixed commercial uses (Tideway Wharf, planning reference 2011/3735). To the west the Battersea Power Station site has complete redevelopment approved (reference 2009/3575). Part of the power station redevelopment includes a business park 150m to the south, which included a petrol filling station. This facility, following decommissioning, was subject to a full site investigation, risk assessment and subsequent remediation (including excavation and enhanced natural breakdown using the injection of oxidants). Final verification was accepted in March 2011. Full details of planning applications can be obtained from the Wandsworth Planning Web pages by entering the reference numbers into the register search at: http://www.wandsworth.gov.uk/gis/search/Search.aspx
- The 1869 OS mapping shows the site and land adjoining west to be undeveloped other than a detached house. Further west, 220m+, is a water treatment works, with treatment beds and a reservoir. Adjoining land to the east is used as wharves including two small docks. A whiting & lime works to be located 225m to the east. A gasworks site is 180m+ to the southeast, including a gasometer 200m southeast. The gas works are served by an inlet off the River Thames extending 330m into the gas works site. There are

gasometers at 50m & 200m southeast and 140m southwest. Tideway Wharf adjoining to the west is made up of small wharves and warehouses.

- The 1896 OS mapping shows more wharves and warehouses to the east, with the two small docks replaced by a single one. The gas works have expanded and are served by a coal conveyor from a dock at the inlet on the eastern boundary of Tideway Wharf, west of the site of concern. Paint & colour works are operating at the site of concern and on adjoining land south. This is likely to have included lead based paint as the company (T & W Farmiloe) also owned white and red lead works.
- The 1916 mapping shows a number of changes to the 1896 epoch. A jam factory is operating at 50m east on the Tideway Wharf site and a sewage pumping station is operating 225m east. The other industries continue to operate, but the water works are largely disused other than the associated pumping station at 220m southwest. Steel engineering works are on land adjoining west.
- By the 1930s half of Battersea Power Station is in operation on the site of the ex-water treatment works. A railway goods yard is to the south of it. The water pumping station, however, continues. The jam factory to the east has become a wharf and warehousing. The gasworks and paintworks continue to operate. The inlet/dock to the gasworks has been partially infilled such that it extends only 180m south from the Thames. The steel works continues west. A large tank has been constructed on the gasworks site at 180m to the southeast.
- The layout and uses of the 1930s continue unchanged on the mapping of 1947. There were a number of high explosive bombs and V1 rockets that were recorded to have fallen in the southern parts of the wider area of interest during the Second World War. The situation also remains fairly unchanged during the 1950s and 1960s, other than the second half of Battersea Power Station being constructed in the mid-1950s. The wider area started to become redeveloped following the closure of the gas works in 1970.
- Aerial photography from 1971 shows that the inlet serving the gas works was infilled other than a small dock off the River Thames. The steelworks site to the west became an aggregate distribution and cement batching site. Tideway Wharf to the east was given approval for the current industrial estate in 1980. The southern part of the paint works was redeveloped as a business centre (Brooks Court) in 1988, but the paint works ceased operating before this time as the riverside factory became a warehouse. The main site of interest has had various uses including vehicle parking, a telecoms base, a security company base & depot, and storage space for a museum.
- The land in the area has alluvium as superficial deposits overlying a London Clay solid geology. The alluvium is classified as a minor aquifer but no abstractions are taken from it. In the area of Tideway Wharf and the power station is made ground.

Based on the information within our possession we conclude that there may be soils and groundwater impacted by contaminants in the area of interest, resulting from the variety of historical industrial uses and infill materials. This is likely to be widespread over the area. I am sending you a copy of the Battersea Power Station site investigation reports, etc, seperately.

I trust that this information is useful to you. If you would like to discuss any matter raised in this letter, please do not hesitate to contact me. I acknowledge the payment of the fee payable for carrying out this search. A receipt for the payment is being sent to you by our administration team (including five other search areas).

Yours sincerely,

R G Fox
Area Environmental Health Officer
Environmental Services and Community Safety Division

F.3 Detailed Unexploded Ordnance (UXO) risk assessment

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Detailed Unexploded Ordnance (UXO) Risk Assessment

Study Site: Work Area PWH11 – Kirtling Street
Document Number: 336-RG-TPI-PWH11-000001
Client Name: Thames Water
6 Alpha Project Number: P2853_R3_V2.0
Date: 11th May 2012

Originator: Max Chainey (3rd May 2012)
Quality Review: Lisa Askham (11th May)
Released by: Lee Gooderham (14th May)

Contents

Figures

EXECUTIVE SUMMARY

Study Site	The Client has specified the Study Site as Work Area PWH11, located at National Grid Reference "529274, 177570". For the purposes of this report, the Site has been divided into **AREA A** (Land aspect of main Work Area) and **AREA B** (Foreshore and river of main Work Area).
Key Findings	In light of the research for this report, 6 Alpha has assessed the threat on this Site based on these pertinent facts: • **AREA A** is situated on what was primarily developed land during World War Two (WWII). The Site was used for industrial purposes, consisting mainly of an "engineering works" and a "paint and colour works". **AREA B** overlaps the foreshore of the *River Thames* and contains a "jetty". • **AREA A and B** are located in a particularly prominent area of bombing targets, including likely "works" targets within **AREA A**, as well as several primary targets in close proximity to the Site. These include *Battersea Power Station*, "gasometers" and "gas works". • *Battersea Metropolitan Borough*, where the Site is located, experienced a bombing density of 214 High Explosive (HE) bombs per 1,000 acres. This is a medium bombing density for *London*. • Three HE bomb strikes occurred within **AREA A**, as well as seven bomb strikes within the buffered Site boundary. A further thirteen HE bomb strikes were recorded within 100m of the buffered Site boundary. A V1 bomb strike occurred within the eastern portion of **AREA A.** • Bomb damage, whilst not extensive, was significant within the west and south of **AREA A**, causing "damage beyond repair" to several structures. • The Site has not been noticeably developed since WWII, except for some slight demolition of structures within **AREA A** and the construction of a "jetty" extending out into the *River Thames* in **AREA B**. Therefore, it is unlikely that buried UXO items would have been removed through development. The risk assessment and risk mitigation outlined below are based on the indicative engineering drawings and proposed works provided by *Thames Water*, and therefore it should be noted that any changes to the engineering drawings or proposed works may affect the risk assessment.
Potential Threat Source	The threat is primarily posed by WWII *German* HE bombs, with a secondary threat from Incendiary Bombs and *British* Anti-Aircraft Artillery (AAA) projectiles.
Risk Pathway	Given the type of munitions that might be present on Site, all types of aggressive intrusive engineering activities may generate a significant risk pathway.
Risk Level	**AREA A** **MEDIUM/HIGH** **AREA B** **HIGH**
Recommended Risk Mitigation	**The following actions are recommended before undertaking any activity on the Study Site:** **ALL AREAS** **1. Operational UXO Risk Management Plan;** appropriate site management documentation should be held on site in the event of a suspected or real UXO discovery. **2. UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of explosive ordnance encounter and are a vital part of the general safety requirement. **AREA A** **3. On-Site Banksman;** all open excavation works should be accompanied by an UXO Specialist to monitor works down to the maximum bomb penetration depth. **AREA B** **4. Non-intrusive Magnetometer Survey**; Prior to any dredging of the foreshore, 6 Alpha recommend a non-intrusive magnetometer survey. Any magnetic contacts that model as UXO should either be investigated or avoided.

ASSESSMENT METHODOLOGY	
Approach	6 Alpha Associates are independent, specialist risk management consultants and the UXO related risk on the Site has been assessed using the process advocated by both the *Construction Industry Research & Information Association* (CIRIA) best practice guide (C681) and by the *Health & Safety Executive* (HSE). Therefore, any risk levels identified in the assessments are objective, quantifiable and not simply designed to generate "follow on survey or contracting work"; any mitigation solution is recommended *only* because it delivers the Client a risk reduced to As Low As Reasonably Practicable (ALARP) at best value. Potential UXO hazards have been identified through investigation of Local and National archives covering the Site, *Ministry of Defence* (MoD) archives, local historical sources and historical mapping, as well as contemporaneous aerial photography (as and if, it is available). Potential hazards have only been recorded if there is specific information that could reasonably place them within the boundaries of the Site. Key source material is referenced within this document, whilst data of lesser relevance (which may have been properly considered and discounted by 6 Alpha), is available upon request. The assessment of UXO risk is a measure of ***probability*** *of encounter* and ***consequence*** *of encounter*; the former being a function of the identified hazard and proposed development methodology; the latter being a function of the type of hazard and the proximity of personnel (and/or other "sensitive receptors"), to the hazard at the moment of encounter. Should a measurable UXO risk be identified, the methods of mitigation recommended are reasonably and sufficiently robust to reduce these to As Low As Reasonably Practicable (ALARP). We believe that the adoption of the legal ALARP principle is a key factor in efficiently and effectively ameliorating UXO risks. It also provides a ready means for assessing the Client's tolerability of UXO risk. In essence the principle states that if the cost of reducing a risk significantly outweighs the benefit, then the risk may be considered tolerable. Clearly this does not mean that there is no requirement for UXO risk mitigation, but any mitigation must demonstrate that it is beneficial. Any additional mitigation that delivers diminishing benefits **and** that consume disproportionate time, money and effort are considered *de minimis* and thus unnecessary. Because of this principle unexploded bomb (UXB) risks will rarely be reduced to zero (nor need they be).
Important Notes	Although this report is up to date and accurate, our databases are continually being populated as and when additional information becomes available. Nonetheless, 6 Alpha have exercised all reasonable care, skill and due diligence in providing this service and producing this report. The assessment levels are based upon our professional opinion and have been supported by our interpretation of historical records and third party data sources. Wherever possible, 6 Alpha has sought to corroborate and to verify the accuracy of all data we have employed, but we are not accountable for any inherent errors that may be contained in third party data sets (e.g. National Archive or other library sources), and over which 6 Alpha can exercise no control. The intention of this report is to provide the Client with a concise summary of the risks posed to the site investigation and construction works. The background risk has been established in a Threat & Preliminary Risk Assessment Report that will be provided separately. Whilst this document may be used in isolation, an overarching report is available that outlines the procedures, details and methodologies used to assess the UXO risk to this project.

STAGE ONE – SITE LOCATION AND DESCRIPTION

Study Site

The Client has specified the Study Site as Work Area PWH11. The Site is located at National Grid Reference "529274, 177570". For the purposes of this study, a 50m assessment radius will be applied to the work area to provide flexibility should it need to be relocated.

Additionally, the Site has been divided into **AREA A and B** for the purpose of this report.

See *Figures 1* and *2* for the Site location.

Location Description ***(Figure 3)***

The Work Area is situated to the southwest of the *City of London* within the *Battersea Metropolitan Borough*. Current aerial photography has identified the following within each area:

AREA A: Industrial work developments throughout.

AREA B: *River Thames*, foreshore and a "jetty".

Proposed Engineering Works

Thames Water have specified a summary of the proposed engineering works. These works have been divided between **AREAS A and B**, however where not explicitly stated, 6 Alpha has made an assumption of which area the work will be carried out in.

AREA A

- A 30m diameter main tunnel drive shaft, 48m deep. It is anticipated that the shaft will be constructed by diaphragm wall techniques.
- This will be a double drive site with construction of the main tunnels d/s to Chambers Wharf and u/s to Carnwath Road Riverside.
- The main tunnel shaft will be surrounded by hard standing area for crane access to the shaft for operational requirements.
- A below ground ventilation filter chamber with a 10m ventilation column.
- A control kiosk containing telemetry equipment.

The existing warehouse buildings on the site will need to be demolished to allow construction to take place.

Within the construction compounds there will be offices/welfare facilities, storage areas for construction materials including precast concrete tunnel linings, storage and handling facilities for excavated material.

AREA B

In the river there will be a 130m long jetty for removal of excavated material with two overhead conveyors from the works site. The area in front of the jetty may need to be dredged and there may be the requirement for the construction of campsheds.

Ground Conditions

Thames Water have indicated the following ground conditions for the Work Areas as:

Site Geology	Depth Below Ground Level (m)	Thickness (m)
Made Ground	0.00	3.80
Alluvium	3.80	2.00
River Terrace Deposits	5.80	3.10
London Clay	8.90	33.30
Lambeth Group	42.20	15.80
Thanet Sand	58.00	10.20
Seaford Chalk	68.20	Proven 13.80

It is important to establish the ground conditions within this report to determine both the maximum *German* unexploded bomb (UXB) bomb penetration depth (BPD) as well as the potential for other types of munitions to be buried on this Site.

STAGE TWO – REVIEW OF HISTORICAL DATASETS	
Sources of Information Consulted	The following primary information sources have been used in order to establish the background UXO threat: 1. Home Office WWII Bomb Census Maps; 2. WWII & post-WWII Aerial Photography; 3. Official Abandoned Bomb Register; 4. National Archives in Kew; 5. Internet based research; 6. Historic UXO information provided by 33 Engineer Regiment (Explosive Ordnance Disposal) at Carver Barracks, Wimbish.
Site History and Use	According to the County Series (CS) & Ordnance Survey (OS) historical mapping, the following site history can be recorded immediately prior to and post-WWII: **1938 CS mapping** – **AREA A** is situated on predominantly developed land, and overlaps with a "paint and colour works". *Nine Elms Lane*, *Cringle Street*, and *Kirtling Street* all transect the Site. **AREA B** contains no structural developments. **1949 OS mapping** – No noticeable or significant changes have been observed in **AREA A or B.**
1945 Aerial Photography ***(Figure 4)***	**AREA A:** The 1945 aerial photography confirms structural development on Site, and despite the lack of clarity in the aerial photography, we can infer that much of the Site is intact, given the buildings present on the photograph are concomitant with mapping from 1938. **AREA B**: Whilst not indicated on the 1949 OS mapping, the 1945 aerial photography appears to show a "jetty-like" structure within this area.
WWII Luftwaffe Bombing Targets ***(Figure 5)***	**ALL AREAS:** A "gas works" that would have been a primary target, has been identified as extending into the buffered Site boundary. Additional primary bombing targets include "gas works" located 750m to the northeast, "gasometers" 350m to the southwest and *Battersea Power Station* 175m to the west. Additionally, as a major transport route, the *River Thames* to the north would have been a primary target. "Opportunistic" targets include railway infrastructure and stations, "depots", "goods sheds", "docks" and *Chelsea Barracks* all located within 1km of the Site.
WWII HE Bomb Strikes ***(Figure 6)***	Air Raid Precaution (ARP) reports indicate the following: **AREA A:** Three HE bomb strikes and one V1 strike occurred within the area. **AREA B:** No bomb strikes. Additionally, seven bomb strikes occurred within the buffered Site boundary. A further thirteen HE bomb strikes were recorded within 100m of the buffered Site boundary.
WWII Bomb Damage ***(Figure 7)***	*London County Council* (LCC) bomb damage maps indicate the following: **AREA A:** Various damage to structures in the area ranging from "blast damage; minor in nature" in the south, to "damage beyond repair" in the south and west and "total destruction" of the "paint and colour works" structure centrally. **AREA B:** No bomb damage. There is further "damage beyond repair" to structures within the buffered Site boundary.
WWII HE Bomb Density ***(Figure 8)***	The Study Site is located within the *Battersea Metropolitan Borough,* which recorded 214 HE bombs per 1,000 acres. This figure does not include incendiary devices, as they were often released in such large numbers that they were seldom recorded.
Abandoned Bombs	According to the Official Abandoned Bomb Register, no abandoned bombs were recorded within 1,000m of the Site.

STAGE THREE – DATA ANALYSIS	
Was the ground undeveloped during WWII?	**AREA A:** No; the main area was predominantly developed with various "works", and contained structural developments throughout. **AREA B:** Yes; this area overlaps the *River Thames* and was undeveloped.
Is there a reason to suspect that the immediate area was a bombing target during WWII?	**ALL AREAS:** Yes; there are also numerous bombing targets within and around the areas and buffered Site boundary.
Is there firm evidence that ordnance landed on Site?	**AREA A:** Yes; there were three bomb strikes and a V1 strike within the area boundary. **AREA B:** No; but unlikely to have been recorded given the environment. Additionally, seven bomb strikes were recorded within the buffered Site boundary.
Is there evidence of damage sustained on Site?	**AREA A:** Yes; the area suffered bomb damage to varying degrees. **AREA B:** No; but unlikely to have been recorded given the environment. Within the buffered Site boundary there has been "damage beyond repair" to a number of structures.
Is there any reason to suspect that military training may have occurred at this location?	**ALL AREAS:** No; there is no evidence to suggest that military training occurred within any of the areas.
Would an UXB entry hole have been observed and reported during WWII?	**AREA A:** Likely; the land was mostly developed and a UXB entry hole would be witnessed. However the significant "damage beyond repair" from bomb damage to the "engineering works" and "paint and colour works" within the west and central aspect of the Site, as well as similar damage to the south, would have created debris that may have obscured any bomb strike observations and decreased the likelihood of finding UXB entry holes. **AREA B:** Unlikely; UXBs falling in the *River Thames* are unlikely to have been observed and reported. Additionally, any impact craters of UXBs falling on the foreshore during low tide would have been masked and covered by the high tide.
What is the expected UXO contamination?	**ALL AREAS:** The most likely source of UXO contamination is from *German* aerial delivered ordnance, which ranges from small incendiary bombs through to large HE bombs (of which the latter forms the principal threat).
Would previous earthworks have removed the potential for UXO to be present?	**AREA A:** Unlikely; the changes to the area have not been significant as many of the buildings present during WWII are still present today. **AREA B:** Unlikely; there has been a "minor" development of a "jetty" within the portion of the Site that covers the *River Thames*, and this would have required some piling, however this "jetty" covers only a small portion of the area and would therefore not mitigate the potential for UXO to be present.

STAGE FOUR – RISK ASSESSMENT		
Threat Items	The threat is predominately posed by WWII *German* HE bombs and Incendiary Bombs. Additionally, *British* Anti Aircraft Artillery (AAA) projectiles (the latter were used to defend against German bombing raids) may also be present. However, AAA does not have the potential for deep burial, and thus is unlikely to be encountered at depths greater than 1m bgl.	
Maximum Penetration	Considering the general ground conditions (highlighted in Stage 1) including the potential depth of made ground and the hard surface geology within **AREA A**, the most likely Bomb Penetration Depth (BPD) for a 250kg bomb is assessed to be a maximum of 6m bgl, dependant on the depth of rock. As the boundary of **AREA B** overlaps with the foreshore of the *River Thames* and the river itself, the BPD will vary due to the softer ground conditions and the water causing a deceleration of the impacting bomb. Whilst the *Luftwaffe* used larger bombs, their deployment was so few and only used against notable targets, to use them within this risk assessment would not be justified. Additionally, smaller items such as *German* incendiary bombs and *British* AAA projectiles would have a significantly reduced penetration capability and would not be expected to be encountered at depths greater than 1m.	
Risk Pathway	Intrusive engineering activities are likely to be in the form of excavations. Although for the purposes of this report 6 Alpha will use a range of generic construction activities for the risk assessment.	
Consequence	**Potential consequences of UXO initiation**	1. Kill and/or critically injure personnel 2. Severe damage to plant and equipment 3. Blast damage to nearby buildings 4. Rupture and damage underground services
	Potential consequences of UXO discovery	1. Delay the project 2. Disruption to local community/infrastructure 3. Incurring of additional costs
Site Activities	A number of construction methodologies have been identified for analysis on this Site. There is a large amount of variation in the probability of encountering, or initiating items of UXO when conducting different activities on Site. Additionally the consequences of initiating UXO vary greatly depending on how the item of UXO was initiated on Site.	

STAGE FOUR – RISK ASSESSMENT (…continued)

UXO RISK CALCULATION TABLE

Risk Rating Calculation	6 Alpha's Semi-Quantitative Risk Assessment identifies the Risk Rating posed by the most probable threat items when conducting a number of different construction activities on the Site. Risk Rating is determined by calculating the probability of encountering UXO and the consequences of initiating it.

Activity	AREA A		
	Probability (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Enabling Works	3x1=3	3x2=6	3x6=18
Tunnelling	3x2=6	1x2=2	6x2=12
Shaft Installation	3x2=6	1x2=2	6x2=12
Open Excavations	3x2=6	2x2=4	6x4=24

Activity	AREA B		
	Probability (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Tunnelling	3x2=6	1x2=2	6x2=12
Cofferdam (Sheet Piles)	3x3=9	2x2=4	9x4=36
Dredging	3x3=9	3x2=6	9x6=54

Abbreviations – Site History (SH), Engineering Methodology (EM), Probability (P), Depth (D), Consequence (C), Proximity to Sensitive Receptors (PSR) and Risk Rating (RR).

STAGE FIVE – RECOMMENDED RISK MITIGATION MEASURES WITH RESULTING RISK RATING	
If a geophysical survey is required are the ground conditions an issue?	**Non-Intrusive Methods of Mitigation –** The suitability for an effective non-intrusive method of mitigation is largely dependent on the depth (3.8m for this Site) and composition of made ground, as any magnetometer results are highly likely to be affected by ferro-magnetic contamination due to previous construction activities within the Study Site location. This method may be more effective on the foreshore as this is area is undeveloped. **Intrusive Methods of Mitigation –** Intrusive magnetometry is expected to be possible on this Site, however deep excavation of made ground is required prior to the use of this methodology. It should be noted that ferro-contamination of any made ground/fill material, particularly at the fill layer, is likely to adversely affect detection capability of the equipment.

MITIGATION MEASURES TO REDUCE RISK TO 'ALARP'		
Activity	**Risk Mitigation Measures**	**Final Risk Rating**
ALL AREAS	**The following actions are recommended before undertaking any activity on the Study Site:** 1. **Operational UXO Risk Management Plan;** appropriate site management documentation should be held on site to plan for and guide upon the actions to be carried out in the event of a suspected or real UXO discovery. 2. **UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of explosive ordnance encounter and are a vital part of the general safety requirement. All personnel working on the site should receive a general briefing on the identification of UXB, what actions they should take to keep people and equipment away from the hazard and to alert site management. Posters and information of the general nature of the UXB threat should be held in the site office for reference and as a reminder.	ALARP
AREA A	**3. On-Site Banksman;** all open excavation works should be accompanied by an UXO Specialist to monitor works down to the maximum bomb penetration depth.	
AREA B	**4. Non-intrusive Magnetometer Survey**; Prior to any dredging of the foreshore, 6 Alpha recommend a non-intrusive magnetometer survey. Any magnetic contacts that model as UXO should either be investigated or avoided. It should be noted that there is likely to be scrap metal on the foreshore and riverbed that will reduce the effectiveness of non-intrusive magnetometry.	
This assessment has been conducted based on the information provided by the Client, should the proposed works change then 6 Alpha should be re-engaged to refine this risk assessment.		

Report Figures

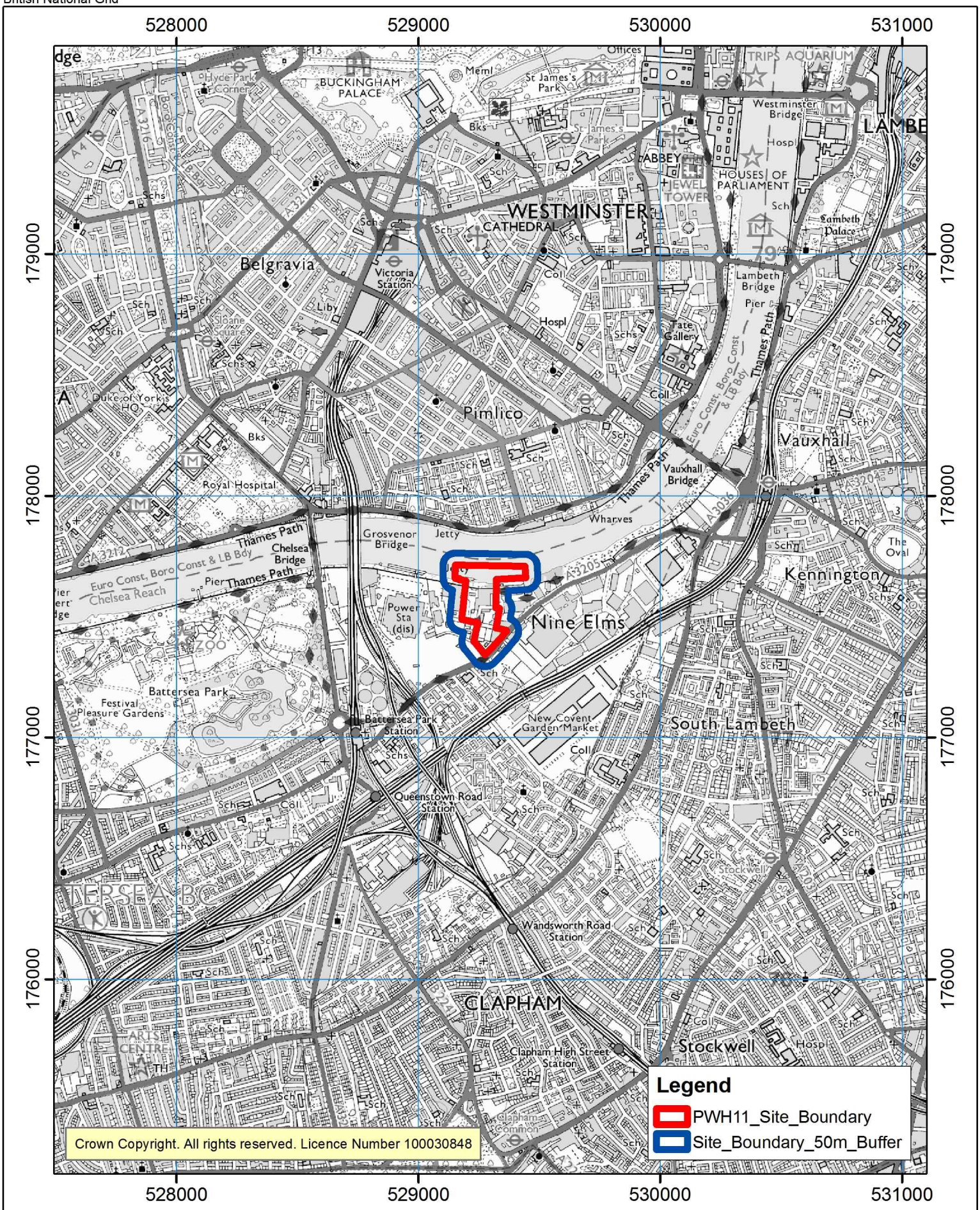
Figure One

Site Location

Thames Tideway Tunnel - Work Area PWH11
Site Location

Figure 1

British National Grid



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Project Number: P2853_PWH11
Drawn By: Dominique René
Checked by: Lee Gooderham
Date: 3rd May 2012

Figure Two

Site Plan

Thames Tideway Tunnel - Work Area PWH11 Site Boundary

Figure 2

British National Grid

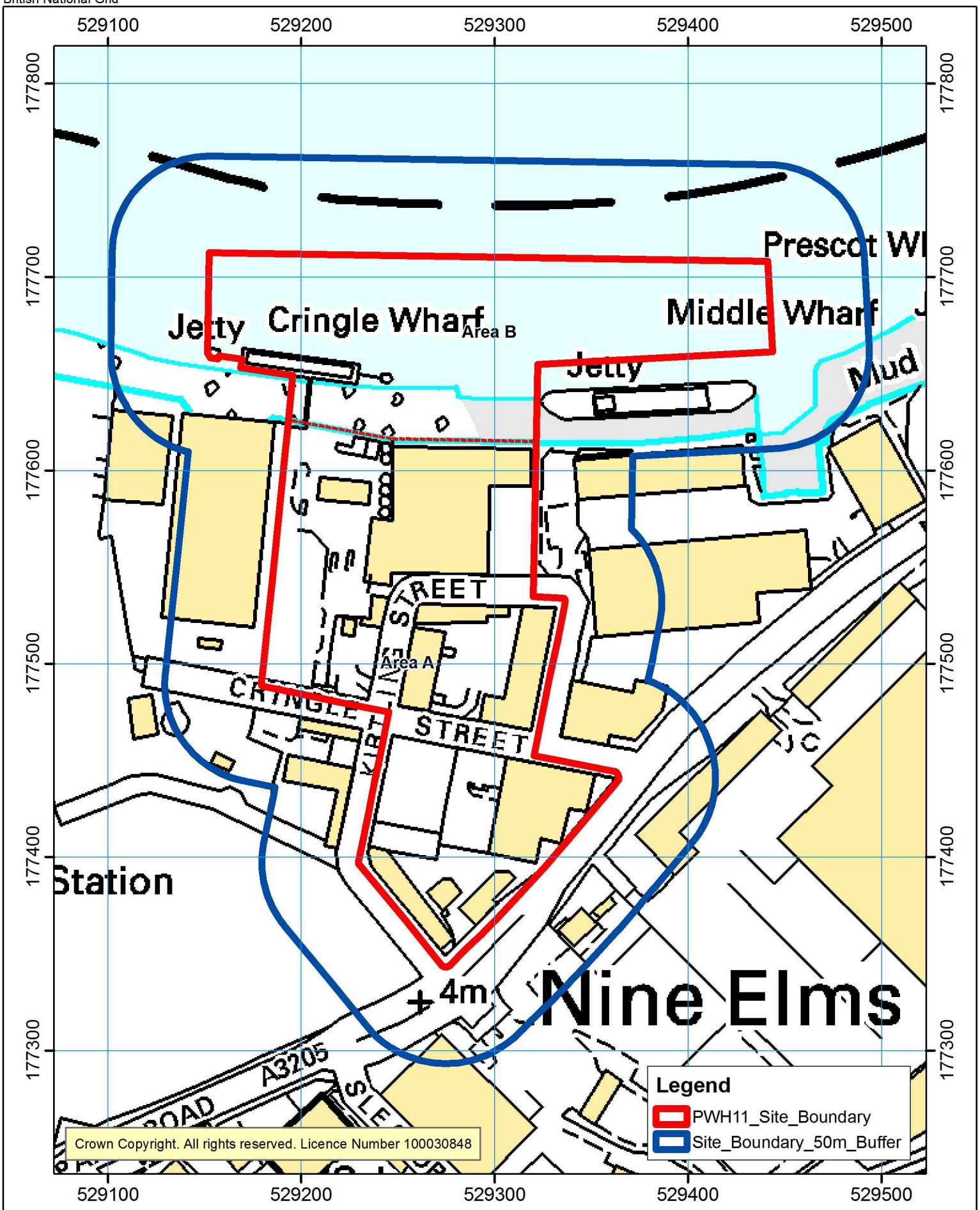

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Figure Three

Current Aerial Photography

Thames Tideway Tunnel - Work Area PWH11
Current Aerial Photography

Figure 3

British National Grid

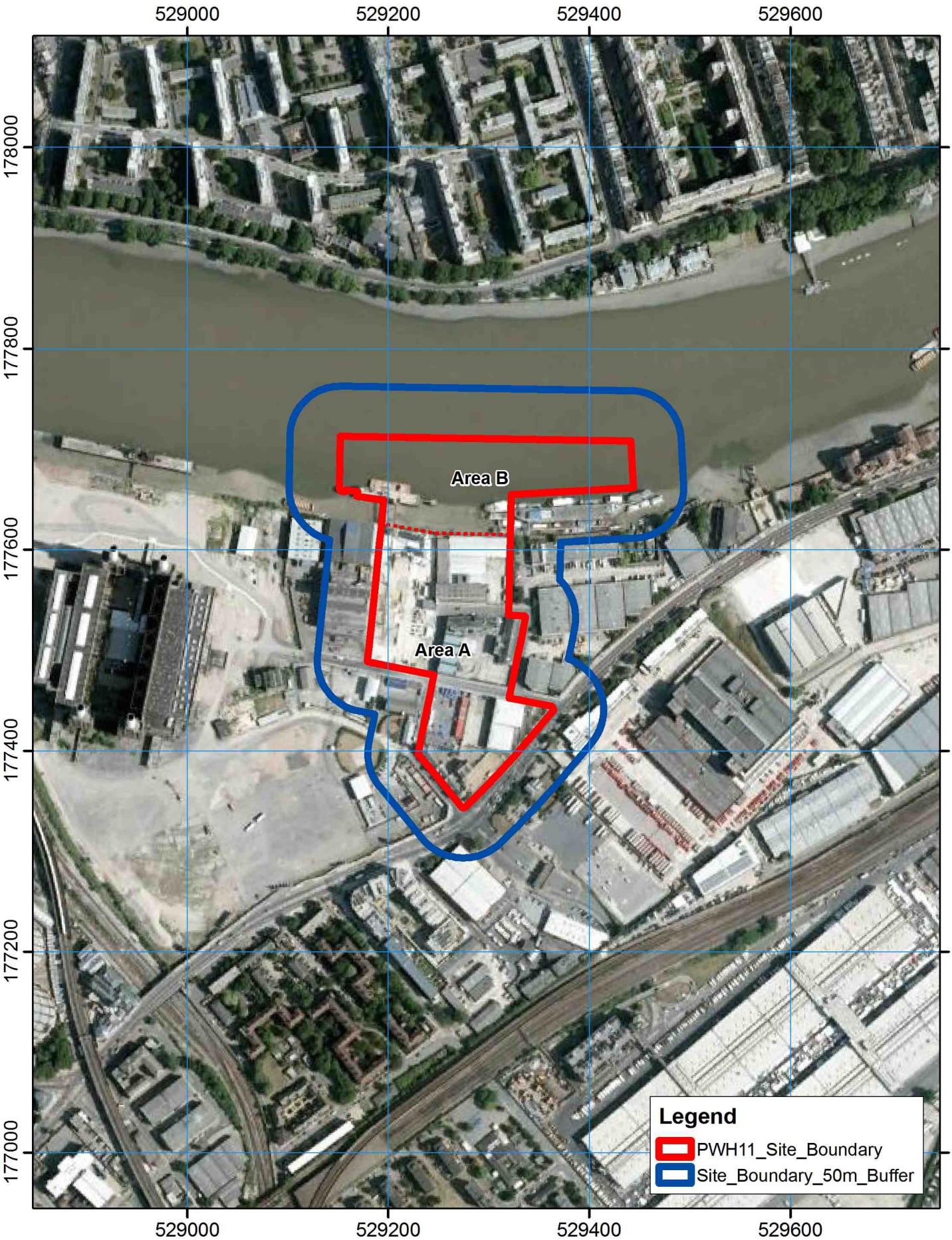

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Figure Four

1945 Aerial Photography

Thames Tideway Tunnel - Work Area PWH11
1945 Aerial Photography

Figure 4

British National Grid

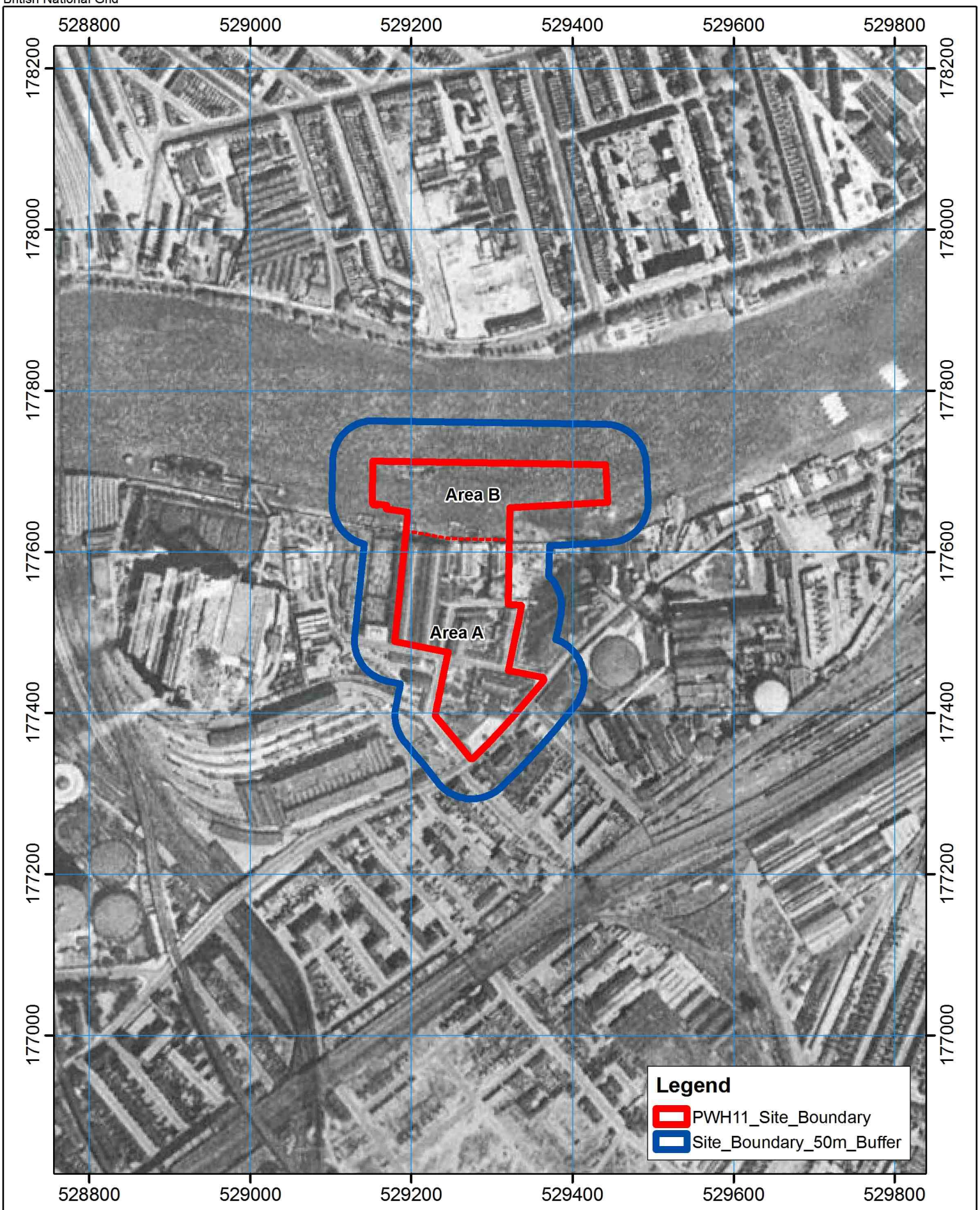

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Figure Five

WWII Luftwaffe Bombing Targets

Thames Tideway Tunnel - Work Area PWH11
WWII Luftwaffe Bombing Targets

Figure 5

British National Grid

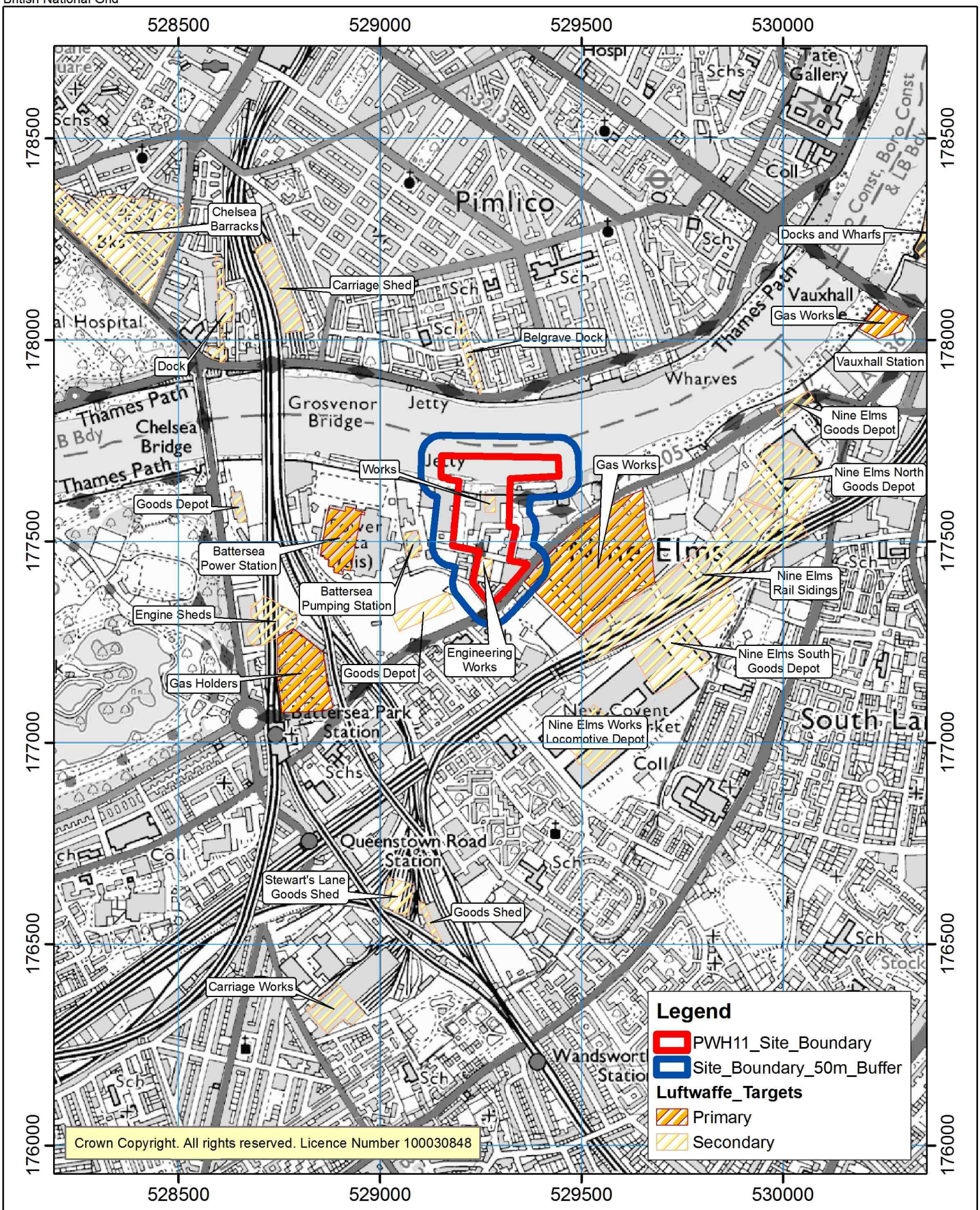

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Figure Six

WWII High Explosive Bomb Strikes

Thames Tideway Tunnel - Work Area PWH11
WWII High Explosive Bomb Strikes

Figure 6

British National Grid

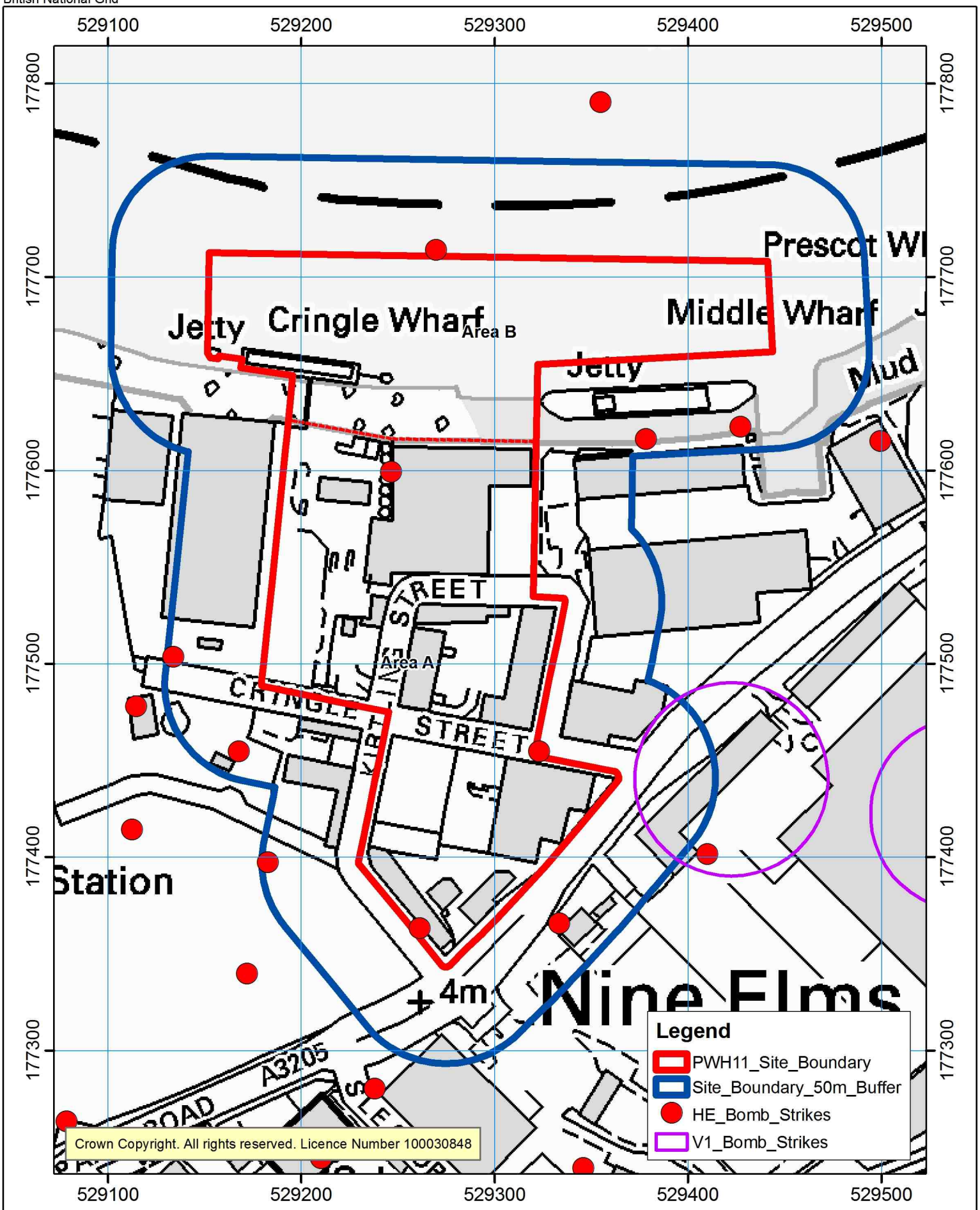

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Figure Seven

London County Council Bomb Damage Mapping

Thames Tideway Tunnel - Work Area PWH11
London County Council Bomb Damage Map

Figure 7

British National Grid

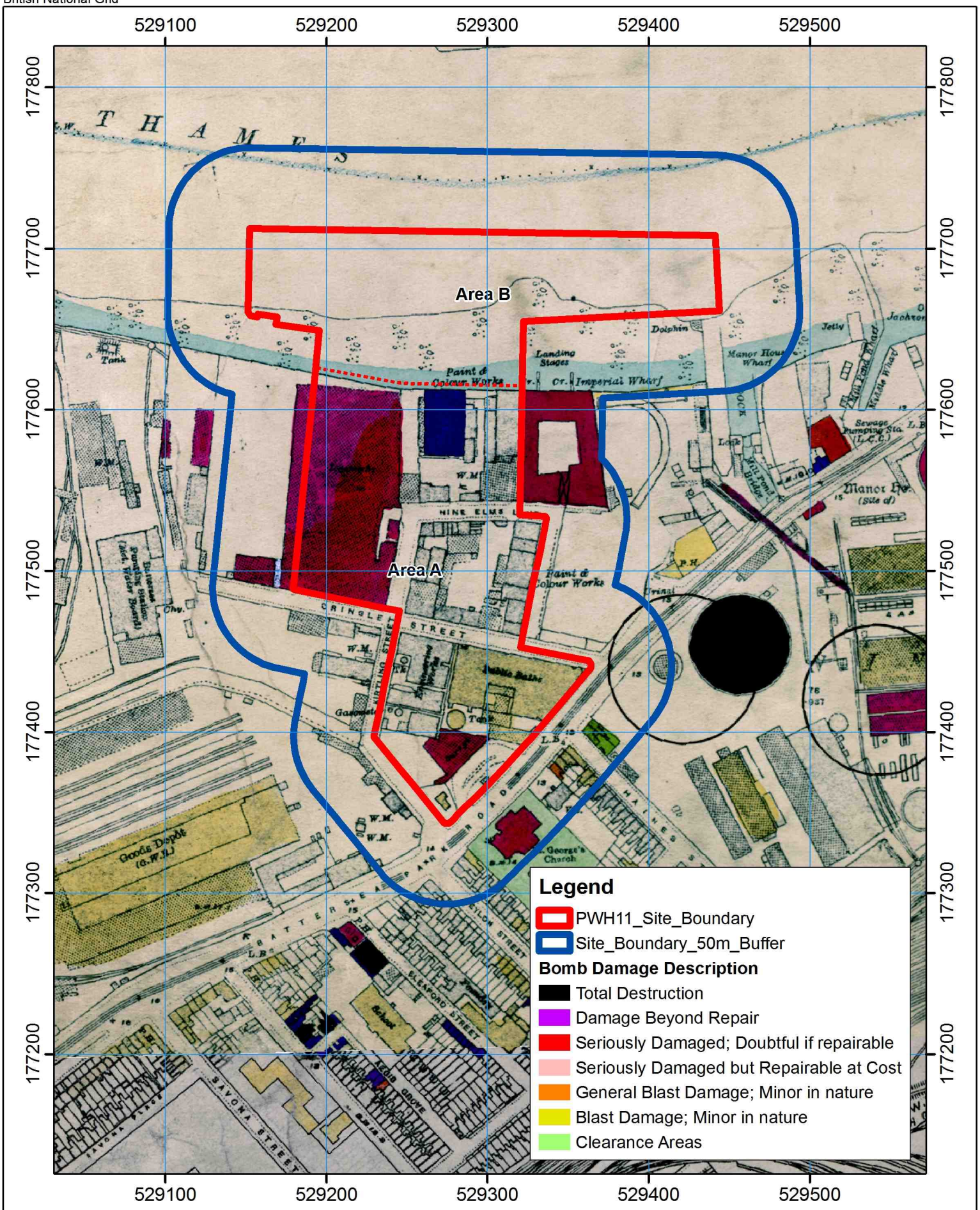

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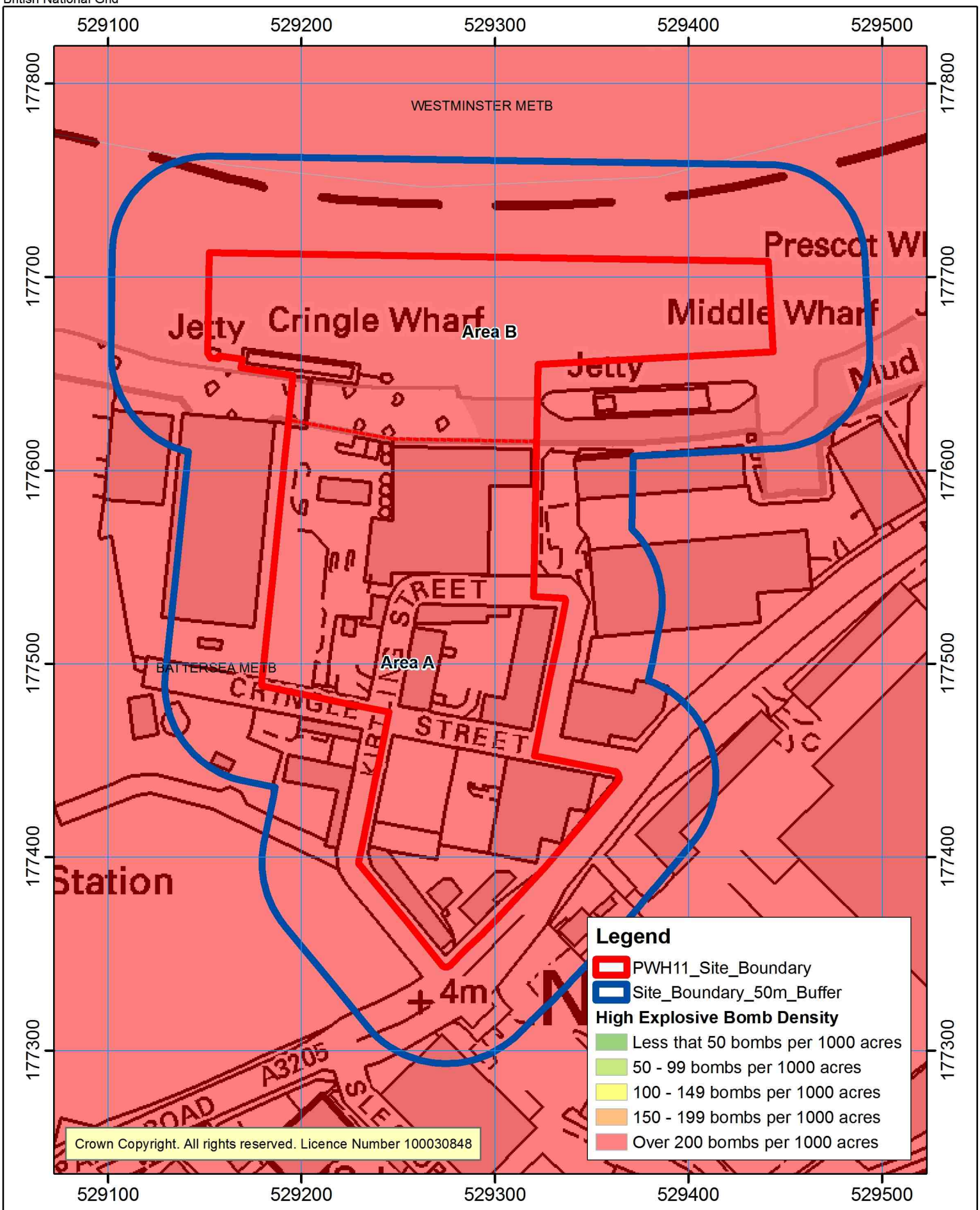
Figure Eight

WWII High Explosive Bomb Density

Thames Tideway Tunnel - Work Area PWH11
WWII High Explosive Bomb Density

Figure 8

British National Grid



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Date: 3rd May 2012

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References

[1] Department for the Environment, Food and Rural Affairs (Defra) and The Environment Agency, *CLR8: Potential Contaminants for the assessment of land* (2002).

[2] Department of the Environment, Industry Profiles (various), available from http://www.environment-agency.gov.uk/research/planning/33708.aspx, accessed 25th March 2011.

[3] 6 Alpha Associates Limited. Detailed Unexploded Ordnance Risk Assessment. Study site: Work area PWH11 – Kirtling Street

[4] Summarised form AGS data for Thames Tunnel Phase One ground investigation, Norwest Holst and Fugro Engineering Services, 2009.

[5] Defra/EA. *Soil Guideline values for industrial and light commercial land use* (2009).

[6] Land Quality Management/Chartered institute of Environmental Health. *Generic Assessment Criteria for Human Health Risk Assessment*, 2nd Edition (2009).

[7] Structural Soils Limited, Interpretative *Report on Contamination Investigation at Kirtling Street, Wandsworth*, June 2012, Report No: 726367.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.14**

Volume 14: Kirtling Street appendices

Appendix G: Noise and vibration

APFP Regulations 2009: Regulation **5(2)(a)**

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January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 14 Kirtling Street appendices

Appendix G: Noise and vibration

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Appendix G: Noise and vibration

G.1 Baseline noise survey

Introduction

G.1.1 As described in Volume 2 Environmental assessment methodology, the main purpose of the noise survey has been to determine representative ambient and background noise levels at a number of different types of noise sensitive receptor.

G.1.2 The nearest identified receptors to Kirtling Street are the residential dwellings close to the site as well as the future mixed-use development at Tideway Industrial Estate, known as Riverlight. There are no non-residential receptors that fall within the assessment area for this site.

Survey methodology

G.1.3 The London Borough of Wandsworth has been consulted regarding the noise assessment and monitoring locations, prior to completing the surveys.

G.1.4 An initial baseline noise survey was completed on 19-20th June, 2011. Additional data was collected on 22nd June, 2011 and 28-29th June. The initial survey comprised short term attended measurements during the daytime and night-time on a typical weekend day at three measurement locations, and also included continuous overnight unattended monitoring. The additional data collection on the 22nd June comprised further short term attended measurements during the daytime on a typical weekday. The additional data collection on the 28-29th June comprised further short term attended measurements during the evening and night-time on a typical weekday.

G.1.5 During the initial baseline survey measurements were undertaken during the interpeak periods of 14:00-18:00 and 00:00-04:00 on a typical weekend day, so that the baseline data is representative of the quieter periods where any disturbance from construction would be most noticeable. Continuous unattended monitoring was also completed at one location over a four day period (19th-22nd June).

G.1.6 For the additional surveys completed on 22nd June and 28-29th June, further short-term attended measurements were undertaken during the interpeak periods of 10:00-12:00, 20:00-22:00 and 00:00-04:00 on a typical weekday.

G.1.7 Vol 14 Table G.1 describes the survey equipment that was used to collect the baseline data at the site.

Vol 14 Table G.1 Noise – survey equipment

Item	Type	Manufacturer	Serial Number(s)	Laboratory Calibration Date
Initial Baseline Survey: 19th - 20th June, 2011				
Hand-Held Analyzer(s)	2250	Brüel & Kjær	2659069 2506362 2626232	11/03/2011* 25/05/2011* 15/02/2010**
½ " Microphone(s)	4189	Brüel & Kjær	2650595 2519772 2621211	10/03/2011* 12/05/2011* 15/02/2010**
B&K Sound Calibrator(s)	4231	Brüel & Kjær	2619375	12/01/2011**
Additional baseline survey: 22nd June, 2011				
Hand-Held Analyzer(s)	2250	Brüel & Kjær	2506362 2626232	25/05/2011* 15/02/2010**
½ " Microphone(s)	4189	Brüel & Kjær	2670669 2621211	10/03/2011* 15/02/2010**
B&K Sound Calibrator(s)	4231	Brüel & Kjær	2619373 2619375	10/02/2011** 12/01/2011**
Additional baseline survey: 28th - 29th June, 2011				
Hand-Held Analyzer(s)	2250	Brüel & Kjær	2626231 2626233	20/01/2010** 15/02/2010**
½ " Microphone(s)	4189	Brüel & Kjær	2621208 2621212	19/01/2010** 15/02/2010**
B&K Sound Calibrator(s)	4231	Brüel & Kjær	2619372 2619374	13/01/2011** 21/02/2011**

**Hand-held analyser(s), ½ " microphone(s) and calibrator(s) valid for one year from the date listed.*

***Hand-held analyser(s) and ½ " microphone(s) valid for two years from the date listed, calibrator(s) valid for one year from the date listed*

G.1.8 Prior to and on completion of the surveys, the sound level meters and microphone calibration was checked using a Brüel and Kjær sound level meter calibrator. On-site calibration checks were performed before and after all measurements with no significant deviation being observed. The sound level meters and calibrators have valid laboratory calibration certificates.

G.1.9 For the attended measurements, the sound level meters were tripod-mounted with the microphone approximately 1.3m above ground level. A windshield was fitted over the microphone at all times during the survey period to minimise the effects of any wind induced noise.

G.1.10 For the unattended measurement, the environmental case used for the continuous data logging was locked to avoid any potential tampering. The microphone was tripod-mounted approximately 1.3m above ground level. A windshield with bird spikes was fitted over the microphone at all times during the survey period to minimise the effects of any wind induced noise and to prevent birds from perching on the equipment.

G.1.11 The prevailing weather conditions observed during the baseline surveys are described in Vol 14 Table G.2.

G.1.12 Contemporary weather data recorded at Heathrow Airport (EGLL) has been summarised in Vol 14 Table G.3. This is deemed to be representative of the prevailing weather conditions for the continuous unattended monitoring kit.

Vol 14 Table G.2 Noise – weather conditions during baseline noise survey

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation	Description
Initial Baseline Survey – 19th June, 2011 (daytime, 14:00-18:00)				
Maximum: 1.4-2.8 Average: 0.3-0.8	W; SW	18-21	No	Overcast and breezy
Additional baseline survey – 20th June, 2011 (night-time, 00:00 – 04:00)				
Maximum: 0.4-1.8 Average: 0-0.5	Variable	12-13	No	Dry, calm and cloudy
Additional baseline survey – 22nd June, 2011 (daytime, 10:00–12:00)				
Maximum: 0.8-4.8 Average: 0.4-1.6	SW, SSW	16-19	Yes, damp with light drizzle for second hour	Overcast and breezy
Additional baseline survey – 28th June, 2011 (evening, 20:00–22:00)				
Maximum: 1.7-4.5 Average: 0.3-1.6	NW; NNW	16-18	Yes, light drizzle for 10 mins in middle of survey period	Overcast and breezy
Additional baseline survey – 29th June, 2011, (night-time, 00:00 – 04:00)				
Maximum: 1.0-3.4 Average: 0.3-1.1	NW, WNW	14-17	No	Partly cloudy with occasional breeze

Vol 14 Table G.3 Noise – contemporary weather data for Heathrow airport

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation	Description
Sunday 19th June, 2011 (15:00 onwards) a				
2-7.9	Variable (Predominantly W, WSW and SW)	12-18	No	Overcast and breezy
Monday 20th June, 2011b				
1-5.7	Variable (Predominantly S and SSW)	10-21	Yes (Light rain between 5PM and 10PM)	Scattered cloud and dry for majority of day
Tuesday 21st June, 2011c				
3.6-9	Variable (Predominantly SW and WSW)	13-21	No	Scattered cloud, dry and breezy
Wednesday 22nd June, 2011(until 13:30) d				
2.6-7.2	Variable (Predominantly SW and SSW)	12-17	Yes (Light rain from 12.20PM onwards)	Cloudy and breezy. Dry for majority of day

a http://www.wunderground.com/history/airport/EGLL/2011/6/19/DailyHistory.html
b http://www.wunderground.com/history/airport/EGLL/2011/6/20/DailyHistory.html
c http://www.wunderground.com/history/airport/EGLL/2011/6/21/DailyHistory.html
d http://www.wunderground.com/history/airport/EGLL/2011/6/22/DailyHistory.html

Measurement locations

G.1.13 Vol 14 Table G.4 details the measurement locations which are also presented in Vol 17 Figure G.1 Noise – measurement locations (see separate volume of figures), and shown in Vol 14 Plate G.1 to Vol 14 Plate G.5.

Vol 14 Table G.4 Noise – measurement locations

Measurement location number	Description	Co-ordinates	
		X	Y
KST01	On public footpath adjacent to Nine Elms Lane, outside residential dwelling	529327	177365
KST02	On public footpath along Cringle Wharf, near to Tideway Industrial Estate	529338	177610
KST03	On public footpath adjacent to Grosvenor Road, opposite Keats House	529333	177877
KST04	On private land within Thames Water owned site off Cringle Street	529147	177466
HEA02	Within Heathwall Pumping Station, east of main building	529569	177623

Results

G.1.14 The range of values for each of the parameters collected during the baseline survey are summarised in Vol 14 Table G.5 to Vol 14 Table G.10.

Vol 14 Table G.5 Noise – sampled noise survey results - KST01

Location Detail: KST01, on public footpath adjacent to Nine Elms Lane, in front of residential dwellings						
Measurement period	**Noise level (dB(A) free-field)**			**Averaged ambient noise level, $dBL_{Aeq,15min}$**		**$dBL_{Aeq,15min}$ (rounded to nearest 5dB)**
	L_{AFmax}	**$L_{A90,15min}$**	**$L_{Aeq,15min}$**	**Free field**	**Façade**	**Façade**
Daytime (10.00-12.00, 14.00-16.00)	85	61	70-71	70	73*	75
Evening (20.00-22.00)	99	58	69-73	71	74*	75
Night (00.00-04.00)	90	49	64-67	66	69*	70
Weekend day (14.00-18.00)	98	59	69-72	71	74*	70
Weekend night (00.00-04.00)	88	48	62-67	65	68*	70

** An approximation of the averaged ambient façade noise level has been obtained by adding 3dB to the calculated averaged ambient free-field level*

Vol 14 Table G.6 Noise – sampled noise survey results - KST02

Location Detail: KST02, on public footpath along Cringle Wharf, adjacent to Tideway Industrial Estate						
Measurement period	**Noise level (dB(A) free-field)**			**Averaged ambient noise level, $dBL_{Aeq,15min}$**		**$dBL_{Aeq,15min}$ (rounded to nearest 5dB)**
	L_{AFmax}	**$L_{A90,15min}$**	**$L_{Aeq,15min}$**	**Free field**	**Façade**	**Façade**
Daytime (10.00-12.00, 14.00-16.00)	87	58	62-66	64	67*	65
Evening (20.00-22.00)	86	50	62-65	64	67*	65
Night (00.00-04.00)	82	48-50	56-61	59	62*	60
Weekend day (14.00-18.00)	76	49	60	60	63*	65
Weekend night (00.00-04.00)	79	49	57-60	58	61*	60

** An approximation of the averaged ambient façade noise level has been obtained by adding 3dB to the calculated averaged ambient free-field level*

Vol 14 Table G.7 Noise – sampled noise survey results - KST03

Location Detail: KST03, on public footpath adjacent to Grosvenor Road, opposite Keats House						
Measurement period	**Noise level (dB(A) free-field)**			**Averaged ambient noise level, $dBL_{Aeq,15min}$**		**$dBL_{Aeq,15min}$ (rounded to nearest 5dB)**
	L_{AFmax}	**$L_{A90,15min}$**	**$L_{Aeq,15min}$**	**Free field**	**Façade**	**Façade**
Daytime (10.00-12.00, 14.00-16.00)	97	63	70-27	71	74*	75
Evening (20.00-22.00)	86	61	69-70	70	73*	75
Night (00.00-04.00)	82	45	66	66	69*	70
Weekend day (14.00-18.00)	85	59	66-67	67	70*	70
Weekend night (00.00-04.00)	83	44	64-66	65	68*	70

** An approximation of the averaged ambient façade noise level has been obtained by adding 3dB to the calculated averaged ambient free-field level*

Vol 14 Table G.8 Noise – continuously logged noise survey results - KST04

Location Detail: KST04, Within private grounds of Thames Water pumping station off Cringle Street							
Day	**Period**	**Period noise level (dB(A) free-field)**			**Quietest hourly noise level in period (dB(A) free-field)**		
		L_{AFmax}	**L_{A90}**	**L_{Aeq}**	**L_{AFmax}**	**L_{A90}**	**L_{Aeq}**
Weekday	07.00-08.00	80	53	60			
	08.00-18.00	90	54	60			
	18.00-19.00	79	54	58			
	19.00-22.00	78	53	57			
	22.00-07.00	77	51	55	65	50	52
Sunday	07.00-21.00*	86	52	60			
	21.00-07.00	81	50	55	62	49	50

** The data presented in this row is deemed to be representative of the reference period. The continuous monitors only started collecting data from 15:00 onwards*

Vol 14 Table G.9 Noise – continuously logged noise survey results – HEA02

Location Detail: HEA02, within the private grounds of Heathwall Pumping Station, east of main building							
Day	**Period**	**Period noise level (dB(A) free-field)**			**Period noise level (dB(A) façade)**		
		L_{AFmax}	**L_{A90}**	**L_{Aeq}**	**L_{AFmax}**	**L_{A90}**	**L_{Aeq}**
Weekday	07.00-08.00	86	57	64	89	60	67
	08.00-18.00	105	57	65	108	60	68
	18.00-19.00	82	57	64	85	60	67
	19.00-22.00	89	54	62	92	57	65
	22.00-07.00	95	46	60	98	49	63
Sunday	07.00-21.00*	88	53	62	91	56	65
	21.00-07.00	90	44	59	93	47	62

**The data presented in this row is deemed to be representative of the reference period. The continuous monitors only started collecting data from 4PM on the Sunday after the engineers had successfully installed it onsite.*

Vol 14 Table G.10 Noise measurements near embankment (for river-based traffic assessment)

Sensitive receptor locations	**Measurement location**	**Measurement period**	**Noise level (dBL_{Aeq}, facade)**
Battersea Power Station	KST04	Night time (23.00 - 07.00)	55
Nine Elms Pier	KST02	Night time (23.00 - 07.00)	62

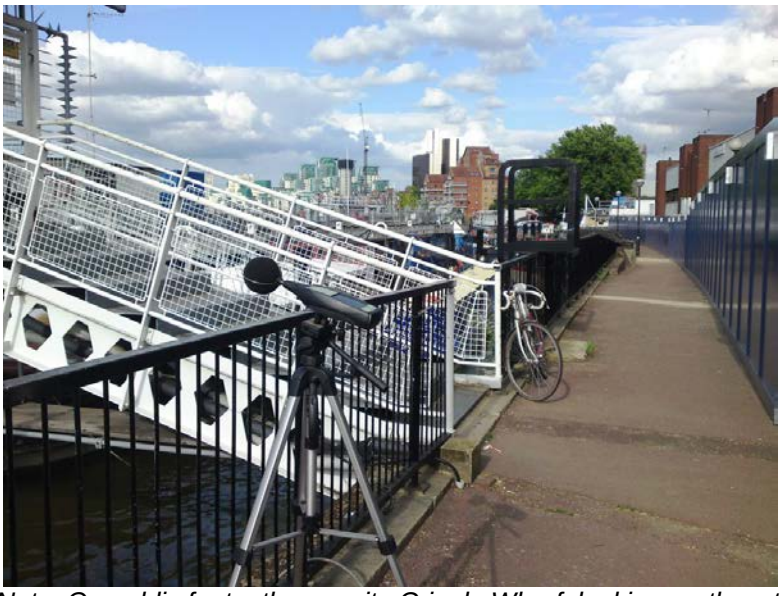
Plates of noise measurement locations

G.1.15 The following plates (Vol 14 Plate G.1 to Vol 14 Plate G.5) illustrate the noise measurement locations.

Vol 14 Plate G.1 Noise measurement location KST01

Note: On public footpath alongside Nine Elms Lane, looking southwest

Vol 14 Plate G.2 Noise measurement location KST02



Note: On public footpath opposite Cringle Wharf, looking northeast

Vol 14 Plate G.3 Noise measurement location KST03

Note: Within private grounds of Cringle Street Pumping Station, looking west

Vol 14 Plate G.4 Noise measurement location KST04

Note: Within private grounds of Cringle Street Pumping Station, looking west

Vol 14 Plate G.5 Noise measurement location HEA02

Note: Within Heathwall Pumping Station, looking north towards River Thames

G.2 Construction noise prediction results

G.2.1 The construction noise prediction methodology follows the methodology provided in Volume 2 Environmental assessment methodology.

G.2.2 The assessment has been carried out based on a typical construction programme which has been used to calculate the average monthly noise levels.

G.2.3 Construction plant assumptions used in the assessment presented in Vol 14 Table G.11.

G.2.4 Time histories of the predicted daytime construction noise levels across the programme of construction works are shown in Vol 14 Plate G.6 to Vol 14 Plate G.16.

Vol 14 Table G.11 Noise – typical construction plant schedule

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
Hoarding General site equipment NOT applicable during this phase	Excavator digging post holes for hoarding	1	105	30	BS5228-1i: Table C.2, Item 2	Tracked excavator, 71 t
	Generator 35kVA	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Circular saw cutting timber	1	110	10	BS5228-1: Table D.7, Item 77	Hand-held electric circular saw, 225 mm blade
	Cutting equipment (diamond saw)	1	108	10	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	Nail guns for erection of hoarding	2	101	10	BS5228-1: Table C.4, Item 95	Handheld cordless nail gun, 15 to 50 mm nails
	Compressor 250cfm	1	93	30	BS5228-1: Table D.5, Item 5	Compressor for hand-held pneumatic breaker,
	Hand-held percussive breaker	1	111	30	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker,
	Waste collection via skip or tipper lorry	1	106	10	BS5228-1: Table C.8, Item 21	Skip wagon,
	Oxyaceteline cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
Site set up and general	Oxyaceteline cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
site	JCB with hydraulic breaker	1	116	20	BS5228-1: Table C.5, Item 1	Backhoe mounted hydraulic breaker,
	Cutting equipment (diamond saw)	2	108	10	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	Compressor 250cfm	1	93	50	BS5228-1: Table D.5, Item 5	Compressor for hand-held pneumatic breaker,
	Generator - 200 kVA	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Fuel delivery vehicle	1	104	5	BS5228-1: Table C.4, Item 15	Fuel tanker lorry,
	Scissor lift	1	106	20	BS5228-1: Table C.4, Item 59	Diesel scissor lift,
	Telescopic Handler/FLT	1	99	30	BS5228-1: Table C.2, Item 35	Telescopic handler, 10 t
	Wheel wash	1	91	20	BS5228-1: Table C.3, Item 13	Water jet pump,
	Hiab lorry/crane	1	105	5	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Water settling/treatment	1	104	100	Measured	Dirty water plant,
	Dewatering Pump	1	96	100	BS5228-1: Table C.4, Item 88	Water pump,
	Well drilling Rig	1	107	50	Manufacturer	Bauer BBA well drilling

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
						rig,
Demolition General site equipment also applicable during this phase	Service Crane 25T mobile Crane	1	98	30	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	22T Excavator c/w hydraulic hammer	1	116	30	BS5228-1: Table C.5, Item 1	Backhoe mounted hydraulic breaker,
	Site dumper	1	104	30	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Pneumatic breaker	1	111	20	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker,
	Concrete crusher	1	101	80	BS5228-1: Table C.2, Item 15	Tracked crusher, 32 t
	Vibrating rollers	2	101	50	BS5228-1: Table C.2, Item 38	Roller, 18 t
Jetty construction	400 cfm compressor	1	93	50	BS5228-1: Table D.5, Item 5	Compressor for hand-held pneumatic breaker,
	50t crawler crane	1	103	60	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	Barges	1	101	10	Measured	Barges
	Generator	1	93	100	BS5228-1: Table C.4, Item 83	Diesel generator,
	Jack-up barge	1	100	10	Measured	Jack-up barge,

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
	Oxyacetylene cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
	Vibratory piling rig	1	116	60	BS5228-1: Table C.3, Item 8	Vibratory piling rig, 52 t
Diaphragm wall General site equipment also applicable during this phase	Diaphragm wall rig (grab)	1	114	20	BS5228-1: Table D.4, Item 10	D wall rig,
	Diaphragm wall rig (hydrofraise)	2	110	80	Measured	Hydrofraise D wall rig,
	Diaphragm wall slurry treatment plant	1	100	100	Measured	Slurry treatment plant,
	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging),
	Concrete pump	1	95	20	BS5228-1: Table C.4, Item 24	Concrete pump + cement mixer truck (discharging), 8 t / 350 bar
	Waste water treatment plant	1	104	100	Measured	Dirty water plant,
	Compressor 400cfm	1	93	50	BS5228-1: Table D.5, Item 5	Compressor for hand-held pneumatic breaker,
	Dumper	1	104	50	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	150t crawler crane	2	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
Shaft excavation General site equipment also applicable during this phase	Ventilation fans	2	90	100	Measured	Ventilation plant,
	Dewatering pump	4	96	100	BS5228-1: Table C.4, Item 88	Water pump (diesel), 100 kg
	20t excavator with breaker	1	116	10	BS5228-1: Table C.5, Item 1	Backhoe mounted hydraulic breaker,
	25t excavator	1	105	80	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Dumper	1	104	50	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	150t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	80t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	Long reach excavator	2	106	80	BS5228-1: Table C.7, Item 1	Long reach tracked excavator, 21 m arm / 39 t
Main tunnel construction	250t mobile (TBM assembly only)	1	106	25	BS5228-1: Table C.4, Item 38	Wheeled mobile telescopic crane, 400 t
	500t mobile (TBM assembly only)	1	106	25	BS5228-1: Table C.4, Item 38	Wheeled mobile telescopic crane, 400 t
Main tunnel drive	150t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
General site equipment also applicable during this phase	Air compressor 600cfm	4	93	50	BS5228-1: Table D.5, Item 5	Compressor for hand-held pneumatic breaker,
	Sump pumps 150mm	4	96	100	BS5228-1: Table C.4, Item 88	Water pump (diesel), 100 kg
	Waste water treatment plant	1	104	100	Measured	Dirty water plant,
	Flatbed trucks for materials haulage	1	105	20	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Flatbed trucks for segment haulage	1	105	20	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Alimak service hoist	1	96	10	BS5228-1: Table C.4, Item 61	Caged material hoist, 500 kg
	Dumper	2	104	25	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Telehandler 5t	2	99	80	BS5228-1: Table C.2, Item 35	Telescopic handler, 10 t
	Gantry cranes 30t, 25m span with cantilever one end	2	105	80	Measured	Gantry crane,
	Dewatering pumps 150mm submersible	8	96	100	BS5228-1: Table C.4, Item 88	Water pump (diesel), 100 kg
	Ventilation fans - set	4	90	100	Measured	Ventilation plant,
	Grout mixer including silos and feeders	1	95	50	Measured	Batching,

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
	25T loading shovel	2	114	30	BS5228-1: Table C.9, Item 8	Wheeled loader, 50 t
	Barge conveyor	2	90	90	Measured	Conveyor,
	Stockpiler conveyor	2	90	50	Measured	Conveyor,
	Shaft HAC conveyor	2	90	50	Measured	Conveyor,
	Land conveyor to stockpile	2	104	100	BS5228-1: Table C.10, Item 21	Conveyor drive unit,
	Mains substation	1	56	100	Measured	Schneider generator, 1000kVA
	Barge loading	1	101	100	Measured	Barge loading slurry,
Main tunnel secondary lining General site also applicable during this phase	Air compressor 600cfm	4	93	50	BS5228-1: Table C.5, Item 5	Compressor for hand-held pneumatic breaker
	Concrete batching plant 80m3/hr	1	95	80	Measured data	Batching
	Concrete pump	1	106	20	BS5228-1: Table C.3, Item 25	Concrete pump
	Gantry cranes 30t, 25m span with cantilever one end	2	105	80	Measured	Gantry crane,
	25T loading shovel	2	114	30	BS5228-1: Table C.9, Item 8	Wheeled loader, 50 t

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
	Mains substation	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Sump pumps 150mm	4	96	100	BS5228-1: Table C.4, Item 88	Water pump (diesel), 100 kg
	Waste water treatment plant	1	104	100	Measured	Dirty water plant
	Alimak service hoist	1	96	50	BS5228-1: Table C.4, Item 61	Caged material hoist, 500 kg
Shaft secondary lining General site equipment also applicable during this phase	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging),
	Concrete pump	2	106	20	BS5228-1: Table C.3, Item 25	Concrete pump
	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	Service Crane 40T mobile Crane	1	98	25	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
Piling for culvert support	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	25 tonne mobile crane	1	98	50	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	Vibratory piling rig	1	116	80	BS5228-1: Table C.3, Item 8	Vibratory piling rig, 52 t

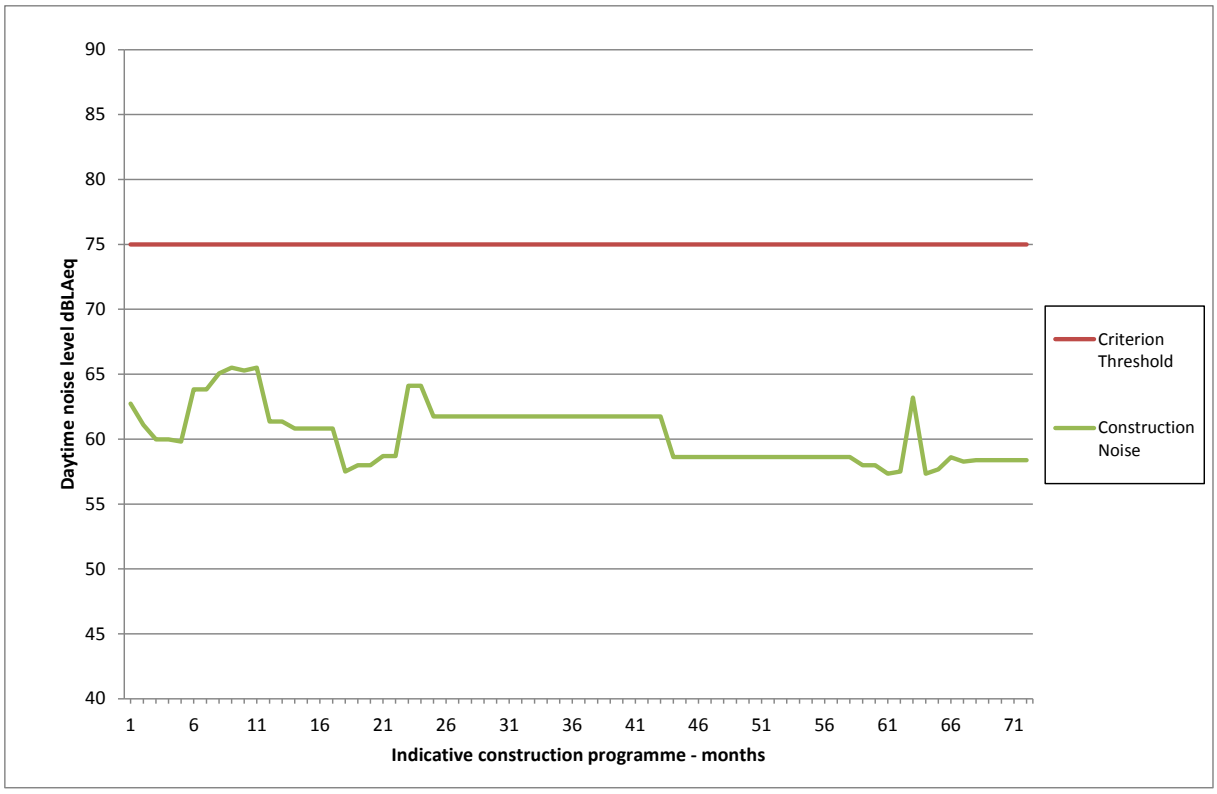
Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
Culvert and chamber works General site equipment also applicable during this phase	Service crane - 100T mobile crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	25t excavator	1	98	50	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	Dumper	1	104	50	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging),
	Concrete boom pump	1	108	20	BS5228-1: Table C.4, Item 29	Truck mounted concrete pump + boom arm, 26 t
	Fixed and portable concrete vibrators	4	106	20	BS5228-1: Table C.4, Item 33	Poker vibrator,
Landscaping General site equipment NOT applicable during this phase	25t excavator	1	105	50	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Dumper	1	104	70	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Telescopic Handler/FLT	1	99	30	BS5228-1: Table C.2, Item 35	Telescopic handler, 10 t
	Hiab lorry/crane	1	105	5	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Compressor for hand-held breaker	1	102	10	BS5228-1: Table C.1, Item 8	Hydraulic breaker power pack, 63 kg/ 138 bar

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
	Hand-held percussive breaker	1	111	10	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker,
	Plate compactors	2	108	10	BS5228-1: Table C.2, Item 41	Vibratory plate (petrol),
	Vibrating rollers	1	101	70	BS5228-1: Table C.2, Item 38	Roller, 18 t

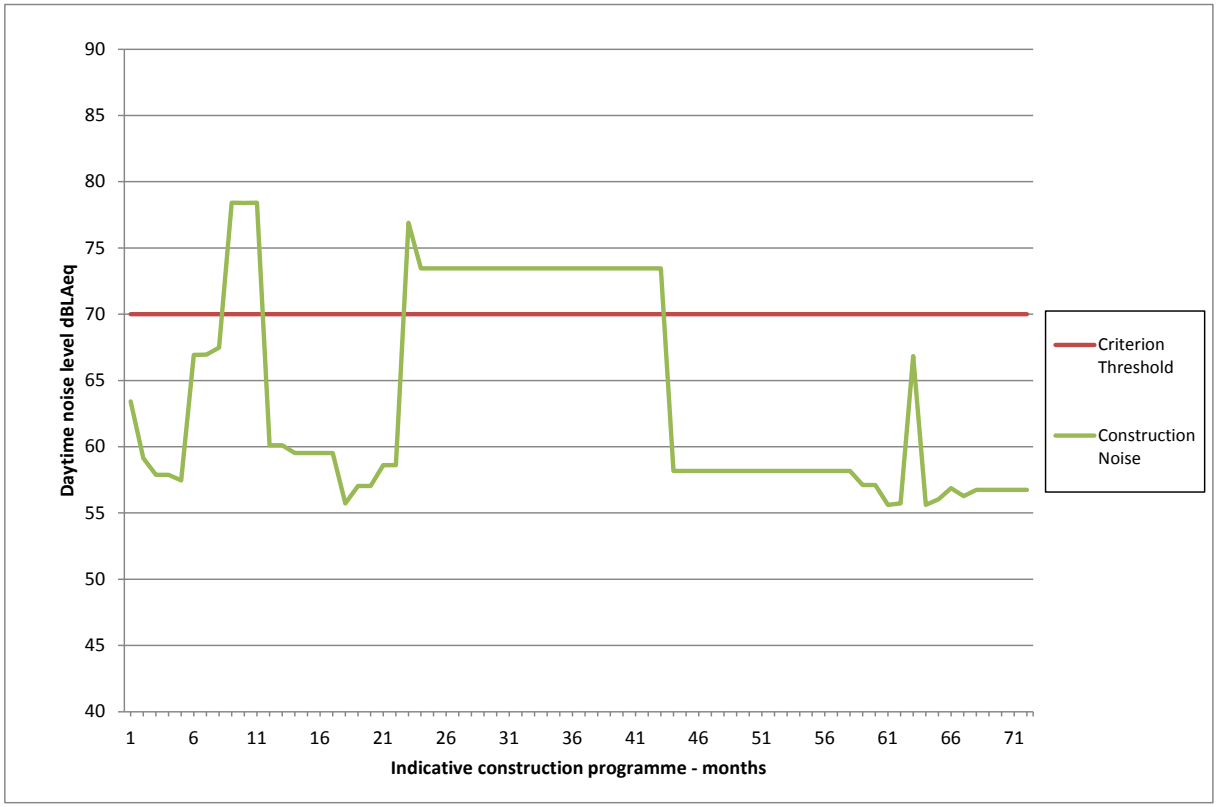
Note: This schedule provides an illustration of typical plant that could be used in the construction of the Thames Tideway Tunnel at this site. The appointed Contractor must comply with section 6 of the CoCP but may vary the method and plant to be used. This schedule therefore represents the most reasonable assumption for the assessment that can be made at this stage.

G.2.5 The predicted construction noise over time at each receptor is shown in the figures below. It should be noted that these representations are for the worst-case scenarios for noise exposure at the upper floors. For comparison with the construction noise, the figures also show either the potential significance criterion threshold for residential receptors, or the ambient noise level. This comparison is discussed in the main assessment text. The night-time noise levels have also been assessed for the short period of night-time works, these results are described in the main assessment text and not presented here.

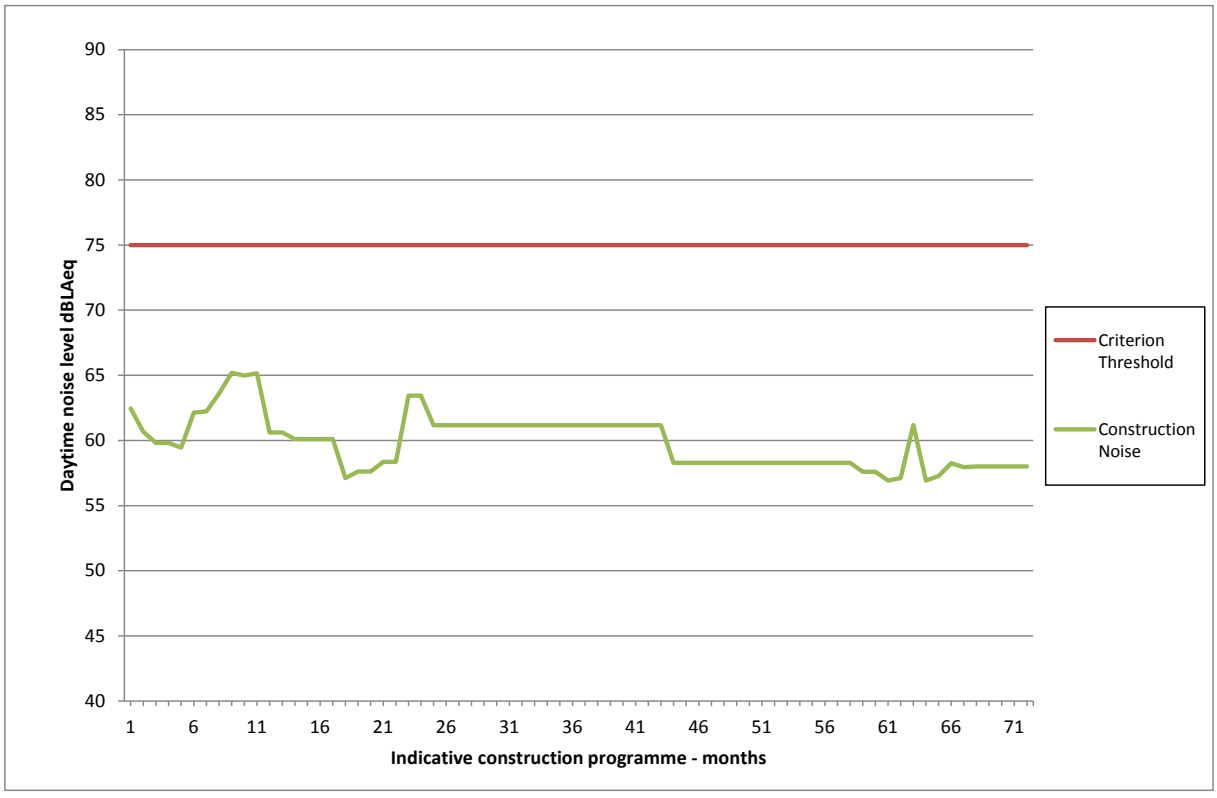
Vol 14 Plate G.6 Average monthly daytime noise level over duration of construction –Shelley House (KS1)



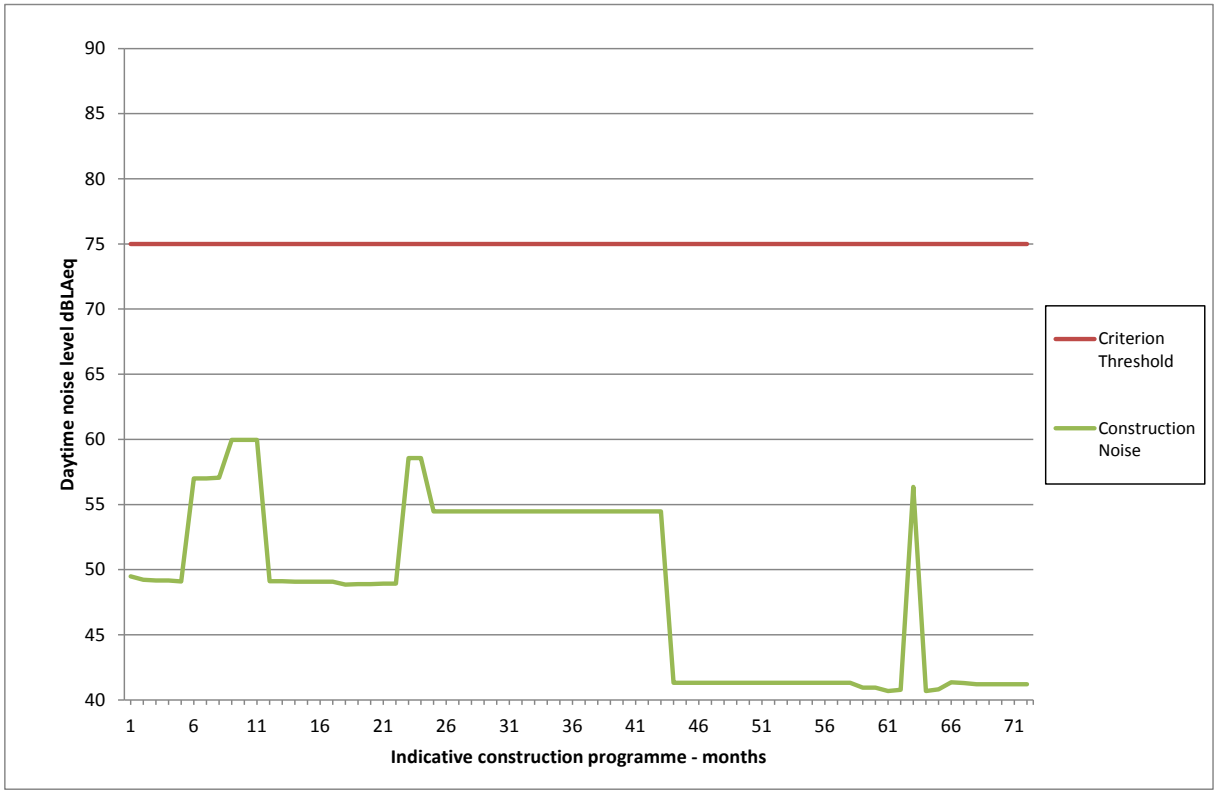
Vol 14 Plate G.7 Average monthly daytime noise level over duration of construction – Nine Elms Pier Houseboats (KS2)



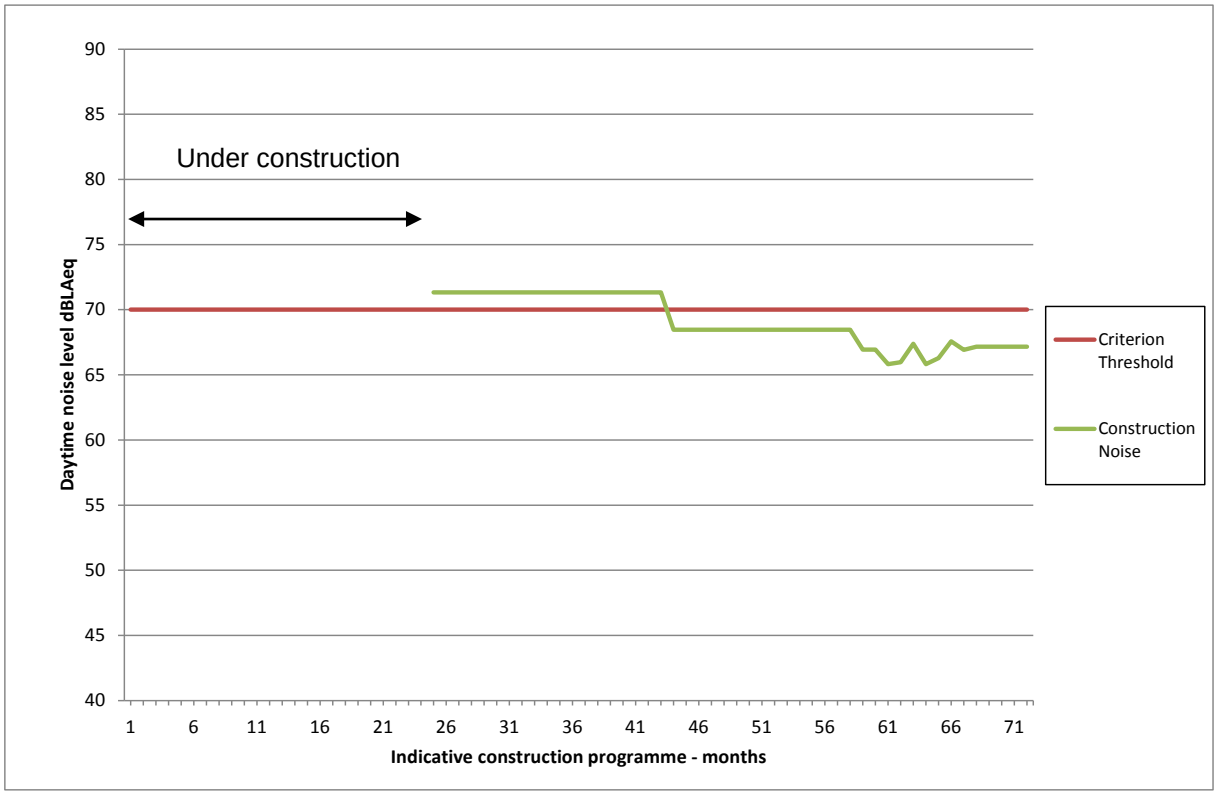
Vol 14 Plate G.8 Average monthly daytime noise level over duration of construction –River Lodge (KS3)



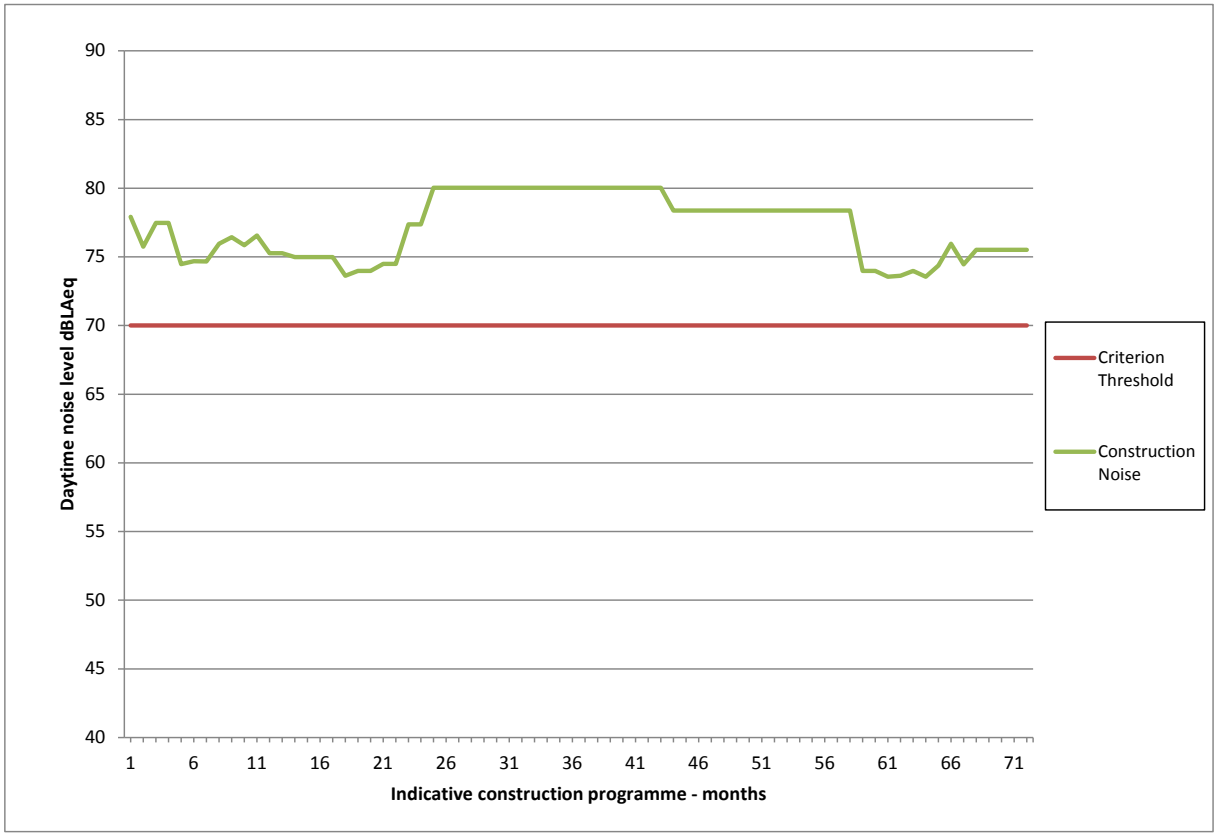
Vol 14 Plate G.9 Average monthly daytime noise level over duration of construction –Elm Quay (KS4)



Vol 14 Plate G.10 Average monthly daytime noise level over duration of construction – Riverlight Block A (KS5)



Vol 14 Plate G.11 Average monthly daytime noise level over duration of construction –Riverlight Block B (KS6)

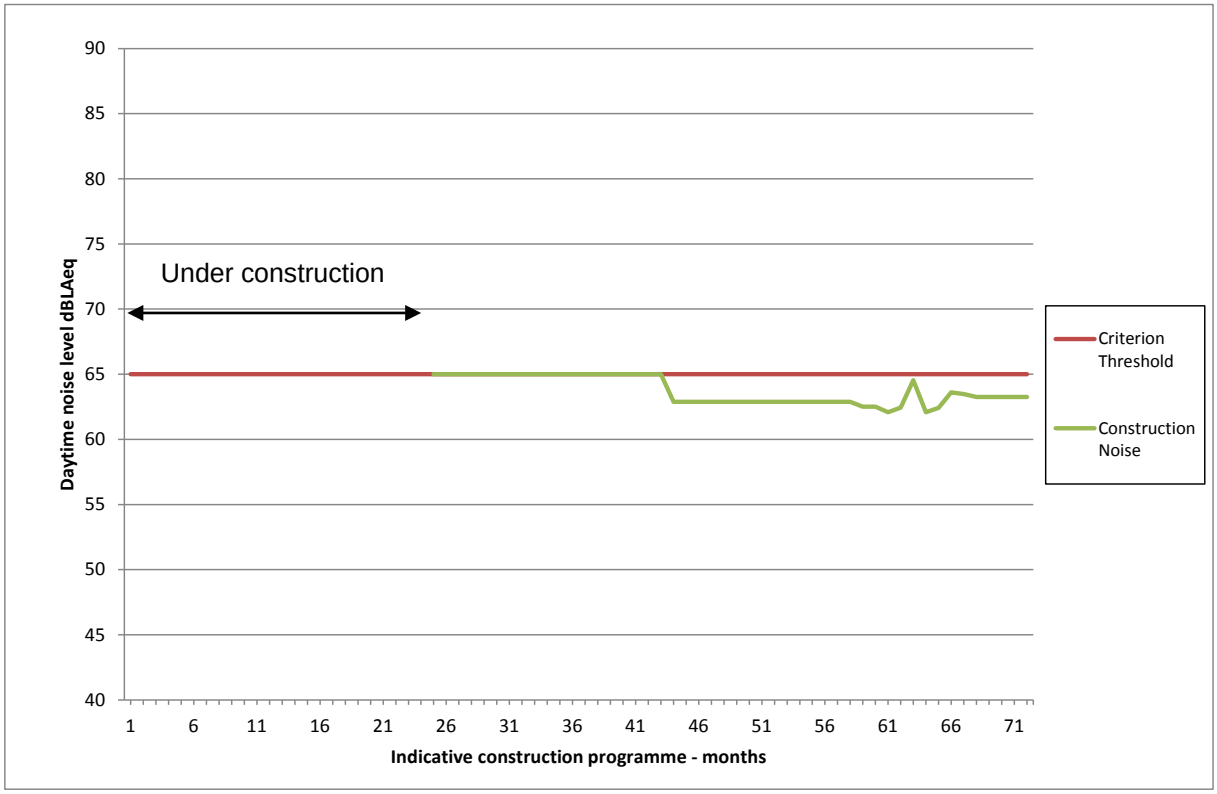


Vol 14 Plate G.12 Average monthly daytime noise level over duration of construction –Riverlight Block C (KS7)

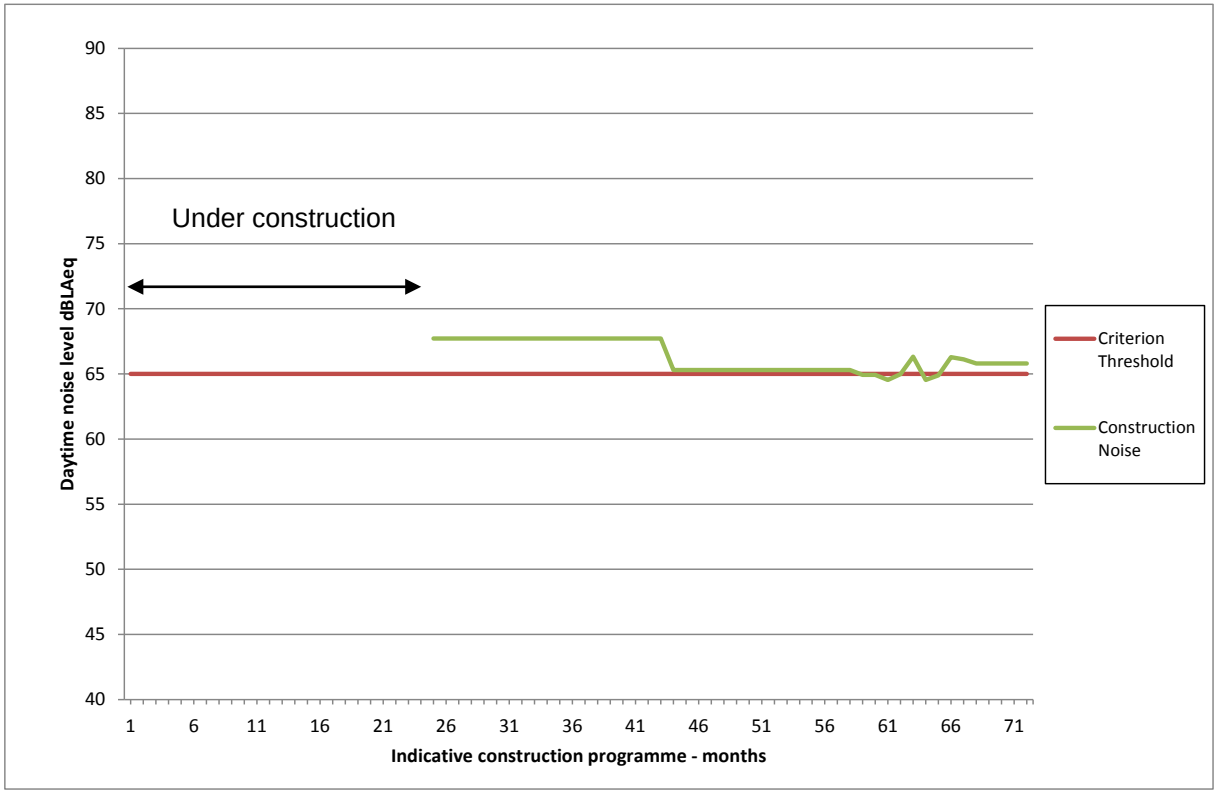
Vol 14 Plate G.13 Average monthly daytime noise level over duration of construction – 33 Nine Elms Lane (KS8)

Vol 14 Plate G.14 Average monthly daytime noise level over duration of construction – Battersea Power Station, Block PS (KS9)

Vol 14 Plate G.15 Average monthly daytime noise level over duration of construction – Battersea Power Station, Block O1 (KS10)



Vol 14 Plate G.16 Average monthly daytime noise level over duration of construction – Battersea Power Station, Block RS4 (KS11)



References

[i] BRITISH STANDARDS INSTITUTION, *BS 5228 Code of Practice for Noise and Vibration Control on Open Construction Sites*, British Standards Institution (2009)

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.14**

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Appendix H: Socio-economics

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Appendix H: Socio-economics

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Appendix H: Socio-economics

H.1 Baseline community profile

H.1.1 The community profile is based on both Output Area (OA) and local authority level data from the Office of National Statistics (ONS). The data have been obtained from four sources: Census 2001[1] (the last census for which data are available[i]), Department of Communities and Local Government Deprivation Indices 2010[2], London Public Health Observatory 2012[3], and the Network of Public Health Observatories 2011[4] (see Volume 2 Methodology). Data is grouped according to those 'protected characteristics'[ii] or groups which are relevant for consideration in relation to this socio-economic impact assessment. This baseline community profile provides context for this socio-economic assessment.

H.1.2 On the basis of likely impacts on receptors identified in this socio-economic assessment, the community profile examines the 'immediate area' surrounding the construction site (ie, within an assessment area of 250m) the 'wider local area' (ie, within an assessment area of 1km) and the overall borough level (which in this case is the London Borough [LB] of Wandsworth).

H.1.3 The main protected characteristic groups concentrated[iii] within 250m of the site are:

a. persons aged over 65
b. persons belonging to Black and Minority Ethnic (BME) groups
c. persons with a long term limiting illness
d. persons who suffer from income deprivation and overall deprivation.

H.1.4 The main protected characteristic groups concentrated within 1km of the site are:

a. persons aged under 16 years old
b. persons who suffer from income deprivation.

H.1.5 Further detail on the socio-economic profile of the local community is provided below.

Resident population

H.1.6 The resident population was approximately 1,150 within 250m of the site and 36,600 within 1km at the time of the last census.

[i] Census 2001. This type of data for the 2011 Census had not been released at the time of the assessment.

[ii] The Equalities Act 2010 defines 'protected characteristics' as: age, disability, gender reassignment, marriage and civil partnership, pregnancy and maternity, race, religion or belief, sex, and sexual orientation. Of these characteristics, age, disability, race and religion are relevant for consideration in relation to this socio-economic impact assessment.

[iii] In this instance 'concentrated' refers to the occurrence of a particular protected characteristic group, the proportion of which is notably higher than borough wide proportions.

Gender and age

H.1.7 Of the total population within 250m of the site 53.8% of residents are female, slightly higher than within 1km (51.7%) and the LB of Wandsworth (52.5%).

H.1.8 Vol 14 Table H.1 outlines age breakdown by assessment area, it illustrates that the proportion of under 16 year olds within 250m (16.4%) and 1km (15.9%) is broadly in line with the LB of Wandsworth level (16.3%). Within the above assessment areas however, the proportion of under 16 year olds is moderately lower than the Greater London average (20.2%).

H.1.9 Within 250m, the proportion of 65 year olds (18.3%) is considerably higher than within 1km (12.8%), the LB of Wandsworth (10.4%) average and at a Greater London (12.4%) level.

Vol 14 Table H.1 Socio-economics – age breakdown by assessment area

Age group	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
Under 16 years old	16.4%	15.9%	16.3%	20.2%
Over 65 years old	18.3%	12.8%	10.4%	12.4%

Ethnicity

H.1.10 Vol 14 Table H.2 outlines ethnicity by assessment area, showing that within 250m of the site, White residents make up over two thirds of the population (68.7%) with BME groups making up the remaining 31.3% residents.

H.1.11 The proportion of White residents within 250m (68.7%) is broadly in line with the proportion within 1km (73.7%) and the Greater London (71.2%) average. The proportion of White residents within the LB of Wandsworth (78.0%) is slightly higher than within the above assessment areas.

H.1.12 The proportion of BME residents within 250m (31.3%) is broadly in line with the Greater London proportion (28.8%). Black residents comprise 14.9% residents within 250m, slightly higher than within 1km (13.6%) and somewhat higher than the LB of Wandsworth and Greater London levels (9.6% and 10.9% respectively). The proportion of Asian residents within 250m (6.2%), 1km (5.0%) and within the LB of Wandsworth (7.0%) are considerably lower than the Greater London average (12.1%).

Vol 14 Table H.2 Socio-economics – ethnicity by assessment area

Ethnicity	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
White	68.7%	73.7%	78.0%	71.2%
BME	31.3%	26.3%	22.1%	28.8%
Asian	6.2%	5.0%	7.0%	12.1%
Black	14.9%	13.6%	9.6%	10.9%
Other	4.6%	3.7%	2.1%	2.7%
Mixed	5.5%	4.0%	3.4%	3.2%

Note: The figure for BME data presented in Table H.2 is the sum of data for Asian, Black, Other and Mixed ethnicities.

Religion and belief

H.1.13 The proportion of Christians within 250m of the site (61.3%) and at a borough wide level (61.8%) is slightly lower than within 1km (64.3%). Christians are the predominant religious group within all assessment areas. Muslims are the second most predominant religious group accounting for 9.5% of residents within 250m and 7.4% within 1km. These levels are higher than for the overall borough, where Muslims make up 5.2% of residents.

H.1.14 Within all of the above assessment areas, approximately 25% residents do not follow a religion, broadly in line with the Greater London average of 24.3%.

Health indicators

H.1.15 Vol 14 Table H.3 outlines health indicators by assessment area, noting that the proportion of residents suffering from a long term or limiting illness within 250m of the site (19.9%) is moderately higher than within 1km (16.3%) and the Greater London (15.5%) average, and considerably higher than the LB of Wandsworth (13.4%) average. Those residents who claim disability living allowance within 250m and 1km (6.4% and 5.4% respectively) are considerably higher than both the LB of Wandsworth levels (3.9%) and Greater London levels (4.5%).

Vol 14 Table H.3 Socio-economics – health indicators by assessment area

Health indicator	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
Long term limiting sick	19.9%	16.3%	13.4%	15.5%

Health indicator	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
Disability living allowance	6.4%	5.4%	3.9%	4.5%

H.1.16 In the Middle Layer Super Output Area (MSOA)[iv5] in which the construction site falls within, levels of adult and child obesity are in the middle quintile in the borough.

H.1.17 Data available at a borough level only indicates that adults are the most physically active and fall within the highest quintile (ie, the highest being the best) of all the London boroughs. Contrastingly, numbers of children undertaking physical activity are the lowest (ie, lowest being the worst) of the boroughs.

H.1.18 Death rates by heart disease within the MSOA are in the middle quintile within the borough. Death rates by cancer, circulatory disease and stroke are slightly more prevalent and fall within the second highest quintile (ie, highest being the worst). Death rates by respiratory disease fall within the highest quintile in the borough.

H.1.19 Female life expectancy in the MSOA is in the second lowest quintile within the borough (ie, the lowest being the worst). Male life expectancy is in the lowest quintile, with average life expectancy of female residents being 80.3-81.9 years old and male life expectancy at 74.6-80.3 years old.

Lifestyle and deprivation indicators

H.1.20 Vol 14 Table H.4 outlines lifestyle and income deprivation indicators by assessment area, showing that a reasonably high proportion of households within 250m of the site (60.4%) do not own cars, within 1km the proportion is similarly high (59.1%). This is moderately higher than both the LB of Wandsworth and Greater London averages (40.7% and 37.5% respectively).

Vol 14 Table H.4 Socio-economics – lifestyle and income deprivation levels by assessment area

Indicator	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
No car households	60.4%	59.1%	40.7%	37.5%

[iv] MSOAs are areas determined by the Office of National Statistics (ONS) to collect local area statistics. MSOAs have a minimum size of 5,000 residents and 2,000 households. MSOAs have an average population size of 7,200 residents.

Indicator	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
Income	74.1%	28.8%	15.4%	21.5%
Overall	53.2%	19.5%	10.1%	18.3%

H.1.21 Levels of deprivation[v] within 250m measured by both income deprivation (74.1%) and overall deprivation (53.2%) are considerably higher than income deprivation (28.8%) and overall deprivation (19.5%) within 1km. While deprivation levels drop notably within 1km, they remain moderately higher than the LB of Wandsworth and Greater London proportions for income deprivation (15.4% and 21.5% respectively). Overall deprivation within 1km (19.5%) is broadly in line with the Greater London average (18.3%) while at a borough level, overall deprivation is considerably lower (10.1%).

[v] Income deprivation and overall deprivation in this instance both refer to the percentage of the population which fall within the top 20% of deprived areas nationally. Percentages therefore refer to the proportion of residents within each assessment area who fall within the highest quintile of deprivation within England.

H.2 Baseline economic profile

H.2.1 This section presents a profile of the economy local to the proposed construction site at Kirtling Street.

H.2.2 Data are presented for the geographical area within a radius or 'catchment' of approximately 250m from the boundary of the Limits of land to be acquired or used (LLAU) of the project site. Data are also provided at the overall borough level (which in this case is the London Borough [LB] of Wandsworth) and for Greater London.

H.2.3 Data is sourced from Experian's National Business Database (2012)[6], which draws primarily on regularly updated records from Companies House[vi].

Employment and businesses

H.2.4 Within 250m of the site there are approximately 1,800 jobs.[vii] Vol 14 Table H.5[viii] below illustrates the breakdown of employment by sector, based on the UK Standard Industrial Classification (SIC) 2007[7]. It shows data for those sectors which account for more than 5% of total employment within approximately 250m. It can be seen that:

a. Wholesale and Retail Trade account for 28% of employment within 250m, approximately double that within both the LB of Wandsworth (14%) and Greater London (16%).

b. Administrative and Support Services account for 11% of employment within 250m, slightly more than at the other two geographical levels (both 8%).

c. Transportation and Storage account for 11% of employment within 250m, considerably more than within the LB of Wandsworth (3%) and Greater London (4%).

d. Professional, Scientific and Technical Services account for 9% to 11% of employment at all three geographical levels.

e. Manufacturing accounts for 7% of employment within 250m, somewhat more than within the LB of Wandsworth (3%) and Greater London (3%).

f. Accommodation and Food Services activities account for 6% of employment within 250m, somewhat lower than within both the LB of Wandsworth (9%) and Greater London (8%).

[vi] Information on employees and businesses reflects aggregated data for seven digit post-code units falling wholly or partially within a 250m boundary of the LLAU. This includes post code units on the opposite side of the River Thames, if relevant. Please refer to Volume 2 Appendix H for further details.

[vii] Employees data reflect a head count of workers on-site rather than Full Time Equivalent (FTE) jobs . While employee figures are mostly based on actual reported data, a proportion is based on modelled data.

[viii] Data in tables rounded to nearest whole percentage and do not always sum due to rounding.

Vol 14 Table H.5 Socio-economics – employment by top six sectors (2012)

	Assessment area		
Sector (Standard Industrial Code 2007)	**Immediate area (250m)**	**Borough wide (LB of Wandsworth)**	**Greater London**
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	28%	14%	16%
Administrative and Support Services	11%	8%	8%
Transportation and Storage	11%	3%	4%
Professional, Scientific and Technical Activities	9%	9%	11%
Manufacturing	7%	3%	3%
Accommodation and Food Service Activities	6%	9%	8%
Other (including unclassified)	17%	43%	50%

H.2.5 Within approximately 250m of the site there are approximately 170 businesses (defined here as business locations[ix]). The split of businesses by sector within 250m generally reflects the breakdown of employment by sector set out above, with a relatively high number of businesses engaged in Wholesale and Retail Trade (15%), Administrative and Support Services (12% of businesses), Professional Scientific and Technical Activities (12%), Manufacturing (7%), and Accommodation and Food Services Activities (6%).

H.2.6 Vol 14 Table H.6 illustrates the size of businesses in terms of the number of employees on site. At all geographical levels, businesses within the smallest size band (1 to 9 employees) account for the greatest proportion. However, there are a greater proportion of larger businesses within approximately 250m of the site than within the wider geographical areas. Within 250m, 77% of business units have 1 to 9 employees on site, compared to 90% within the LB of Wandsworth and 88% within Greater London. Businesses with 25 or more employees account for 9% of all businesses within 250m of the site, somewhat higher than within the LB of Wandsworth (3%) and Greater London as a whole (4%).

H.2.7 For the sectors accounting for the greatest proportions of jobs and businesses within approximately 250m, the size banding of businesses varies somewhat. 86% of Professional Scientific and Technical Activities have 1 to 9 employees while 78% of Wholesale and Retail Trade businesses are of this size, compared to an average across all sectors of 76%. Within the Administrative and Support Services sector, the

[ix] This count relates to business 'locations' or 'units'; an enterprise may have a number of business locations / units. It includes private sector, public sector and voluntary sector / charitable entities.

proportion of businesses with 1 to 9 employees is lower at 64%, with 27% of firms employing 10 to 24 staff.

Vol 14 Table H.6 Socio-economics – businesses by size band (employees at site)

Assessment area / sector	Size band (employees at site)					
	1-9	**10-24**	**25-49**	**50-99**	**100-249**	**250+**
Immediate area (250m)	76%	16%	4%	4%	0%	1%
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	78%	15%	4%	0%	0%	4%
Administrative and Support Services	64%	27%	5%	5%	0%	0%
Professional Scientific and Technical Activities	86%	5%	5%	5%	0%	0%
Borough wide (LB of Wandsworth)	90%	7%	2%	1%	0%	0%
Greater London	88%	8%	2%	1%	1%	0%

References

[1] ONS. *Neighbourhood Statistics* (2001). Available at: http://neighbourhood.statistics.gov.uk/dissemination/

[2] Department for Communities and Local Government. *Index of Multiple Deprivation 2010* (2010). Available at: http://www.communities.gov.uk/communities/research/indicesdeprivation/deprivation10/

[3] London Public Health Observatory. *Fair Society, Healthy Lives: The Marmot Review (2012)*. Available from: http://www.lho.org.uk/LHO_TOPICS/NATIONAL_LEAD_AREAS/MARMOT/MARMOTINDICATORS.ASPX. Accessed 30 August 2012

[4] Network of Public Health Observatories. *Health Profiles: London* (2011-2012) Available at: http://www.apho.org.uk/resource/view.aspx?QN=HP_REGION_H. Accessed February 2012.

[5] Office of National Statistics. Super Output Areas: Introduction (2012). Available from: http://www.neighbourhood.statistics.gov.uk/dissemination/Info.do;jessionid=vtvdPZRWZ3yhT9ShjB6TTcw00WNTZcPQgyVpGLvZjTzh7nYnBhqL!1624269762!1327075798387?m=0&s=1327075798387&een=1&page=aboutneighbourhood/geography/superoutputareas/soa-intro.htm&nsjs=true&nsck=true&nssvg=false&nswid=1225. Accessed on: 29 May 2012

[6] Experian. *National Business Database* (Database of employment and enterprise statistics). Accessed: September 2012.

[7] Office of National Statistics. *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007)*, 2009. Available at: http://www.ons.gov.uk/ons/guide-method/classifications/current-standard-classifications/index.html. Accessed 5/9/12.

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Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

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Appendix I: Townscape and visual

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Appendix I: Townscape and visual

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I.1.1 Construction and operational effects assessments at this site for this topic do not require the provision of any supporting information, so this appendix is intentionally empty.

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Appendix J: Transport

J.1 Introduction

J.1.1 Construction and operational effects assessments at this site for this topic do not require the provision of any supporting information, so this appendix is intentionally empty.

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Appendix K: Water resources - groundwater

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Appendix K: Water resources – groundwater

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Appendix K: Water resources – groundwater

K.1 Geology

K.1.1 A summary of the anticipated geological succession at the Kirtling Street site is shown in Vol 14 Table K.1.

Vol 14 Table K.1 Groundwater - anticipated geological succession

Period	Series	Group	Formation
Quaternary	Holocene	Superficial deposits	Made Ground
			Alluvium
	Pleistocene		River Terrace Deposits
Palaeogene	Eocene	Thames	London Clay
			Harwich
	Palaeocene	Lambeth	Upper Shelly Beds
			Upper Mottled Beds
			Laminated Beds
			Lower Shelly Beds
			Mid-Lambeth Hiatus*
			Lower Mottled Beds
			Upnor
		No group	Thanet Sand
Cretaceous	Upper Cretaceous	White Chalk Subgroup	Seaford Chalk**

** Not a Formation but an important depositional feature*
*** Subdivided into the Haven Brow, Cuckmere and Belle Tout members.*

K.1.2 The superficial and solid geology in the vicinity of the site, as published by the British Geological Survey (BGS, 2009)[1], is shown in Vol 14 Figure 13.4.1 and Vol 14 Figure 13.4.2 respectively (see separate volume of figures).

K.1.3 The ground investigation undertaken for the Thames Tideway Tunnel project has involved drilling boreholes both on the banks and within the main river channel for the purposes of understanding the geology and hydrogeology within the assessment area. The depths and thicknesses of geological layers have been extrapolated from nearby ground investigation boreholes drilled at the Heathwall Pumping Station site; these are boreholes SR1086 and PR1085 (at 250m and 280m respectively). A series of five shallow boreholes, up to 10m deep, have been drilled on site in 2012. The locations of all these boreholes are shown in Vol 14 Figure

13.4.1 (see separate volume of figures). The depths and thicknesses of geological layers encountered are summarised in Vol 14 Table K.2.

Vol 14 Table K.2 Groundwater - anticipated ground conditions

Formation	Top elevation* (mATD)**	Depth below river bed (m)	Thickness (m)
Made Ground	104.40	0.00	4.50****
Alluvium***	99.90	4.50	1.40
River Terrace Deposits	98.40	6.00	1.90*****
London Clay			
B	96.60	7.80	7.20
A3ii	89.40	15.00	9.92
A3i	79.48	24.92	2.35
A2	77.13	27.27	11.90
Harwich Formation	65.23	39.17	0.65
Lambeth Group			
USB	64.58	39.82	1.20
UMB	63.38	41.02	3.40
LtB/LSB	59.98	44.42	2.60
LMB	57.38	47.02	6.10
UPN (Gv)	51.28	53.12	1.00
UPN	50.28	54.12	2.88
Thanet Sand	47.40	57.00	9.50
Seaford Chalk	37.90	66.50	Not proven

** Based on an assumed ground level of 104.40mATD*
***mATD = metres above tunnel datum. A commonly used term for sub-surface construction projects, which defines height above a datum set at -100mAOD (above Ordnance Datum).*
**** Alluvium was not present in ground investigation boreholes drilled on site*
**** The Made Ground was 0.9m and 3m thick at the on site boreholes*
***** The River Terrace Deposits were between 6m and 8.9m thick at the on-site boreholesUSB–Upper Shelly Beds; UMB–Upper Mottled Beds; LtB–Laminated Beds; LSB-Lower Shelly Beds; LMB-Lower Mottled Beds; UPN (Gv)-Upnor Formation (Gravel); UPN-Upnor Formation*

K.1.4 The main tunnel shaft at the Kirtling Street site would extend down to approximately 56.98mATD and would pass through the Made Ground, Alluvium, River Terrace Deposits, London Clay Formation, Harwich Formation, Lambeth Group and into the Lower Mottled Beds (Lambeth Group). The base slab would extend to approximately 48.98mATD and into the Upnor Formation (top of the lower aquifer).

K.1.5 The Made Ground, comprising of gravely sand or sandy clay with brick, flint, concrete, tile, clinker and glass, is expected to be 4.5m at the Kirtling

Street site. The on site boreholes gave variable Made Ground thicknesses of between 0.9m and 3m.

K.1.6 The Alluvium, comprising slightly sandy, silty clay or silty gravely sand with occasional scattered pebbles and granules is expected to be 1.4m thick at the Kirtling Street site. The on site boreholes did not record any Alluvium.

K.1.7 The River Terrace Deposits are formed of extensive alluvial sand and gravel deposits laid down in river terraces, a braided river system of approximately 5km width, since the Anglian glaciation. The River Terrace Deposits are expected to be 1.9m thick at the Kirtling Street site. The on site boreholes gave variable River Terrace Deposit thicknesses of between 6m and 8.9m.

K.1.8 The London Clay is described by the BGS as "fine, sandy, silty clay/silty clay, glauconitic at base" (British Geological Survey, 2012)[2] and is comprised of stiff to very stiff clay at the Kirtling Street site. The London Clay is divided into sub-units referred from oldest to youngest as A to E, with some of these sub-units dividing further, for example A2, A3i-iii, B in decreasing age order. The London Clay Formation is expected to be 31.37m thick at the Kirtling Street site.

K.1.9 The Harwich Formation is expected to be 0.65m thick at the Kirtling Street site and comprises fine-grained glauconitic sand and rounded black flinty pebble beds, commonly deposited in a series of superimposed channels.

K.1.10 The Upper Shelly Beds (USB) of the Lambeth Group comprises grey, shelly clays with scattered glauconite grains. The Upper Shelly Beds are expected to be 1.2m thick at the Kirtling Street site.

K.1.11 The Upper Mottled Beds (UMB) of the Lambeth Group comprises silty clay and clay, generally un-bedded, fissured and blocky, with up to 50% silt and sand. The Upper Mottled Beds are expected to be 3.4m thick at the Kirtling Street site.

K.1.12 The Laminated Beds (LtB)/ Lower Shelly Beds (LSB) comprises thinly interbedded fine to medium grained sand, silt and clay with shells and dark grey to black clay with abundant shells respectively. These units in combination are expected to be 2.6m thick at the Kirtling Street site.

K.1.13 The Lower Mottled Beds (LMB) of the Lambeth Group comprises silty clay and clay, generally un-bedded, fissured and blocky, with up to 50% silt and sand. The Lower Mottled Beds are expected to be 6.1m thick at the Kirtling Street site.

K.1.14 The Upnor Formation (UPN) is a variably bioturbated fine- to medium-grained sand with glauconite, rounded flint pebbles and minor clay, with distinctive pebble beds and base and top (Upn (Gv)). The Upnor Formation is expected to be 3.88m thick at the Kirtling Street site.

K.1.15 The Thanet Sand Formation is described by the BGS as "marine glauconitic clayey silts and fine sands, varying in thickness" (BGS, 2012) and only occurs in the London Basin (British Geological Survey, 2000)[3]. The Thanet Sand is expected to be 9.5m thick at the Kirtling Street site.

K.1.16 The Seaford Chalk is the upper unit of the White Chalk, comprising of as firm to soft non-nodular Chalk with flint beds. Thin marl seams are found in the lower 8m and absent higher up. A hard ground marks the top of the Seaford Chalk. The total thickness of Seaford Chalk was not proven through the available ground investigation.

K.1.17 In terms of geological structure, it is noted that there is a series of N-S and SSW-NNE trending faults are identified between Battersea and Chelsea bridges – referred to as the Chelsea Embankment (Albert Bridge) Fault Zone - intersecting the tunnel alignment at near to the perpendicular (Royse, 2008)[4]. It is reported that there is up to 5m vertical displacement of strata over this zone (Royse, 2008)[4], resulting in uplift of the top of the Lambeth Group deposits into the proposed tunnel invert on the east side of Albert Bridge and tunnel construction at Chelsea Embankment. The Kirtling Street site is to the east of this fault zone; however, there may be minor faulting and fractures local to the site, together with localised displacement. Faults may enhance or impede groundwater movement.

K.2 Hydrogeology

K.2.1 A summary of the anticipated hydrogeological conditions at the Kirtling Street site is shown in Vol 14 Table K.3.

Vol 14 Table K.3 Groundwater - anticipated hydrogeological units

Group	Formation	Hydrogeology
Superficial Deposits	(Made Ground) Alluvium	Confining layer
	River Terrace Deposits	Upper aquifer
Thames	London Clay	Aquiclude*
	Harwich	Aquitard** / aquifer
Lambeth	Upper Shelly Beds Upper Mottled Beds Laminated Beds Lower Shelly Beds ---Mid Lambeth Hiatus--- Lower Mottled Beds Upnor	Aquitards/ aquifers
No group	Thanet Sand	Lower aquifer
White Chalk Subgroup	Seaford Chalk	

** Aquiclude - a hydrogeological unit which, although porous and capable of storing water, does not transmit it at rates sufficient to furnish an appreciable supply for a well or spring (USGS, 1989)[5].*

*** Aquitard - a poorly-permeable geological formation that does not yield water freely, but may still transmit significant quantities of water to or from adjacent aquifers (EA, 2012)[6].*

K.2.2 The Made Ground and Alluvium are likely to confine the underlying River Terrace Deposits or upper aquifer above the upper aquifer in the vicinity of ground investigation borehole SR1086, where clay was recorded.

K.2.3 The upper aquifer (River Terrace Deposits) is defined by the Environment Agency (EA) as a secondary A aquifer. These deposits are described as "permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers" (EA, 2012)[7].

K.2.4 The lower aquifer comprises the Upnor and the Thanet Sand formations (both classified as secondary aquifers by the EA), and the Chalk (classified as a principal aquifer by the EA). A principal aquifer is described by the EA as "layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer" (EA website, 2012).

K.2.5 The main tunnel shaft would pass through the upper aquifer and then the London Clay Formation (B, A3ii A3i and A2 sub divisions). The London Clay Formation is generally acknowledged as an aquiclude between the upper and lower aquifers. Any groundwater present in a majority of the London Clay Formation is likely to consist of localised seepages and/or minor flows, the exception being unit A3ii which is regarded as the most porous section of this formation. It is anticipated that below the River Terrace Deposits the main tunnel shaft would be excavated in predominantly dry London Clay Formation with the exception of minor seepage at various horizons, namely silt or claystone horizons. In unit A3ii, the presence of fine sand laminea/lenses at this horizon, may act as horizontal conduits for migration of groundwater from a nearby source.

K.2.6 The main tunnel shaft would pass through the Harwich Formation, which may form a minor aquifer unit where it is isolated from the lower aquifer (Chalk / Thanet Sands) by the Lambeth Group. There may be limited connection via erosive features to the lower aquifer.

K.2.7 The main tunnel shaft would also pass through the Lambeth Group, in which several confined groundwater bodies are anticipated to be encountered. Groundwater inflows are expected during excavation within the Upper Shelly Beds (USB) with potentially small inflows and more significantly at sub-artesian pressures within the Laminated Beds (formerly part of the Woolwich Formation).

K.2.8 The base slab would extend into the top of the lower aquifer (the Upnor Formation) by approximately 2.3m. The Upnor Formation is considered to be in hydraulic continuity with the underlying Thanet Sands and the Chalk.

K.2.9 The hydrogeological properties of the Chalk (principal aquifer) are defined by its transmissivity [the ability of rock to transmit water and is a function of its permeability and aquifer thickness] and storativity [the amount of water which the aquifer releases per unit change in water level]. The Chalk in

the area around Kirtling Street is expected to have a medium to high transmissivity value of between 200m^2/d and 700m^2/d (average of 450m^2/d). The storativity value is expected to be approximately 1 x10^{-4} (EA and ESI, 2010)[8].

K.3 Groundwater level monitoring

K.3.1 Groundwater level monitoring was undertaken at a number of ground investigation boreholes across the assessment area with a few exceptions. In addition, the EA has a regional network of monitoring boreholes, mainly within the lower aquifer, across London which records are available dating back over 50 years.

K.3.2 Information on groundwater levels for this assessment was collected from three ground investigation boreholes located off site and within 180m from the Kirtling Street site (PR1081, SA1082 and SA1084). These boreholes have response zones[i] and monitor groundwater levels in the River Terrace Deposits, the Thanet Sands and the Chalk. The response zone depths, the monitored strata and the frequency of monitoring are detailed in Vol 14 Table K.4. The manual dip and logger data collected from these monitoring boreholes is shown in Vol 14 Table K.5.

Vol 14 Table K.4 Groundwater - monitoring boreholes

Borehole	Response zone depths mATD	Strata	Monitoring
SA1084	99.51 - 96.71	River Terrace Deposits	Fortnightly dips
SA1082	48.55 - 44.55	Thanet Sand Formation	Fortnightly dips and logger
PR1081	45.8 – 47.2	Seaford Chalk	Fortnightly dips and logger
TQ27/334	Not available	Chalk	Monthly dips

Vol 14 Table K.5 Groundwater – summary level data

Borehole	Period of record	Maximum Month Year		Minimum Month Year		Average over the period of record	
		mbgl	mATD	mbgl	mATD	mbgl	mATD
SA1084	28/05/2009 – 13/07/2011	4.46 (Oct. 2010)	100.55 (Oct. 2010)	4.81 (July 2009)	100.20 (July 2009)	4.66	100.35

[i] Response zone - the section of a borehole that is open to the host strata (EA, 2006)

Borehole	Period of record	Maximum Month Year		Minimum Month Year		Average over the period of record	
		mbgl	mATD	mbgl	mATD	mbgl	mATD
SA1082	18/5/2009 – 13/07/2011	4.22 (Dec. 2009)	100.83 (Dec. 2009)	4.92 (May 2011)	100.13 (May 2011)	4.61	100.44
PR1081	28/05/2009 – 13/07/2011	26.27 (Oct. 2010)	78.59 (Oct. 2010)	36.58 (July 2009)	68.28 (July 2009)	30.99	73.87
TQ27/334	30/10/1992 – 20/09/2012	25.85 (April 2000)	79.65 (April 2000)	48.17 (Dec. 2011)	57.33 (Dec. 2011)	34.67	70.80

K.3.3 The recorded water levels in the River Terrace Deposits at SA1084 range from 100.2mATD to 100.55mATD. These water levels consistently remain above the top of the formation at 98.4mATD, indicating that this formation is fully saturated and is confined by the overlying Made Ground and Alluvium.

K.3.4 The recorded water levels (piezometric head) in the Thanet Sands at SA1082 range from 68.97mATD to 79.27mATD. These water levels consistently remain above the top of the formation at 47.4mATD, indicating that this formation is fully saturated and is confined by the overlying London Clay Formation and Lambeth Group.

K.3.5 The recorded water levels (piezometric head) in the Chalk at PR1081 range from 68.28mATD to 78.59mATD. These water levels consistently remain above the top of the formation at 37.9mATD, indicating that this formation is fully saturated and confined by the overlying London Clay Formation and Lambeth Group. In addition, these water levels are very similar to those recorded in the Thanet Sands, indicating that these units are in hydraulic continuity.

K.3.6 A plot of groundwater levels within the upper aquifer and lower aquifer in the vicinity of the site is shown in Vol 14 Figure 13.4.3 (see separate volume of figures). There is only one borehole in the upper aquifer near the site (SA1084) and as such it is difficult to determine the direction of groundwater flow. However it is likely that the direction of groundwater movement is to the north, towards the River Thames, in these shallow deposits.

K.3.7 The EA network does not include any monitoring boreholes sufficiently close by to provide representative water level in the upper aquifer at the site.

K.3.8 The nearest EA groundwater level observation borehole in the lower aquifer, with records up to 2012 (TQ27/334), is located at 0.8km to the northwest on the opposite side of the River Thames and is shown in Vol 14 Figure 13.4.4 (see separate volume of figures).

K.3.9 The fluctuations in Chalk piezometric level vary annually by around 1.5m (as in 1989). Some larger fluctuations of up to 15m have occurred in certain years (2004), indicating that abstraction influences may be affecting the piezometric levels in this observation borehole. It is noted that the influence on the long term trend of rising water table commenced in late 2000. The recent lowering of levels reflects increase use of groundwater in central London.

K.3.10 The EA have produced regional groundwater contour plots which display the groundwater flowing in a northwest direction across site (EA, 2011)[9].

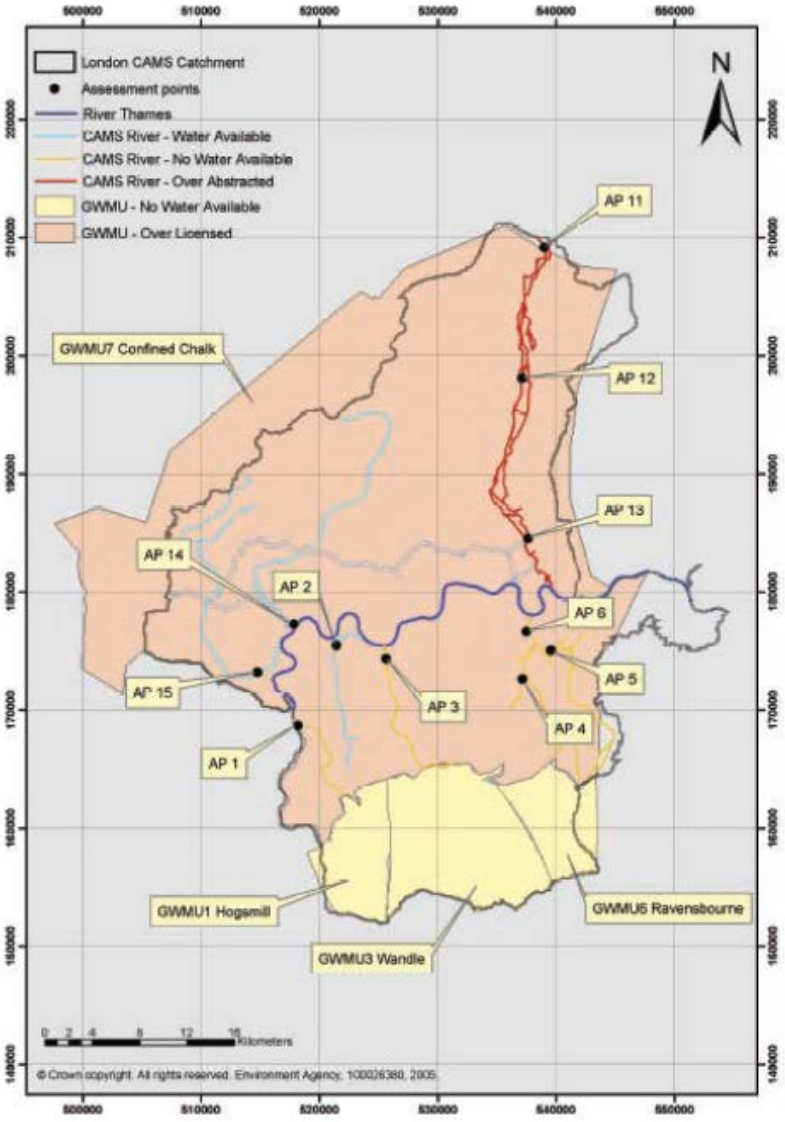
K.4 Groundwater abstractions and protected rights

Groundwater licensing policy

K.4.1 The London Catchment Abstraction Management Strategy (CAMS), (EA, 2006)[10] does not identify a condition status for the upper aquifer.

K.4.2 The EA identifies a condition status for the lower aquifer and defines a policy through its London CAMS, which restricts new abstractions in central, east and south London and further abstraction in areas approaching their sustainable limit (EA, 2006)[11]. The Kirtling Street site is located within the confined Chalk groundwater management unit GWM7, which is classified as being over-licensed (see Vol 14 Plate K.1) (EA, 2006). Within this area, there is a limit on the availability of groundwater resources such that large abstractions (>1-2Ml/d) would generally not be granted unless the applicant can demonstrate that the resources are available (EA, 2006). In addition, large abstractions may also have a time limit shorter than the London CAMS common end date of 2013 (EA, 2006).

Vol 14 Plate K.1 Groundwater - confined Chalk licensing



**Reproduced from EA, 2006*
Note: GWMU – groundwater management unit, AP – assessment point

K.4.3 The CAMS policy also states that, "every application would be assessed on its own merits, be subject to a detailed local hydrogeological assessment and require the submission of the necessary supporting justification and reports for a decision to be made on an individual scheme" (EA, 2006)[10]. A preliminary hydrogeological assessment, following guidance provided in the CAMS policy, has been completed for the proposed development in Vol 14 Table K.6.

Vol 14 Table K.6 Groundwater licensing assessment

No.	Question	Preliminary response
1.	Has there been any long-term (several years) downward trend in the groundwater level in the vicinity of the application?	The hydrograph in Vol 14 Figure 13.4.4 (see separate volume of figures) for an EA observation borehole at the site shows the groundwater level increased from 1986 to 2000; displayed a downward trend from 2000 to 2004 and started to rise again in 2009.
2.	The groundwater level in relation to the base of the London Clay. If the groundwater level is near the base of the London Clay, then the EA would be unlikely to grant the abstraction licence. The EA would use discretion if there is a significant thickness of the Lambeth Group below the London Clay, but the aim is to manage abstraction to keep groundwater levels above the Thanet Sands.	The EA data confirms that groundwater levels measured in the Chalk by the EA have consistently remained between 76 to 89mATD between 1986 and 2000, declining to about 60mATD in 2001; between 1m below and 12m above the base of the London Clay between 1986 and 2000, dropping to a level corresponding the Upper Shelly Bed and Upper Mottled Beds since 2000. Whilst there would be a need to depressurise the lower aquifer, dewatering would be to above the top of the Thanet Sands and Upnor Beds.
3.	Any recent abstraction development in the same area. If groundwater levels have not yet responded to a recent change in abstraction, the EA may not grant further licences in that area.	No recent developments are known.
4.	Other proposals in the area that have been refused for water resource reasons in the last five years.	No refusals known.
5.	Proximity of the proposal to an existing or proposed Artificial Recharge Scheme (ARS). Artificial Recharge scheme proposals would be treated as a special case as they involve the management of groundwater levels to provide additional resource to the scheme operator.	No known ARS in the vicinity.

K.4.4 The estimated average rate of dewatering required at Kirtling Street site from the lower aquifer is approximately 440m^3/d and are above the most restrictive abstraction licensing limit set by the EA of 0.2Ml/d (200m^3/d) for

Central and South London (EA, 2006)[10]. Therefore a detailed local assessment is likely to be required by the EA.

Licensed abstractions

K.4.5 The EA licenses abstraction from groundwater within London for all sources in excess of 20m3/d. Groundwater abstractions within 1km of the site have been identified and are displayed in Vol 14 Figure 13.4.5. The locations of public water supply sources are not presented due to restriction on the display of this information.

K.4.6 There are several licensed groundwater abstractions from the Chalk within a one kilometre radius of the site. These abstraction points lie to the east, west and northeast of the Kirtling Street site. There is one licensed groundwater abstraction from the River Terrace Deposits or upper aquifer located approximately 1.1km to the northwest.

K.4.7 The nearest licensed groundwater abstraction from the River Terrace Deposits or upper aquifer is licence number 28/39/39/0225, held by the Royal Horticultural Society for agricultural purposes and is located approximately 1.1km to the northwest of the Kirtling Street site.

K.4.8 The nearest licensed groundwater abstraction from the Chalk (TH/39/42/007) is held by St James Group Ltd., is located at approximately 0.1km to the east of the Kirtling Street site, consists of three abstraction points and three discharge points and is used as an open loop GSHP scheme.

K.4.9 The consented groundwater abstraction TP07/005 is held by St George South London Ltd., is located approximately 0.7km to the east of the Kirtling Street site, consists of three abstraction points and three discharge points and is used as an open loop GSHP scheme.

K.4.10 The licensed groundwater abstraction 28/39/39/0139 is held by Panoramic Management Ltd., is located approximately 0.9km northwest of the site, consists of two abstraction points and is used for industrial and for use open loop GSHP scheme purposes.

K.4.11 The licensed groundwater abstraction 28/39/39/0141 is held by Mantilla Ltd., is located within 1km, to the north of the Kirtling Street site, consists of five abstraction points and is used for water supply purposes.

K.4.12 The licensed groundwater abstraction 28/39/42/0074 is held by Halcyon Estates Ltd., is located within 1km of the site, to the west of the Kirtling Street site and is used for water supply purposes.

K.4.13 Groundwater abstraction licence (28/39/42/0072) is held by Thames Water Utilities Ltd., and is located <1km to the west of the Kirtling Street site. It is used for public water supply purposes.

K.4.14 Further details of these licensed abstractions are given in Vol 14 Table K.7.

Vol 14 Table K.7 Groundwater - licensed abstractions

Licence number	Licence holder	Purpose	Aquifer
28/39/39/0225	Royal Horticultural Society	Agriculture	River Terrace Deposits
28/39/39/0139	Panoramic Management Co Ltd	Industrial, commercial and public services and GSHP	Chalk
28/39/39/0141	Mantilla Limited	Water supply	Chalk
28/39/42/0074	Halcyon Estates Limited	Water supply	Chalk
28/39/42/0072	Thames Water Utilities Limited	Water supply	Chalk
TH/39/42/007	St James Group Limited	Evaporative cooling	Chalk
TP07/005	St George South London Limited	Evaporative cooling	Chalk

K.4.15 There are no known unlicensed groundwater abstractions located within 1km of the Kirtling Street site.

K.5 Groundwater Source Protection Zones

K.5.1 The EA defines Source Protection Zones (SPZ) around all major public water supply abstractions sources and large licensed private abstractions in order to safeguard groundwater resources from potentially polluting activities.

K.5.2 The Kirtling Street site is located within the modelled SPZ 1 (50 day time of travel to the source) for the Thames Water Utilities source located at approximately <1km to the west (see Vol 14 Figure 13.4.2 in separate volume of figures).

K.5.3 There is a second modelled SPZ 1 approximately within a kilometre, to the north-northeast of the Kirtling Street site, which is designated for the Mantilla Limited source, which is located <1km to the north.

K.5.4 Due to the proximity of both of these abstractions, and the size of the license abstractions, it is anticipated that when abstraction is taking place, the groundwater flow would be towards these abstraction points rather than consistent with the direction of regional groundwater flow expected beneath the site. A seasonal control on this groundwater gradient may be led by a seasonal demand of abstractions from the Thames Water Utilities

supply source, thereby impacting on the regional gradient (see Section K.3.5).

K.5.5 As part of this assessment, a capture zone[ii] (Hiscock, 2005)[12] was estimated the licensed groundwater abstraction from the River Terrace Deposits or upper aquifer 28/39/39/0225, using licence information and appropriate aquifer properties. The boundaries of this capture zone would be approximately 1km from the Kirtling Street site.

K.6 Environmental designations

K.6.1 There are no designations relevant to groundwater such as SSSI, SAC and SNCIs, within 1km of the Kirtling Street site.

K.7 Groundwater quality and land quality assessment

K.7.1 Historical land use mapping, reviewed as part of the land quality assessment, shows unidentified Works, Paint and Colour Works at the Kirtling Street site during 1916-1952 and warehousing from 1976 to present). In addition, a historical landfill site has been identified within 60m of the site (Vol 14 Section 8). Land quality may impact on groundwater quality through the creation or promotion of preferential pathways for existing contamination during construction of the proposed development.

K.7.2 The groundwater quality data presented in K.7.5Vol 14 Table K.8 has been sourced from the ground investigation and monitoring works undertaken as part of the Thames Tideway Tunnel project and includes data from monitoring boreholes located off site and up to 800m away (PR1085, SR1086, SA1084, SA1082, PR1081, SR1083 and PR1088) (for locations see Vol 14 Figure 13.4.1 in separate volume of figures) and within the River Terrace Deposits and Chalk. Any exceedances of the UK drinking water standards (The Water Supply Regulations, 2000)[13] or relevant Environmental Quality Standards – EQS) (River Basin Districts Typology, 2010)[14] are shaded in blue in this table.

K.7.3 The data shows exceedances of the relevant standards within the River Terrace Deposits at PR1088 (located at 798m from the site) with respect to ammonia, chloride, cypermethrin, sodium and turbidity, at SA1084 (located at 95m from the site) with respect to arsenic and at PR1085 (located at 280m from the site) with respect to ammonia, chloride, heavy metals, PAH's and turbidity. The data also shows exceedances within the Chalk at SR1083 (located at 71m from the site) with respect to polycyclic aromatic hydrocarbons (PAH's), at PR1081 (located at 102m from the site) with respect to heavy metals and sulphate. PAH's may be formed during a range of human activities, including incomplete combustion of carbon-based fuels and other industrial processes (EA, 2010)[15]. In addition, PAH's are considered to be Priority Hazardous Substances under the

[ii] Capture zone - a zone of contribution around a well that encompasses all areas or features that supply groundwater to the well.

Water Framework Directive (Commission of the European Communities, 2009)[16].

K.7.4 The EA monitors groundwater quality at number of points across London. The nearest EA monitoring is at Dolphin Square at approximately 0.4km to the north of the Kirtling Street site, on the other side of the River Thames. The data here shows exceedances of the UK drinking water standard within the Chalk with respect to ammonia, pesticides, herbicides, heavy metals, sulphate, potassium, PAH's and benzene.

K.7.5 The land quality data from the ground investigation boreholes used in the groundwater quality assessment show no exceedances of the human health screening values (EA, 2009)[17] (soil guideline values designed to be protective of human health) within the River Terrace Deposits but exceedances with respect to heavy metals and hydrocarbons in the overlying Made Ground and Alluvium. Further detail is provided in the land quality assessment (see Vol 14 Appendix F).

Vol 14 Table K.8 Groundwater – groundwater quality results

Source of data*				SI	SI	SI	SI	SI	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT
Name				SR1083	SA1084	PR1081	SA1082	PR1085	PR1085	PR1085	PR1085	PR1085	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	SR1089	SR1089	SR1089
Hydrogeological unit**				SCK	RTD	SCK	CK	ALV	ALV	ALV	ALV	ALV	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	TSF	TSF	TSF
Distance from site	EQS Criteria			71m	95m	102m	177m	280m	280m	280m	280m	280m	798m	798m	798m	798m	798m	798m	798m	798m	1039m	1039m	1039m
Chemical	Value	Units	Source	2009	2009	2009	2009	2009	14/11/11	13/1/12	20/4/12	31/5/12	22/8/11	2/11/11	9/1/2012	23/3/12	2/5/2012	14/8/12	17/8/12	18/11/11	18/1/12	19/3/12
1,1 - Dichloroethane	10	ug/l	WFD 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1 - Dichloroethene	30	ug/l	WHO 2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1 - Dichloropropene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1,1 - Trichloroethane	100	ug/l	SW Regs 98	-	-	-	-	-	<0.08	<0.08	-	< 0.08	<0.08	<0.08	<0.08	-	< 0.08	<0.08	-	<0.08	<0.08	-
1,1,1,2 - Tetrachloroethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1,2 - Trichloroethane	400	ug/l	SW Regs 98	-	-	-	-	-	<0.2	<0.2	-	< 0.2	<0.2	<0.2	<0.2	-	< 0.2	<0.2	-	<0.2	<0.2	-
1,1,2,2 - Tetrachloroethane {Acetosan}{Bonaform}{Cas Rn 79-34-5}	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,2 - Dibromo - 3 - Chloropropane	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,2 - Dibromoethane	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,2 - Dichlorobenzene	1000	ug/l	WHO 2004	-	<3.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,2 - Dichloroethane {Ethylene Dichloride}	3	ug/l	WS Regs 20	-	-	-	-	-	<0.12	<0.12	-	< 0.12	<0.12	<0.12	<0.12	-	< 0.12	<0.12	-	<0.12	<0.12	-
1,2 - Dichloroethene (Trans)	30	ug/l	WHO 2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,2 - Dichloropropane	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,2,3 - Trichlorobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,2,3 - Trichloropropane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,2,4 - Trichlorobenzene	-	ug/l	None	-	<2.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,2,4 - Trimethylbenzene	-	ug/l	None	<1.7	-	<1.7	<1.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,3 - Dichlorobenzene	-	ug/l	None	-	<2.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,3 - Dichloropropane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,3 - Dichloropropene (Trans)	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,3 - Dichloropropane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,3 - Dichloropropene (Trans)	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,3,5 - Trichlorobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,3,5 - Trimethylbenzene	-	ug/l	None	<1.8	<2.7	<1.8	<1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 - Chloronaphthalene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 - Chlorophenol	50	ug/l	WFD 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 - Chlorotoluene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 - Methylnaphthalene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 - Methylphenol {O-Cresol}	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 - Nitroaniline	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 - Nitrophenol	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2,2 - Dichloropropane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2,3 - Dimethylphenol {2,3-Xylenol}	-	ug/l	None	-	-	-	-	-	-	-	<0.0500	-	-	-	-	<0.0500	-	-	-	-	-	<0.0500
2,3,5,6 - Tetrachloroaminobenzene {2,...Aniline}	-	ug/l	None	-	-	-	-	-	-	-	0.00170	-	-	-	-	<0.0050 0	-	-	-	-	-	<0.0050 0
2,4 - Dichlorophenol	20	ug/l	WFD 2010	-	-	-	-	<0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2,4 - Dimethylphenol {2,4-Xylenol}	-	ug/l	None	-	-	-	-	<0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2,4 - Dinitrotoluene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2,4,5 - Trichlorophenol	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2,4,6 - Trichlorophenol	-	ug/l	None	-	-	-	-	<0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2,6 - Dichlorophenol	-	ug/l	None	-	-	-	-	<0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2,6 - Dimethylphenol {2,6 Xylenol}	-	ug/l	None	-	-	-	-	-	-	-	<0.0500	-	-	-	-	<0.0500	-	-	-	-	-	<0.0500
2,6 - Dinitrotoluene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 - Nitroaniline	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3,4 - Dimethylphenol {3,4 Xylenol}	-	ug/l	None	-	-	-	-	-	-	-	<0.0500	-	-	-	-	<0.0500	-	-	-	-	-	<0.0500
4 - Bromophenylphenyl ether	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4 - Chloro - 3- Methylphenol {P-Chloro-M-Cresol}	40	ug/l	WFD 2010	-	-	-	-	<0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Source of data*				SI	SI	SI	SI	SI	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT
Name				SR1083	SA1084	PR1081	SA1082	PR1085	PR1085	PR1085	PR1085	PR1085	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	SR1089	SR1089	SR1089
Hydrogeological unit**				SCK	RTD	SCK	CK	ALV	ALV	ALV	ALV	ALV	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	TSF	TSF	TSF
Distance from site	EQS Criteria			71m	95m	102m	177m	280m	280m	280m	280m	280m	798m	798m	798m	798m	798m	798m	798m	798m	1039m	1039m	1039m
Chemical	Value	Units	Source	2009	2009	2009	2009	2009	14/11/11	13/1/12	20/4/12	31/5/12	22/8/11	2/11/11	9/1/2012	23/3/12	2/5/2012	14/8/12	17/8/12	18/11/11	18/1/12	19/3/12
4 - Chloroaniline	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4 - Chlorophenyl phenyl ether	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4 - Chlorotoluene	-	ug/l	None	<1.9	-	<1.9	<1.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4 - Isopropyltoluene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4 - Nitroaniline	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4 - Nitrophenol	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4-Methylphenol {para-Cresol}	-	ug/l	None	-	-	-	-	-	-	-	<0.0500	-	-	-	-	<0.0500	-	-	-	-	-	<0.0500
Acenaphthene	-	ug/l	None	1.55	<1	<0.015	<0.015	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acenaphthylene	-	ug/l	None	0.331	<1	<0.011	<0.011	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acenapthene	-	ug/l	None	-	-	-	-	-	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
Acenapthylene	-	ug/l	None	-	-	-	-	-	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
Aliphatics >C10-C12	-	ug/l	None	<10	-	<10	<10	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatics >C12-C16 (Aqueous)	-	ug/l	None	1030	-	<10	<10	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatics >C16-C21 (Aqueous)	-	ug/l	None	1480	-	<10	<10	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatics >C21-C35 (Aqueous)	-	ug/l	None	585	-	<10	<10	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatics >C6-C8	-	ug/l	None	<10	-	<10	<10	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatics >C8-C10	-	ug/l	None	<10	-	<10	<10	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatics C5-C6	-	ug/l	None	<10	-	<10	<10	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity (Carbonate)	-	mg/l as CaCO3	None	-	-	-	-	-	<4	-	-	-	-	<4	-	-	-	-	-	<4	-	-
Alkalinity Ph 4.5 - As CaCO3	-	mg/l as CaCO3	None	-	-	-	-	420	510	422	-	392	340	307	294	-	287	-	315	187	184	-
Aluminium Dissolved	200	ug/l as Al	DWS 2010	-	-	-	-	-	-	-	0.35	-	-	-	-	0.076	-	-	-	-	-	0.13
Aluminium Total	200	ug/l as Al	DWS 2010	-	-	-	-	-	240	0.06	-	0.31	37	62	0.034	-	0.013	0.057	-	550	0.047	-
Ammonia - As N	0.39	mg/l as N	WS Regs 20	-	-	-	-	-	20.1	13	-	9.89	2.7	3.4	3.8	-	2.72	2.84	-	<0.05	<0.05	-
Ammoniacal nitrogen	-	mg/l	None	<0.2	-	0.402	0.948	9.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	0.1	ug/l	SW WFD	1.28	<1	0.018	<0.015	<0.01	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
Antimony Total	5	ug/l	DWS 2010	-	-	-	-	-	-	-	1.9	-	-	-	-	0.3	-	-	-	-	-	0.4
Aromatics >C7-C8	50	ug/l	WFD 2010	<10	-	<10	<10	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aromatics >EC10-EC12	-	ug/l	None	<10	-	<10	<10	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aromatics >EC12-EC16 (Aqueous)	-	ug/l	None	852	-	<10	<10	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aromatics >EC16-EC21 (Aqueous)	-	ug/l	None	854	-	<10	<10	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aromatics >EC21-EC35 (Aqueous)	-	ug/l	None	575	-	<10	<10	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aromatics >EC8-EC10	-	ug/l	None	<10	-	<10	<10	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aromatics C6-C7	1	ug/l	DWS 2010	<10	-	<10	<10	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic Total	10	ug/l as As	DWS 2010	3	-	1.4	<0.75	<1	2	3.2	-	2.3	4.1	4.8	4.1	-	3.2	3.9	-	75.1	<1	-
Atrazine { }	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.08000	<0.08000	-	<0.00800	<0.00300	<0.00300	<0.04000	-	<0.00800	<0.00800	-	<0.00300	<0.00300	-
Azobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barium Dissolved	100	ug/l as Ba	SW Regs 96	-	-	-	-	-	-	-	37	-	-	-	-	120	-	-	-	-	-	230
Barium Total	100	ug/l as Ba	SW Regs 96	-	-	-	-	-	-	-	37	-	-	-	-	130	-	-	-	-	-	240
Bentazone	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.00800	<0.00800	-	<0.00800	<0.00800	<0.00800	<0.00800	-	<0.00800	<0.00800	-	<0.00800	<0.00800	-
Benz[a]-Anthracene	-	ug/l	None	-	-	-	-	-	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01

Source of data*				SI	SI	SI	SI	SI	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT
Name				SR1083	SA1084	PR1081	SA1082	PR1085	PR1085	PR1085	PR1085	PR1085	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	SR1089	SR1089	SR1089
Hydrogeological unit**				SCK	RTD	SCK	CK	ALV	ALV	ALV	ALV	ALV	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	TSF	TSF	TSF
Distance from site	EQS Criteria			71m	95m	102m	177m	280m	280m	280m	280m	280m	798m	798m	798m	798m	798m	798m	798m	1039m	1039m	1039m
Chemical	Value	Units	Source	2009	2009	2009	2009	2009	14/11/11	13/1/12	20/4/12	31/5/12	22/8/11	2/11/11	9/1/2012	23/3/12	2/5/2012	14/8/12	17/8/12	18/11/11	18/1/12	19/3/12
Benzene	1	ug/l	DWS 2010	<10	<10	<10	<10	<1	0.13	0.1	<0.07	< 0.07	<0.07	<0.07	<0.07	<0.07	< 0.07	<0.07	-	<0.07	<0.07	<0.07
Benzene (Ethylbenzene)	20	ug/l	FW List II	-	-	-	-	-	-	-	<0.06	-	-	-	-	0.1	-	-	-	-	-	<0.06
Benzo (a) anthracene	-	ug/l	None	0.0576	<1	<0.009	<0.009	<0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo[a]Pyrene	0.01	ug/l	DWS 2010	0.0242	<1	<0.009	<0.009	<0.01	0.01230	<0.00500	<0.01	<0.00500	<0.00500	<0.00500	<0.00500	<0.01	<0.00500	<0.00500	-	0.06580	<0.00500	<0.01
Benzo[b]Fluoranthene	0.03	ug/l	WFD D 10	0.0414	<1	<0.023	<0.023	<0.01	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
Benzo[g,h,i]Perylene	0.002	ug/l	WFD D 10	<0.016	<1	<0.016	<0.016	<0.01	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
Benzo[k]Fluoranthene	0.03	ug/l	WFD D 10	<0.027	<1	<0.027	<0.027	<0.01	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
Bifenthrin	-	ug/l	None	-	-	-	-	-	-	-	0.00910	-	-	-	-	0.01400	-	-	-	-	-	<0.00500
Bis (2 - chloroethoxy) methane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis (2 - chloroethyl) ether	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis(2-ethylhexyl) phthalate	1.3	ug/l	WFD 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron Dissolved	1000	ug/l as B	DWS 2010	-	-	-	-	-	-	-	74	-	-	-	-	190	-	-	-	-	-	290
Boron Total	1000	ug/l as B	DWS 2010	-	-	-	-	350	160	120	-	0.12	210	200	180	-	0.2	0.21	-	200	229	-
Bromate	10	ug/l as BrO3	DWS 2010	-	-	-	-	-	<0.5	<0.5	-	< 5.0	<0.5	<0.5	<0.5	-	< 5.0	<0.5	-	<0.5	<0.5	-
Bromobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bromochloromethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bromodichloromethane	100	ug/l	WS Regs 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bromoform	100	ug/l	WS Regs 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bromomethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Butyl benzyl phthalate	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium Total	5	ug/l as Cd	DWS 2010	<0.22	-	<0.22	<0.22	<2	3	<1.5	<1.5	< 1.5	<1.5	<1.5	<1.5	<1.5	< 1.5	<1.5	-	<1.5	<1.5	<1.5
Calcium Total	250	mg/l as Ca	DWS 2010	-	-	-	-	-	190	140	-	140	150	160	210	-	220	-	200	190	240	-
Carbazole	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbendazim / Benomyl	0.1	ug/l	FW List II	-	-	-	-	-	-	-	-	<0.00500	0.01000	0.01000	0.01100	-	0.00800	<0.00500	-	0.03100	0.02700	-
Carbetamide	-	ug/l	None	-	-	-	-	-	-	-	-	<0.01000	<0.00600	0.00800	0.00800	-	<0.01000	<0.01000	-	<0.00600	<0.00600	-
Carbon Dioxide	-	ug/l	None	-	-	-	-	-	-	-	97600	-	-	-	-	55000	-	-	-	-	-	7080
Carbon disulphide	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbon Organic Dissolved	-	mg/l as C	None	-	-	-	-	-	-	-	4.6	-	-	-	-	2.5	-	-	-	-	-	2.5
Carbon tetrachloride	3	ug/l	DWS 2010	-	-	-	-	-	<0.07	<0.07	-	< 0.070	<0.07	<0.07	<0.07	-	< 0.070	<0.070	-	<0.07	<0.07	-
Chlorfenvinphos	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.00900	<0.00900	-	<0.00900	<0.00900	<0.00900	<0.00900	-	<0.00900	<0.00900	-	<0.00900	<0.00900	-
Chloride	250	mg/l as Cl	DWS 2010	-	-	-	-	210	259	192	-	173	291	389	515	-	621	-	591	913	1300	-
Chlorobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloroethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloroform	100	ug/l	WS Regs 20	-	-	-	-	-	<0.6	<0.6	-	< 0.600	<0.6	<0.6	<0.6	-	< 0.600	<0.600	-	<0.6	<0.6	-
Chloromethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlortoluron	2	ug/l	FW List II	-	-	-	-	-	<0.05000	<0.05000	-	<0.01000	0.00600	0.00600	0.00600	-	<0.01000	<0.01000	-	<0.00400	0.00400	-
Chromium Dissolved	50	ug/l as Cr	DWS 2010	-	-	-	-	-	-	-	10	-	-	-	-	16	-	17	-	-	-	15
Chromium Total	50	ug/l as Cr	DWS 2010	2.39	-	<0.7	1.16	<5	15	14	-	19	15	16	16	-	15	-	-	19	16	-
Chrysene	-	ug/l	None	0.0804	<1	<0.013	<0.013	<0.01	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
cis-1,3 - Dichloropropene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Source of data*				SI	SI	SI	SI	SI	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT
Name				SR1083	SA1084	PR1081	SA1082	PR1085	PR1085	PR1085	PR1085	PR1085	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	SR1089	SR1089	SR1089
Hydrogeological unit**				SCK	RTD	SCK	CK	ALV	ALV	ALV	ALV	ALV	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	TSF	TSF	TSF
Distance from site	EQS Criteria			71m	95m	102m	177m	280m	280m	280m	280m	280m	798m	798m	798m	798m	798m	798m	798m	798m	1039m	1039m	1039m
Chemical	Value	Units	Source	2009	2009	2009	2009	2009	14/11/11	13/1/12	20/4/12	31/5/12	22/8/11	2/11/11	9/1/2012	23/3/12	2/5/2012	14/8/12	17/8/12	18/11/11	18/1/12	19/3/12
cis-1-2-Dichloroethene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clopyralid	-	ug/l	None	-	-	-	-	-	<0.01900	<0.01900	-	<0.01900	<0.01900	<0.01900	<0.01900	-	<0.01900	<0.01900	-	<0.01900	<0.01900	-
Conductivity @ 20°C	2500	uS/cm	WS Regs 20	-	-	1010	997	1440	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper Total	2000	ug/l as Cu	DWS 2010	8.13	-	2.65	1.86	<2	<5.5	<5.5	-	7	<5.5	<5.5	<5.5	-	< 5.5	<5.5	-	5.9	<5.5	-
Coumaphos	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	<0.00500	-	-	-	-	<0.00500	-	-	-	-	-	<0.00500
Cresols	-	ug/l	None	-	-	-	-	<0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyanazine	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.12000	<0.06000	-	<0.00800	<0.00700	<0.00700	<0.00700	-	<0.00800	<0.00800	-	<0.00700	<0.00700	-
Cyanide (Free)	50	ug/l as CN	DWS 2010	-	-	-	-	<20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyanide (Total)	50	ug/l as CN	DWS 2010	-	-	-	-	<40	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cypermethrin	0.0001	ug/l	WFD 2010	-	-	-	-	-	<0.1	<0.1	-	< 0.100	0.19	<0.1	<0.1	-	< 0.100	<0.100	-	<0.1	<0.1	-
Cypermethrin ID	-	Code	None	-	-	-	-	-	-	-	12	-	-	-	-	21	-	-	-	-	-	<5
Dalapon	-	ug/l	None	-	-	-	-	-	<0.05000	<0.05000	-	<0.05000	<0.05000	<0.05000	<0.05000	-	<0.05000	-	-	<0.05000	<0.05000	-
Di - n - octyl phthalate	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diazinon	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.00900	<0.00900	-	<0.00900	<0.00900	<0.00900	<0.00900	-	<0.00900	<0.00900	-	<0.00900	<0.00900	-
Dibenz-[A,H]-Anthracene	-	ug/l	None	<0.016	<1	<0.016	<0.016	<0.01	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
Dibenzofuran	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibromochloromethane	100	ug/l	WS Regs 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibromoethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dichlorodifluoromethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dichloromethane	20	ug/l	WFD 2010	-	-	-	-	-	<3	<3	-	< 3.0	<3	<3	<3	-	< 3.0	<3.0	-	<3	<3	-
Dichlorprop	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.011000	<0.011000	-	<0.011000	<0.011000	<0.011000	<0.011000	-	<0.011000	<0.011000	-	<0.011000	<0.011000	-
Diethyl phthalate	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dimethyl phthalate	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Di-n-butyl phthalate	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diuron	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.050000	<0.050000	-	<0.010000	0.04300	0.03300	<0.100000	-	0.04100	0.04700	-	0.02400	0.01800	-
Enterococci (Species)	-	Nr/100 ml	None	-	-	-	-	-	-	-	>100	-	-	-	-	0	-	-	-	-	-	0
Escherichia coli (Confirmed)	0	Nr/100 ml	WS Regs 20	-	-	-	-	-	-	-	4	-	-	-	-	0	-	-	-	-	-	0
Ethofumesate	-	ug/l	None	-	-	-	-	-	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
Ethylbenzene	-	ug/l	None	<10	<2.5	<10	<10	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fenuron	-	ug/l	None	-	-	-	-	-	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
Fluoranthene	0.2	ug/l	EEC MAC	0.313	<1	<0.014	<0.014	<0.01	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
Fluorene	-	ug/l	None	4.74	<1	0.0188	<0.014	<0.01	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
Fluoride	1.5	mg/l as F	DWS 2010	-	-	-	-	-	0.06	0.07	-	0.326	0.4	0.36	0.25	-	0.33	0.488	-	0.21	0.12	-
Glyphosate	-	ug/l	None	-	-	-	-	-	<0.014000	<0.014000	-	<0.014000	<0.014000	<0.014000	<0.014000	-	<0.014000	<0.014000	-	<0.014000	<0.014000	-
GRO C4-C12	-	ug/l	None	<10	-	<10	<10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness Total - As CaCO3	-	mg/l as CaCO3	None	-	-	-	-	-	-	-	170	-	-	-	-	-	-	-	-	-	-	724
Hexachloro 1,3 Butadiene	0.1	ug/l	WFD 2010	-	<2.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexachlorobenzene	0.01	ug/l	WFD 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexachlorocyclopentadiene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Source of data*				SI	SI	SI	SI	SI	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT
Name				SR1083	SA1084	PR1081	SA1082	PR1085	PR1085	PR1085	PR1085	PR1085	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	SR1089	SR1089	SR1089
Hydrogeological unit**				SCK	RTD	SCK	CK	ALV	ALV	ALV	ALV	ALV	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	TSF	TSF	TSF
Distance from site	EQS Criteria			71m	95m	102m	177m	280m	280m	280m	280m	280m	798m	798m	798m	798m	798m	798m	798m	798m	1039m	1039m	1039m
Chemical	Value	Units	Source	2009	2009	2009	2009	2009	14/11/11	13/1/12	20/4/12	31/5/12	22/8/11	2/11/11	9/1/2012	23/3/12	2/5/2012	14/8/12	17/8/12	18/11/11	18/1/12	19/3/12
Hexachloroethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indeno-[1,2,3-Cd]-Pyrene	0.002	ug/l	WFD D 10	<0.014	<1	<0.014	<0.014	<0.01	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
Iodide Ion	-	ug/l as I	None	-	-	-	-	-	-	-	59	-	-	-	-	41	-	-	-	-	-	17
Irgarol 1051	-	ug/l	None	-	-	-	-	-	-	-	<0.00500	-	-	-	-	<0.00500	-	-	-	-	-	<0.00500
Iron Dissolved	200	ug/l as Fe	DWS 2010	-	-	-	-	-	-	-	5.3	-	-	-	-	5.6	-	-	-	-	-	0.33
Iron Total	200	ug/l as Fe	DWS 2010	-	-	-	-	-	-	-	5.4	-	-	-	-	5.6	-	-	-	-	-	1.2
Isophorone	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isopropylbenzene (Cumene)	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isoproturon (Diip1,3Dithiolan-2-Ylidenemalonate)	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.05000	<0.05000	-	<0.00800	0.00800	0.00600	<0.05000	-	<0.00800	<0.00800	-	<0.00300	<0.00300	-
Lambda Cyhalothrin	-	ug/l	None	-	-	-	-	-	-	-	<5.00	-	-	-	-	<5.00	-	-	-	-	-	<5.00
Lead Total	10	ug/l	WS Regs 20	1.28	-	0.932	0.666	<4	11	<5	-	23	<5	<5	<5	-	< 5	5	-	9	<5	-
Lithium Dissolved	-	ug/l as Li	None	-	-	-	-	-	-	-	<0.0006	-	-	-	-	<0.0006	-	-	-	-	-	<0.0006
Lithium Total	-	ug/l as Li	None	-	-	-	-	-	-	-	<0.0006	-	-	-	-	<0.0006	-	-	-	-	-	<0.0006
Magnesium Dissolved	50	mg/l as Mg	EEC MAC	-	-	-	-	-	-	-	3.7	-	-	-	-	33	-	-	-	-	-	48
Magnesium Total	50	mg/l as Mg	EEC MAC	-	-	-	-	13	13	9.2	-	10	23	26	34	-	36	-	32	44	57	-
Manganese Dissolved	50	ug/l as Mn	DWS 2010	-	-	-	-	-	-	-	0.31	-	-	-	-	0.28	-	-	-	-	-	0.62
Manganese Total	50	ug/l as Mn	DWS 2010	-	-	-	-	-	-	-	0.31	-	-	-	-	0.29	-	-	-	-	-	0.86
MCPA {2-methyl-4-chlorophenoxyacetic acid }	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.00900	<0.00900	-	<0.00900	<0.00900	<0.00900	<0.00900	-	<0.00900	<0.00900	-	<0.00900	<0.00900	-
Mecoprop { }	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.01000	<0.01000	-	<0.01000	<0.01000	<0.01000	<0.01000	-	<0.01000	<0.01000	-	<0.01000	<0.01000	-
Mercury Total	1	ug/l Hg	WS Regs 20	<0.01	-	<0.01	<0.01	<0.05	0.003	<0.002	-	0.005	<0.002	0.006	<0.002	-	< 0.002	0.002	-	0.014	0.011	-
Metazachlor	-	ug/l	None	-	-	-	-	-	<0	<0	-	< 0	<0	<0	<0	-	< 0	<0.00800	-	<0	<0	-
Methane	-	ug/l	None	-	-	-	-	-	-	-	<10.0	-	-	-	-	42	-	-	-	-	-	62000
Molybdenum Total	0	ug/l	GW Regs 98	-	-	-	-	-	-	-	<5	-	-	-	-	<5	-	-	-	-	-	8
MTBE {Methyl Tert-Butyl Ether}	-	ug/l	None	<10	<10	<10	<10	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Multi Residual Scan	-	ug/l	None	-	-	-	-	-	-	-	-	<0.10000	-	-	-	-	<0.10000	-	-	-	-	-
n - Butylbenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	1.2	ug/l	WFD D 10	0.794	<3.5	<0.1	<0.1	<0.01	-	-	0.29	-	-	-	-	0.12	-	-	-	-	-	<0.01
Nickel Total	20	ug/l as Ni	DWS 2010	6.04	-	20.1	3.61	<10	11	4	-	6	<4	<4	<4	-	5	<4	-	19	13	-
Nitrate - N	11.3	mg/l as N	WS Regs 20	2.96	-	0.829	0.0678	<0.1	<0.043	<0.043	-	< 0.068	<0.043	<0.043	<0.043	-	< 0.068	<0.068	-	1.4	2	-
Nitrobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen Total Oxidised	11.3	mg/l as N	WS Regs 20	-	-	-	-	-	-	-	<0.081	-	-	-	-	0.519	-	-	-	-	-	1
N-nitrosodi-n-propylamine	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthophosphate	-	mg/l as P	None	-	-	-	-	-	-	-	<0.18	-	-	-	-	0.25	-	-	-	-	-	<0.18
Oxamyl	-	ug/l	None	-	-	-	-	-	-	-	<0.00500	-	-	-	-	<0.00500	-	-	-	-	-	<0.00500
o-Xylene	-	ug/l	None	<10	<10	<10	<10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PAH 16 Total	0.1	ug/l	DWS 2010	12.8	-	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PAHs Total	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	0.29	-	-	-	-	0.12	-	-	-	-	-	<0.160
PCB Congener 028	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Source of data*				SI	SI	SI	SI	SI	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT
Name				SR1083	SA1084	PR1081	SA1082	PR1085	PR1085	PR1085	PR1085	PR1085	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	SR1089	SR1089	SR1089
Hydrogeological unit**				SCK	RTD	SCK	CK	ALV	ALV	ALV	ALV	ALV	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	TSF	TSF	TSF
Distance from site	EQS Criteria			71m	95m	102m	177m	280m	280m	280m	280m	280m	798m	798m	798m	798m	798m	798m	798m	798m	1039m	1039m	1039m
Chemical	Value	Units	Source	2009	2009	2009	2009	2009	14/11/11	13/1/12	20/4/12	31/5/12	22/8/11	2/11/11	9/1/2012	23/3/12	2/5/2012	14/8/12	17/8/12	18/11/11	18/1/12	19/3/12
PCB Congener 052	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PCB Congener 101	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PCB Congener 118	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PCB Congener 138	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PCB Congener 153	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PCB Congener 180	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PCB Total of 7 Congener (Aqueous)	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pentachlorophenol	9	ug/l	WHO 2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Permethrin (Cis + Trans)	0.01	ug/l	WFD D 10	-	-	-	-	-	<0.01000	<0.10000	-	-	-	<0.10000	<0.10000	-	-	<0.10000	-	<0.10000	<0.10000	-
pH	10	pH units	DWS 2010	7.69	-	8.15	8.15	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenanthrene	-	ug/l	None	2.87	<1	<0.022	<0.022	0.02	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
Phenol	0.5	ug/l	EEC MAC	<2.0	<1	<2.0	<2.0	<0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenol (Pentachlorophenol (PCP))	-	ug/l	None	-	-	-	-	-	<0.00900	<0.00900	-	<0.00900	<0.00900	<0.00900	<0.00900	-	<0.00900	-	-	<0.00900	<0.00900	-
Phenols Total For SWAD (7 Compounds)	-	ug/l	None	-	-	-	-	-	<800.0	459.0	-	<2,500.0	<8.0	<8.0	24.0	-	<8.0	<8.0	-	<8.0	15.0	-
Polynuclear Aromatic Hydrocarbons (Total)	0.1	ug/l	DWS 2010	-	-	-	-	<0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium Dissolved	-	mg/l as K	None	-	-	-	-	-	-	-	6.4	-	-	-	-	20	-	-	-	-	-	32
Potassium Total	-	mg/l as K	None	-	-	-	-	-	14	11	-	13	15	17	20	-	22	-	20	25	31	-
Preparation (Purge And Trap)	-	Text	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Prepared	-	-	-	-
Propazine	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.08000	<0.04000	-	<0.00500	<0.00400	<0.00400	-	-	<0.00500	<0.00500	-	<0.00400	<0.00400	-
Propetamphos	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.00500	<0.00500	-	<0.00500	<0.00500	<0.00500	<0.00500	-	<0.00500	<0.00500	-	<0.00500	<0.00500	-
Propylbenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrene	-	ug/l	None	0.682	<1	<0.015	<0.015	0.02	-	-	<0.01	-	-	-	-	<0.01	-	-	-	-	-	<0.01
SECB	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	10	ug/l as Se	DWS 2010	<1	-	3.48	1.3	<3	-	-	<0.4	-	-	-	-	<0.4	-	-	-	-	-	<0.4
Silicate Reactive Dissolved - As SiO2	-	mg/l	None	-	-	-	-	-	-	-	18	-	-	-	-	18	-	-	-	-	-	9.3
Simazine	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.08000	<0.08000	-	<0.00400	<0.00900	<0.00900	<0.04000	-	<0.00400	<0.00400	-	<0.00900	<0.00900	-
Sisumxylene	-	ug/l	None	<10	-	<10	<10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium Total	200	mg/l as Na	DWS 2010	-	-	-	-	120	140	100	-	100	180	180	230	-	250	-	270	440	590	-
Strontium Dissolved	-	ug/l as Sr	None	-	-	-	-	-	-	-	0.28	-	-	-	-	0.76	-	-	-	-	-	0.96
Strontium Total	-	ug/l as Sr	None	-	-	-	-	-	-	-	0.29	-	-	-	-	0.8	-	-	-	-	-	1.8
Styrene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate	250	mg/l as SO4	DWS 2010	94.2	-	197	183	11	<1.7	8.37	-	48.2	180	173	161	-	175	-	182	193	262	-
Sulphide	-	ug/l	None	-	-	-	-	<10	-	-	<29.0	-	-	-	-	<29.0	-	-	-	-	-	<29.0
Sum of BTEX	-	ug/l	None	<10	-	<10	<10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terbutryn	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.08000	<0.04000	-	<0.00500	<0.00300	<0.00300	<0.00300	-	<0.00500	0.00700	-	<0.00300	<0.00300	-
tert - Butylbenzene	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene (Per/Tetrachloroethylene)	10	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethylene	-	ug/l	None	-	-	-	-	-	<0.09	<0.09	-	< 0.09	<0.09	<0.09	<0.09	-	< 0.09	<0.09	-	<0.09	<0.09	-
Tetrachlorothioanisole	-	ug/l	None	-	-	-	-	-	-	-	<0.00500	-	-	-	-	<0.00500	-	-	-	-	-	<0.00500

Source of data*				SI	SI	SI	SI	SI	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT
Name				SR1083	SA1084	PR1081	SA1082	PR1085	PR1085	PR1085	PR1085	PR1085	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	SR1089	SR1089	SR1089
Hydrogeological unit**				SCK	RTD	SCK	CK	ALV	ALV	ALV	ALV	ALV	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	TSF	TSF	TSF
Distance from site	EQS Criteria			71m	95m	102m	177m	280m	280m	280m	280m	280m	798m	798m	798m	798m	798m	798m	798m	798m	1039m	1039m	1039m
Chemical	Value	Units	Source	2009	2009	2009	2009	2009	14/11/11	13/1/12	20/4/12	31/5/12	22/8/11	2/11/11	9/1/2012	23/3/12	2/5/2012	14/8/12	17/8/12	18/11/11	18/1/12	19/3/12
Tin Total	0	ug/l as Sn	GW Regs 98	-	-	-	-	-	-	-	<5	-	-	-	-	<5	-	-	-	-	-	<5
Titanium	0	ug/l as Ti	GW Regs 98	-	-	-	-	-	-	-	0.032	-	-	-	-	0.078	-	-	-	-	-	0.084
Toluene (Methylbenzene)	50	ug/l	WFD 2010	<10	<10	<10	<10	<1	-	-	<0.55	-	-	-	-	<0.55	-	-	-	-	-	<0.06
Total Aliphatic TPH	-	ug/l	None	-	-	-	-	<10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Aliphatics & Aromatics >C12-C44 (Aqueous)	-	ug/l	None	5380	-	<10	<10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Aliphatics >C12-C35 (Aqueous)	-	ug/l	None	3100	-	<10	<10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Aliphatics C5-C12	-	ug/l	None	<10	-	<10	<10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Aromatic TPH	-	ug/l	None	-	-	-	-	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Aromatics >EC12-EC35 (Aqueous)	-	ug/l	None	2280	-	<10	<10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Aromatics C6-C12	1	ug/l	DWS 2010	<10	-	<10	<10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Chemical Oxygen Demand	-	mg/l	None	-	-	-	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Monohydric Phenols (W)	-	ug/l	None	<15.0	-	<15.0	<15.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethene (Trichloroethylene)	10	ug/l	DWS 2010	-	-	-	-	-	<0.07	<0.07	-	< 0.07	<0.07	<0.07	<0.07	-	< 0.07	<0.07	-	<0.07	<0.07	-
Trichlorofluoromethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trietazine	-	ug/l	None	-	-	-	-	-	<0.04000	<0.02000	-	<0.00800	<0.00600	<0.00600	<0.00600	-	<0.00800	<0.00800	-	<0.00600	<0.00600	-
Trifluralin	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.01000	<0.01000	-	<0.01000	<0.01000	<0.01000	<0.01000	-	<0.01000	-	-	<0.01000	<0.01000	-
Turbidity	1	FTU	WS Regs 20	-	-	-	-	-	238	121	-	49.9	45	51.1	54.1	-	49.9	-	50.3	18.5	0.24	-
Uranium	0	ug/l as U	GW Regs 98	-	-	-	-	-	-	-	0.2	-	-	-	-	<0.1	-	-	-	-	-	1.3
Vinyl Chloride	0.5	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xylene (Meta & Para){1,3+1,4-Dimethylbenzene}	30	ug/l	WFD 2010	<10	-	<10	<10	<1	<0.09	<0.09	<0.180	-	<0.09	0.13	<0.09	<0.180	< 0.09	<0.09	-	<0.09	<0.09	<0.180
Xylene (ortho)	30	ug/l	SW Regs 98	-	-	-	-	-	-	-	<0.09	-	-	-	-	<0.09	-	-	-	-	-	<0.09
Zinc Total	50	ug/l as Zn	DWS 2010	19.5	-	19.7	<5	4	<5	<5	-	10	<5	8	<5	-	36	13	-	7	<5	-

Notes:

xx	GAC1 exceedance
' - '	Not tested
' < '	Less than MDL

** Origin of data: SI – Groundwater quality data collected during site investigation works by Thames Tideway Tunnel project (2009-2011), TT – Groundwater quality data collected during ongoing monitoring works by Thames Tideway Tunnel project (2009-2012)*

*** Hydrogeological unit: CK – Chalk, SCK – Seaford Chalk, RTD – River Terrace Deposits*

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K.8 Groundwater status

K.8.1 The EC Water Framework Directive (WFD) requires the status of groundwater management units (groundwater bodies) within each river basin to be determined as 'good' or 'poor' by 2015. For groundwater there are two separate classifications for groundwater bodies; chemical status and quantitative status. The WFD aims to achieve good status by 2015, or, where this is not possible and subject to the criteria set out in the Directive, the WFD aims to achieve good status by 2021 or 2027.

K.8.1 The Thames River Basin Management Plan (RBMP), (EA, 2009)[18] shows that the Lambeth Group, Thanet Sands and Chalk Formation in the area of the Kirtling Street site are designated as the Greenwich Chalk and Tertiaries groundwater body.

K.8.2 The baseline assessment for groundwater status classification for the Greenwich Chalk and Tertiaries shows poor quantitative status with respect to impact on surface waters and saline intrusions, good quantitative status with respect to groundwater dependent terrestrial ecosystems and resource balance for 2009. The baseline assessment also shows poor chemical status with respect to saline intrusions and drinking water protected area status and good chemical status with respect to general chemical assessment, groundwater dependent terrestrial ecosystems and impact on surface water chemical/ ecological status.

K.8.3 The predicted quantitative and chemical quality was poor for 2015 due to treatment or improvement being disproportionately expensive or technically infeasible.

K.8.4 The baseline assessment for groundwater status classification for the nearby Lower Thames Gravels is good quantitative status and poor quality status for 2009. The predicted chemical quality was poor for 2015 due to treatment or improvement being disproportionately expensive or technically infeasible.

K.8.5 Only eight out of forty-six groundwater bodies within the Thames River basin district are at good status overall; this is not expected to change by 2015 (EA, 2009)[18].

K.8.6 The Thames Tideway Tunnel project would prevent deterioration of the current and predicted status of groundwater and would adhere to the key actions identified in the RBMP to achieve good status by 2021 or 2027, as follows (EA, 2009)[18]:

- The control of pollution to groundwater that may arise from any development which takes place on land.
- Prevent input of nitrates to groundwater body.
- Prevent inputs to and mitigate potential mobilisation of copper, other metals and hazardous substances in groundwater.
- Prevent and mitigate potential inflow of river water to groundwater due to dewatering/ abstraction by implementing working methods to protect

surface and groundwater from impacts, including changes to flow, by producing site-specific water management plans and by monitoring where required.

K.8.7 Prevent direct discharges of pollutants to groundwater.

K.9 Data sources

K.9.1 A list of data used for the Kirtling Street assessment is given in Vol 14 Table K.9.

Vol 14 Table K.9 Groundwater - desk based baseline data sources

Source	Data	Date received	Notes
BGS	British Geological Survey (BGS) 1:50,000 scale digital geological data	February 2009	
EA	Licensed groundwater abstraction boreholes, their ownership and purpose	December 2010, February 2011 and March 2012	Licensed abstraction rates, aquifer, and status (active or dormant)
LB's*	Unlicensed groundwater abstraction boreholes and their details	June 2009	Contacted 14 London Boroughs along tunnel alignment
EA	Designated source protection zones	December 2010	
EA	Groundwater level records for EA observation boreholes	September 2009, June 2011, December 2011 and October 2012	
EA	Groundwater quality results for EA observation boreholes	August 2009 and May 2011	
EA	Ground Source Heat Pump (GSHP) schemes and their details	December 2010 and March 2012	
Thames Tideway Tunnel project	Ground Investigation (2009) borehole logs, construction details, monitoring regime and available water level records and water quality results from 2009	Last updated September 2012	Final ES

Source	Data	Date received	Notes
	to 2012		
Thames Tideway Tunnel project	Groundwater monitoring strategy	Draft strategy Feb 2012	
Thames Tideway Tunnel project	Land quality data	February 2011	
Individual licence holders	Letters sent out to 30 licence holders	December 2011 (Last updated 15th October 2012)	

** LBs – London Boroughs*

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References

[1] British Geological Survey. *British geology onshore digital maps 1:50 000 scale*. Received from Thames Tideway Tunnel (February 2009).

[2] British Geological Survey. *The BGS Lexicon of Named Rock Units*. (Accessed May 2012). Available at: http://www.bgs.ac.uk/Lexicon/.

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[4] Royse, K.R.. *The London Chalk model*. British Geological Survey. Commissioned Report CR/08/125 (2008).

[5] USGS. *Glossary of Hydrologic Terms in The Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport*: Department of Interior, U.S. Geological Survey, Office of Water Data Coordination (August 1989).

[6] Environment Agency. *Environment Agency Website*. Accessed April 2012. Available at: http://www.environment-agency.gov.uk/homeandleisure/117020.aspx

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[14] *River Basin Districts Typology, Standards and Groundwater Threshold Values* (Water Framework Directive) (England and Wales) Direction 2010. Available at: http://www.defra.gov.uk/environment/quality/water/legislation/water-framework-directive/.

[15] Environment Agency. *REACH Annex XVII Restrictions Polycyclic-aromatic Hydrocarbons (PAHs) Guidance Note Part 1* (October 2010). Available at: http://www.environment-agency.gov.uk/static/documents/Business/Part_1_PAH_Guidance_Note.pdf.

[16] Commission of the European Communities. *Directive of the European Parliament and of the Council on environmental quality standards in the field of water policy and amending Directive 2000/60/EC*. (2009). Available at: http://ec.europa.eu/environment/water/water-dangersub/pdf/com_2006_397_en.pdf?lang=_e.

[17] Environment Agency. *Soil Guideline Value Reports* (2009). Available at: http://www.environment-agency.gov.uk/research/planning/64015.aspx.

[18] Environment Agency. *River Basin Management Plan, Thames River Basin District* (December 2009). Available at: http://publications.environ ment-agency.gov.uk/PDF/GETH0910BSWA-E-E.pdf.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.14**

Volume 14: Kirtling Street appendices

Appendix L: Water resources - surface water

APFP Regulations 2009: Regulation **5(2)(a)**

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Appendix L: Water resources – surface water

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Appendix L: Water resources – surface water

L.1 Introduction

L.1.1 Construction and operational effects assessments at this site for this topic do not require the provision of any supporting information, so this appendix is intentionally empty.

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Appendix M: Water resources - flood risk

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Appendix M: Water resources – flood risk

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Appendix M: Water resources – flood risk

M.1 Policy considerations

M.1.1 The relevant planning document that would be used to assess the proposals is the National Policy Statement (NPS) for Waste Water (Defra, 2012)[1] which was published in February 2012.

M.1.2 The Waste Water NPS considers the Thames Tideway Tunnel project as 'nationally significant waste water infrastructure.'

M.1.3 General policy documents (eg, NPS) have been reviewed within Volume 2 Environmental assessment methodology. A summary of local and regional policy relevant to flood risk at Kirtling Street is provided below.

Local policy

Strategic Flood Risk Assessment

M.1.4 The Kirtling Street site lies within the London Borough (LB) of Wandsworth. The LB of Wandsworth has produced Level 1 and Level 2 Strategic Flood Risk Assessments (SFRA) Scott Wilson Ltd, 2009)[2]. The residual risk of breaches in the Thames Tideway Defences at a number of locations along the River Thames was also investigated as part of the Level 2 study.

M.1.5 The SFRAs confirm that the Thames Tidal Defence network (Thames Barrier and Tidal flood defence walls) reduces the annual probability of flooding from the Thames to less than 0.1%. The risk of flooding is therefore a residual risk associated with a breach or overtopping of the defences.

M.1.6 According to the SFRA:

a. The site overlies London Clay.

b. The site is within the Wandsworth Tidal Flood Warning Area and Environment Agency (EA) Flood Zone 3.

c. The site is situated within an area identified as having an increased risk of surface water ponding based on topography, geology and historic flooding records.

d. There are a number of schools within the locality which could act as refuge centres during times of flood.

M.1.7 The SFRA promotes the use of Sustainable Drainage Systems (SuDS) suitable to specific site locations within the Borough, depending on underlying geology.

Surface Water Management Plan

M.1.8 The Council, in partnership with the Greater London Authority (GLA), Thames Water and the EA has produced a Surface Water Management Plan (SWMP) (GLA, 2011)[3] as part of the Drain London project. The SWMP sets out the preferred surface water management strategy for the LB of Wandsworth.

M.1.9 According to the SWMP:

a. The site does not lie within a Critical Drainage Area (CDA)[i].

b. The site does not lie along an identified flow path for the 1% AEP + 30% climate change rainfall event.

c. There are no recorded sewer flood incidents recorded in the vicinity.

Regional policy

Thames Estuary 2100

M.1.10 The Kirtling Street site lies within the Wandsworth to Deptford Policy Unit which has been assigned the P5 flood risk management policy 'P5'; within the Thames Estuary 2100 (TE2100) Plan (EA, 2012)[4], meaning that further action will be taken to reduce flood risk beyond that required to mitigate the impact of climate change.

M.1.11 The TE2100 Plan identifies the local sources of flood risk (relative to the Kirtling Street site) as:

a. tidal flooding from the River Thames

b. a risk of groundwater flooding from superficial strata which is possibly connected to high water levels in the Thames.

M.1.12 Mitigation of flooding from these sources include:

a. the Thames Barrier and secondary tidal defences along the Thames frontage (both making up the Thames Tidal Defences network)

b. Combined Sewer Overflows (CSOs) for mitigation of urban drainage

c. flood forecasting and warning.

M.1.13 The TE2100 Plan seeks to promote, where possible, defence improvements that ensure views are maintained and impacts to river access/views are minimised. Where defence raising in the future to manage the consequences of climate change is not possible secondary defences and floodplain management should be introduced. There is also a vision to increase flood risk awareness within the area.

London Regional Flood Risk Appraisal

M.1.14 For the reach between Hammersmith Bridge and the Thames Barrier (City Reach) the London Regional Flood Risk Appraisal (RFRA) (Greater London Authority, 2009)[5] encourages small scale set back of development from the river walls where possible. The aim of this is to enable modification, raising and maintenance in a sustainable, environmental and cost effective way. Development should be designed in such a way as to take opportunities to reduce flood risk and include resilience.

M.1.15 There is particular concern surrounding confluences of tributaries into the River Thames and the interactions between tidal and fluvial flows in the future due to climate change. This should be taken into consideration during the re-development process.

[i] Area susceptible to surface water flooding.

M.1.16 The RFRA indicates that SuDS should be included within developments to reduce surface water discharge.

References

[1] Department of Environment, Food and Rural Affairs (Defra), *National Planning Policy for Waste Water.* (February 2012)

[2] Scott Wilson Ltd. *London Boroughs of Wandsworth, Merton, Sutton and Croydon Level 1 Strategic Flood Risk Assessment Final Report*. (Dec 2008). Scott Wilson Ltd. *London Boroughs of Wandsworth, Merton, Sutton and Croydon Level 2 Strategic Flood Risk Assessment Final Report*. (Apr 2009).

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

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Doc Ref: **6.2.14**

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Appendix N: Development schedule

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Appendix N: Development schedule

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Appendix N: Development schedule

N.1 Summary

N.1.1 The assessments undertaken for this site take account of other relevant development projects within the vicinity of the site which are under construction, permitted but not yet implemented or submitted but not yet determined. In order to identify the relevant developments for consideration, the Planning Inspectorate, local planning authorities and the Greater London Authority have been consulted on the methodology (see Volume 2) and asked to assist in identifying and verifying the development projects included in the assessment. A schedule is provided in Vol 14 Table N.1 of the resulting development projects, a description of what is proposed and assumptions on phasing. Longer term development projects may be included under both base case, with construction preceding that of the Thames Tideway Tunnel site, and cumulative with construction or operation occurring at the same time as a given Thames Tideway Tunnel site.

N.1.2 Appendix N presents specific information regarding the Northern Line Extension and assumptions made for the Thames Tideway Tunnel environmental impact assessment.

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Vol 14 Table N.1 Development schedule for Kirtling Street

Category types:

a. Under construction

b. Permitted but not yet implemented

c. Submitted but not yet determined

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2019 (peak construction traffic year)	2023 (Year 1 of operation)		
Riverlight (Tideway Industrial Estate)	Adjacent	2011/3748	St James Group Limited	Redevelopment of the site to provide a residential-led mixed-use development of six buildings between twelve and twenty storeys (plus two basement levels) comprising 806 residential units, including affordable housing, flexible commercial uses at ground and first floor levels including retail, financial and professional services, restaurant/café and bar uses, healthcare facilities, a crèche and gallery space (A1/A2/A3/A4 and D1 uses), together with ancillary uses including a concierge/ management suite, a business suite and leisure facilities, and associated car and bicycle parking and landscaping including provision of a riverside walk.	A	90% complete & operational Assume that Blocks B, C, D, E and F are complete and occupied. Assume that Block A is under construction.	100% complete & operational	100% complete & operational	Email from developer St James Ltd (31/01/12) Phasing is proposed east to west – source: discussions with developer. *application supersedes previous 2010/3739	**2016:** Base case = Blocks B, C, D, E & F Cumulative = Block A **2019 & 2023:** Base case = all blocks No cumulative
New Covent Garden Market	Adjacent	2011/4664	Covent Garden Market Authority	Demolition of existing wholesale fruit, vegetable and flower market and ancillary building and structures, and residential building on Nine Elms Lane. Construction of a mixed-use redevelopment comprising a new fruit and vegetable and flower market and ancillary uses, residential flats, hotel, flexible retail uses including retail, financial and professional services, café/restaurant, bar uses and hot food takeaway, offices, non-residential institutions and assembly and leisure uses. Provision of car, cycle and motorcycle parking and servicing and new vehicle access. An energy centre. Provision of open space including part of the Linear Park. Total floor area 426,874sq.m.	B	Buildings B1, B2, B3, B4, B5 & B6 under construction.	Buildings B4, B5 & B6 are complete & operational. Buildings B1, B2, B3 and Site Entrance are under construction.	Buildings B1, B2, B3, B4, B5, B6 & Site Entrance are complete & operational. Buildings T1, T2 & T3 are under construction	Development Specification (Table 8), November 2011.	**2016:** No base case Cumulative = Buildings B1, B2, B3, B4, B5 & B6 **2018:** Base case = Buildings B4, B5 & B6 Cumulative = Buildings B1, B2, B3 & Site Entrance **2023:** Base case = Buildings B1, B2, B3, B4, B5, B6 & Site Entance Cumulative = Buildings T1, T2 & T3

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2019 (peak construction traffic year)	2023 (Year 1 of operation)		
Nine Elms Parkside	20m east	2011/2462	Royal Mail Estates Ltd	An outline planning application for demolition of all existing buildings and construction of a mixed use redevelopment comprising 7 building plots with buildings to a maximum height of 23 storeys (approximately 76m AOD) and a maximum overall floorspace of 222,120sq.m.	B	Plots C & D under construction	Plots B, C & D under construction	Plots A, B, C & D complete & operational. Plots, E, F & G under construction.	Environmental Statement (Chapter 6 Demolition and Construction page 6-1). 2014 start on site assumption.	**2016:** No base case Cumulative = Plots C & D **2019:** No base case Cumulative = Plots B, C & D **2023:** Base case = Plots A, B, C & D Cumulative = Plots E, F & G
Battersea Power Station	55m west	2009/3575 Applications 2009/3576, 2009/3577 and 2009/3578 also accompany the Battersea Power Station application.	REO (Power Station) Ltd	Restoration, extension, alterations and conversion of the Power Station building to provide retail, residential flats, business, cultural, hotel and conference facilities, event space and incidental accommodation; the demolition of other buildings and development of the land surrounding the Power Station and adjacent/ nearby sites to provide retail, restaurants bars and cafes, offices, hotel, residential, community and cultural space, assembly and leisure space, student housing, serviced apartments, an energy centre and basement plant; parking for cars, coaches, motorcycles and bicycles; new access and internal road system and servicing; 'off-site' highway works; works to the jetty to facilitate river transport and fuel delivery, including alterations to the river wall; provision of open space and landscaping works.	B	Phase 1 (RS-1) and Phase 2 (PS) are complete and operational. Phase 3 (RS-4 & O-1) is under construction.	Phase 1 (RS-1), Phase 2 (PS) and Phase 3 (RS-4 & O-1) are complete and operational. Phase 4 (RS-5), part of Phase 5 (RS-2) and Phase 6 (RS-2) are under construction.	Phase 1 (RS-1), Phase 2 (PS), Phase 3 (RS-4 & O-1), Phase 4 (RS-5), part of Phase 5 (RS-2) and Phase 6 (RS-2) are complete and operational. Part of Phase 5 (RS-6) and Phase 7 (RS-WF) are under construction.	Environmental Statement (Chapter 5 Site preparation and construction page 5-2) and Design & Access Statement. Decision notice requires development to be implemented within five years of the date of decision notice (23 August 2011) Assumptions regarding % complete in each assessment year are based on professional judgement using phasing information obtained from Design & Access Statement.	**2016:** Base case = Phases 1 & 2 Cumulative = Phase 3 **2019:** Base case = Phases 1, 2 & 3 Cumulative = Phase 4, part of 5 (RS-2) & Phase 6 **2023:** Base case = Phases 1, 2, 3, 4, part of 5 (RS-2) & 6. Cumulative = Part of Phase 5 (RS-6) & 7
Embassy Gardens, land to the south of Nine Elms Lane comprising DHL Depot and 1-12 Ponton Road and 51 Nine Elms Lane	130m east	2011/1815		An outline planning application for demolition of all existing buildings and construction of a mixed use redevelopment comprising 9 building plots with buildings to a maximum height of 23 storeys (approximately 80m AOD) and a maximum overall floorspace of	B	Buildings A09, A10 & A11 complete & operational. Buildings A01, A02, A03, A04,	Buildings A02, A05, A09, A10 & A11 and part of Phase 2 complete & operational. Buildings A01, A03,	100% complete & operational	Environmental Statement (Chapter 6 Development Programme and Construction page 2-3).	**2016:** Base case = Buildings A09, A10 & A11 Cumulative = Buildings A01, A02, A03, A04, A05 & A07

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2019 (peak construction traffic year)	2023 (Year 1 of operation)		
				263,030sq.m. GEA (including 18,571 sq m basement) including: 163,605 sq.m. and 192,825 sq.m. of residential use (equating to between 1626 and 1982 residential units, including affordable housing, and 6050sq.m. of serviced apartments); up to 7,834sq.m. of retail, financial and professional services, café/restaurant, bar and takeaway uses (A1 to A5); up to 1,886sq.m. GEA of car showroom (Sui Generis); between 21,329sq.m. and 49,159sq.m. of office floorspace (B1); up to 10,400sq.m. of hotel use (C1); 750sq.m. of community uses (D1); 1130sq.m. of assembly and leisure uses (D2) (see LBW website for full description).		A05 & A07 under construction.	A04 & A07 under construction.		Phasing information taken from application drawings (Phasing Diagrams)	**2019:** Base case = Buildings A02, A05, A09, A10 & A11 Cumulative = Buildings A01, A03, A04 & A07 **2023:** Base case = all buildings No cumulative
US Embassy - Land on south side of Nine Elms Lane incorporating Ponton Road	Approx 290m east	2009/1506 & (2009/1507) realignment of Pontoon Road Several non material amendment application and amendments to conditions	US Department of State	**2009/1506** Redevelopment of an area of 2.15 hectares to provide a new United States Embassy, to a maximum possible height of 97m, associated buildings, and new access road from Nine Elms Lane. **2012/2759 (reserved matters)** Details of external appearance of the building, including facing materials, layout of the building, scale of the building and landscaping of the site (condition 3), site levels (condition 4), a scheme to implement mitigation measures within the flood risk assessment (condition 8), a surface water drainage scheme (condition 9), an inclusive access strategy (condition 13), establishment of a Design Review Panel (condition 18), detailed energy strategy (condition 19), details of docking station for cycle hire scheme (condition 20) of outline planning permission ref 2009/1506 dated 12/10/2010 for the redevelopment of an area of 2.15ha to provide a new United States Embassy, associated buildings and access from Nine Elms Lane. Public Art Strategy and details of Design Review Panel pursuant to Clause 2 and Clause 5 of the S106 agreement dated 12/10/2010 relating to planning permission 2009/1506. Details of visitor cycle parking pursuant to condition	B	100% complete & operational	100% complete & operational	100% complete & operational	Environmental Statement (Chapter 6 Development Programme and Construction page 1)	Base case (all years)

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2019 (peak construction traffic year)	2023 (Year 1 of operation)		
				9 of planning permission ref 2009/1507 dated 12/10/2010 for formation of new junctions and new road to replace Pontoon Road.						
Marco Polo House, 346 Queenstown Road	Approx 540m west	2011/2089	Anastasia Ltd	Demolition of existing building. Erection of two new buildings of up to 17 storeys and 15 storeys high to provide 456 residential units and 1,257 sq.m. of commercial floor area comprising of office (B1 & A2), retail (A1) and cafe/restaurant (A3) uses, together with new pedestrian link and vehicular access, basement car and cycle parking, landscaping, excavation works and servicing.	B	Phase 1a complete & operational Phases 1b & 2 under construction	Phases 1a & 1b complete & operational Phase 2 under construction	100% complete & operational (all phases)	Environmental Statement Part 1 (June 2011). Chapter 5 contains a phasing plan and information.	**2016:** Base case = Phase 1a Cumulative = Phases 1b & 2 **2019:** Base case = Phases 1a & 1b Cumulative = Phase 2 **2023:** Base case = whole development No cumulative
Nine Elms Sainsbury's, Wandsworth Road	Approx 550m east	11/02326/OUT	Sainsbury's Supermarkets Ltd	A part detailed and part outline planning application comprising: Full detailed planning permission for the demolition of the existing retail store and petrol station to allow for the erection of a replacement retail store (7,432msq net trading floorspace (13,059msq gross internal floor area), childrens tutoring facility (298msq), lobby/circulation space (1,707msq), energy centre (779msq), flexible retail, community floorspace (787msq), business, office floorspace (1,860msq) and 671 residential units with ancillary gymnasium (369msq) arranged in seven blocks including towers of 19, 28 and 37 storeys. Also proposed are 363 retail and 148 residential parking spaces, 882 cycle spaces together with associated open space, childrens play space, landscaping and public realm improvements along Wandsworth Road and a new route from Wandsworth Road to New Covent Garden. Outline planning permission (with appearance, landscaping and access to be Reserved Matters) for 105msq of flexible A1, A2, A3, A4, D1 floorspace and	B	100% complete & operational	100% complete & operational	100% complete & operational	Information provided by LB Lambeth - if approved in 2012 the development is expected to take 2-3 years to construct. Would therefore be complete and operational by 2016.	Base case (all years)

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2019 (peak construction traffic year)	2023 (Year 1 of operation)		
				66 dwellings within 2 blocks. In addition outline planning permission is also sought for a further 1736msq of flexible floorspace for use in association with either the proposed Nine Elms Northern Line station or A1, A2, A3, A4, D1 use. This application is accompanied by an Environmental Statement.						
10 Pascal Street	Approx 560m southeast	11/03931/FUL	Banham Security	Demolition of existing building and redevelopment of the site involving the erection of a part 13, part 6 and part 3 storey building to provide 3,964 sq m office space (Use Class B1) at ground, first and second floor levels and 63 residential units (Use Class C3) on the upper floors together with a basement level to provide 31 car parking spaces, 5 motor bike spaces and 68 cycle spaces.	C	100% complete & operational	100% complete & operational	100% complete & operational	No construction programme information available in application documentation. Given the size of the development it is assumed that it will be complete by Site Year 1 of construction.	Base case (all years)
Market Towers	Approx 700m east	2012/0380	Kish Six Limited	Demolition of existing buildings and structures. Erection of two new buildings of 58 storeys (up to 200m above ground) and 43 storeys (up to 161m above ground) high to include the following uses with floorspace of up to: 77,548 sq.m. of residential floorspace (up to 491 units); 721 sq.m. of retail uses (classes A1-A4); 10,986 sq.m. of office space (class B1); 11,617 sq.m. hotel (class C1) together with a high level viewing space; provision of private and public open spaces; vehicular access and reconfigured vehicular access routes; provision of cycle, motorcycle and car parking, servicing and energy centre within two level basement; landscaping; excavation works; and other associated works. An Environmental Statement has been submitted with the planning application under the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 2011.	B	100% complete & operational	100% complete & operational	100% complete & operational	ES NTS. Section 6.	Base case (all years)

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2019 (peak construction traffic year)	2023 (Year 1 of operation)		
Riverwalk House, Millbank	Approx 820m northeast	11/09680/FUL	Derwent Valley Central Limited (parent company Derwent London plc)	Demolition of the existing building and erection of two buildings of 17 and 7 storeys linked by a central podium for use as 121 residential units (Class C3); dual/alternative use of part of the ground floor as a cafe/restaurant/gallery (Class A1/A3/D1); three levels of basement including car parking and plant area; replacement stair linking the river walk with Vauxhall Bridge and other associated works to the river walk and adjacent public landscape; works of hard and soft landscaping and other works incidental to the application.	B	100% complete & operational	100% complete & operational	100% complete & operational	Professional judgement – no phasing information available in application documentation	Base case (all years)
Vauxhall Sky Gardens, 143-161 Wandsworth Road	Approx 820m east	09/04322/FUL	Frasers Property Developments Ltd	Redevelopment of the site involving the demolition of existing buildings and the erection of a part one storey, part eight storey and part 36 storey plus basement building to provide a mixed use development comprising ground floor commercial units (flexible use class A1, A2, A3 and D1) of 257 square metres, 4722 square metres of office floorspace (use class B1), 239 residential units, 3220 square metres of amenity space and landscaped amenity areas, 23 car parking spaces, 278 cycle parking spaces, refuse storage, public realm improvements at street level and the formation of new vehicular access from Wyvil Road.	B	100% complete & operational	100% complete & operational	100% complete & operational	Assumptions made on basis that ES (2009) assumes 2011 opening year (ie, two year construction period). As application was granted permission in Sept 2010 it is a reasonable assumption that it will be complete by Site Year 1 of construction.	Base case (all years)
Vauxhall Square Cap Gemini Site (plot bounded by Parry Street, Bondway, Miles Street and Wandsworth Road)	Approx 820m east	11/04428/FUL	Vauxhall Cross Ltd	Demolition of existing buildings (except for the listed buildings on site) to provide a mixed use scheme comprising eight blocks ranging between 6, 9, 11, 16, 21, 26, 48 and 50 storeys, which include 604 dwellings 14,722sqm GIA of new office floor space (B1), 3047sqm GIA of A1-A5 retail, 438 bedroom hotel (C1), 40 bedroom replacement homeless hostel (sui generis), 416 student rooms (C2), new multi-screen cinema (D2), 1167sqm GIA Gym (D2), associated basement car parking and servicing; new public square and children's play area and associated public realm improvements.	C	Under construction	Under construction	100% complete & operational	Information provided by LB Lambeth. If approved, lease on site does not run out until 2014, so works are expected to start 2014/2015 and take up to five years.	**2016 & 2019**: Cumulative **2023:** Base case
Chelsea Barracks Chelsea Bridge	Approx 820m northwest	10/10496/OUT (associated	Project Blue (Guernsey)	Demolition of existing former barracks buildings and warehouse (Dove Walk) in connection with the redevelopment of the	B	Under	Under construction	100% complete & operational	Paragraph 1.67 of the Environmental Statement NTS	

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2019 (peak construction traffic year)	2023 (Year 1 of operation)		
Road		with this: 08/10134/ADFULL (soil tests); 09/01921/ADFULL (COCP); 09/04699/ADFULL (archaeology); 10/10497/LBC (listed building works) and 10/11062/FULL (test geothermal borehole)	Ltd	site for mixed use purposes comprising residential (a maximum of 448 units), sports centre (Class D2), retail (flexible use within Class A1/A2/A3), health centre (Class D1), non-residential institution/leisure uses (flexible use within Classes D1 and/or D2); hard and soft landscaping and open space; reconfigured and new vehicular and pedestrian accesses and works to the public highway; together with all associated works including the construction of basement to provide ancillary vehicular and cycle parking, circulation, servicing and plant areas. Alterations to perimeter railings.		construction			accompanying the application states construction will last nine years, starting in 2011 and finishing in 2019. Given that construction appears at least one year delayed, assume 2020 construction completion. No phasing information available so remains unknown whether it will be phased opening or not. Therefore assumed to be under construction for full nine year period.	**2016:** No base case Cumulative = whole development **2019:** No base case Cumulative = whole development **2023:** Base case = whole development No cumulative
Island Site Vauxhall Gyratory	Approx 830m east	10/02060/FUL	Kylun Ltd	Erection of two towers, Tower A rising to 41 storeys (approx 140m) and Tower B rising to 32 storeys (approx 115m), plus 4 basement levels below ground; to provide a mixed use development comprising 291 residential units (made up of 225 market units, 42 socially rented, 42 intermediate, which makes 23% of the units affordable,663sqm of floorspace for food and drink commercial uses, 2162sqm of floorspace for employment commercial uses, a 179 room hotel and 1371sqm of floorspace for community facilities/assembly and leisure (consisting of a dentist surgery, a soft play facility and a digital cinema/performance. space) – use classes D1 and D2); together with 30 car parking spaces, 10 motorbike parking spaces, 490 cycle parking spaces, refuse storage facilities, the provision of a public space/landscaping at street level, the formation of a new vehicular access from Parry Street and a new vehicle egress to Bondway, and other works incidental to the redevelopment of the site.	C	Under construction	100% complete & operational	100% complete & operational	Appeal in progress . Works are expected to start in 2014 and take 2-3 years.	**2016:** Cumulative **2019 & 2023:** Base case

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2019 (peak construction traffic year)	2023 (Year 1 of operation)		
St Georges Wharf (Vauxhall Tower)	Approx 900m northeast	03/01501/FUL	St George South London Limited	Revised proposal for redevelopment of part of St George Wharf site to provide 200 residential units in a 50-storey tower.	A	100% complete & operational	100% complete & operational	100% complete & operational	Information provided by LB Lambeth – advised of expected completion date of 2014.	Base case (all years)
1-9 Bondway and 4-6 South Lambeth Place	Approx 950m east	10/03151/FUL	Salmon Harvester Properties Ltd	Redevelopment of the site involving the demolition of the existing buildings and the erection of a 6 storey building (plus lower ground floor level) to provide a hotel comprising of 148 bedrooms (Use Class C1) with ancillary bar/restaurant facilities along with commercial floorspace at ground floor level in either Use Classes A1 (retail), A2 (financial and professional services), A3 (restaurants and cafes), A4 (drinking establishments) and formation of roof level plant.	A	100% complete & operational	100% complete & operational	100% complete & operational	Professional judgement – no phasing information available in application documentation	Base case (all years)
Northern Line Extension	Approx 220m southwest(Battersea Power Station) Approx 550m southeast (Nine Elms Station)	N/A	TfL	Extension of the Northern Line (Charing Cross Branch) from Kennington to Battersea, with the creation of two new stations: one at Nine Elms near Wandsworth Road and the other at Battersea Power Station. To include the construction of three permanent shafts at Cottingham Road (intervention shaft), Kennington Green (ventilation shaft) and Kennington Park (ventilation shaft). In addition two temporary shafts would be built at Radcot Street and Harmsworth Street near to Kennington Station.	Not submitted	Under construction	100% complete & operational	100% complete & operational	Information provided by TfL in August 2012. In the absence of publically available information, see Assumptions note used by EIA team at the end of the Development Schedule.	**2016:** Cumulative **2019 & 2023:** Base case

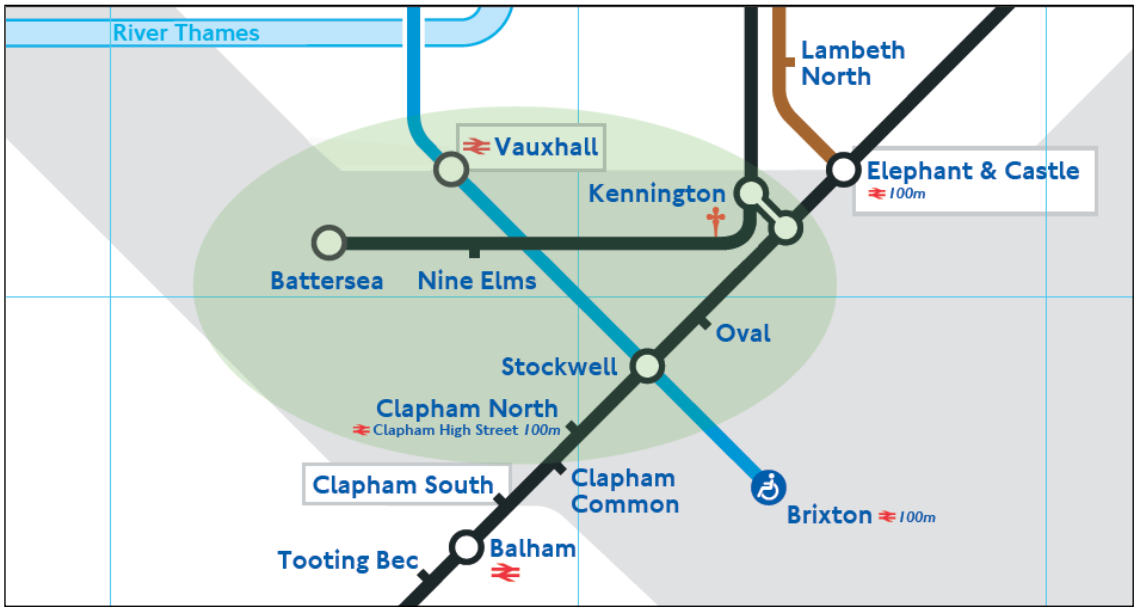
Note: phasing and site layout information has been sourced from local authority planning portals unless otherwise indicated.

N.2 Northern Line Extension – assumptions for Thames Tideway Tunnel EIA

N.2.1 This note has been produced to inform Thames Tideway Tunnel EIA specialists of the proposed Northern Line Extension (NLE) development, to be considered in the topic base case and cumulative effect assessments as appropriate.

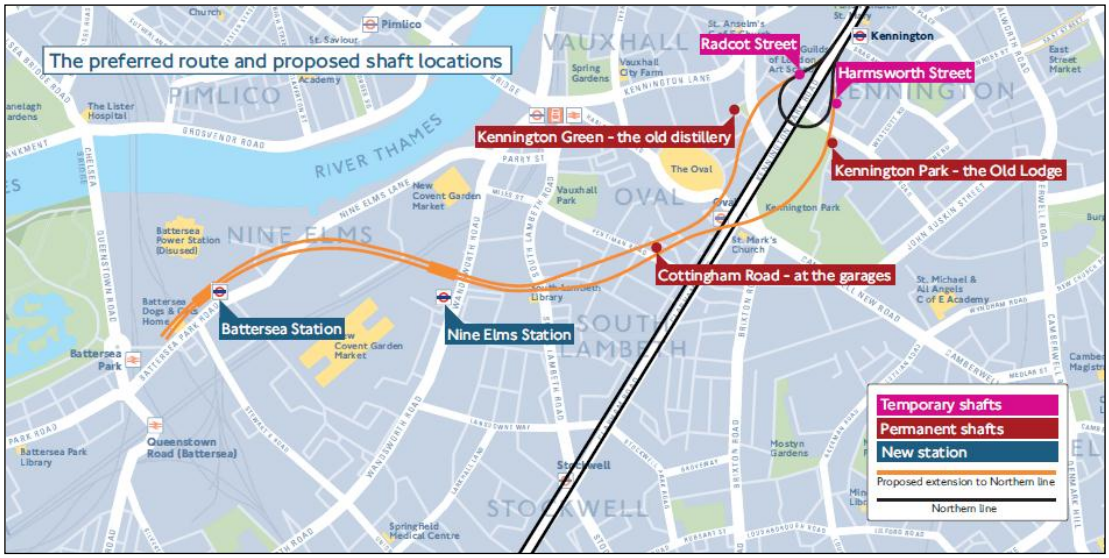
N.2.2 The NLE would extend the Northern Line from Kennington (Charing Cross branch) to Battersea, as shown in Vol 14 Plate N.1 below.

Vol 14 Plate N.1 Tube map showing proposed Northern Line extension



N.2.3 The NLE would include the creation of two new stations: one at Nine Elms near to Wandsworth Road, and the other at Battersea Power Station, as well as the construction of three permanent shafts at Cottingham Road/Claylands Road (intervention shaft), Kennington Green (ventilation shaft) and Kennington Park (ventilation shaft). In addition two temporary shafts would be built at Radcot Street and Harmsworth Street near to Kennington station. The preferred route and proposed shaft locations are shown in Figure 1.2 below.

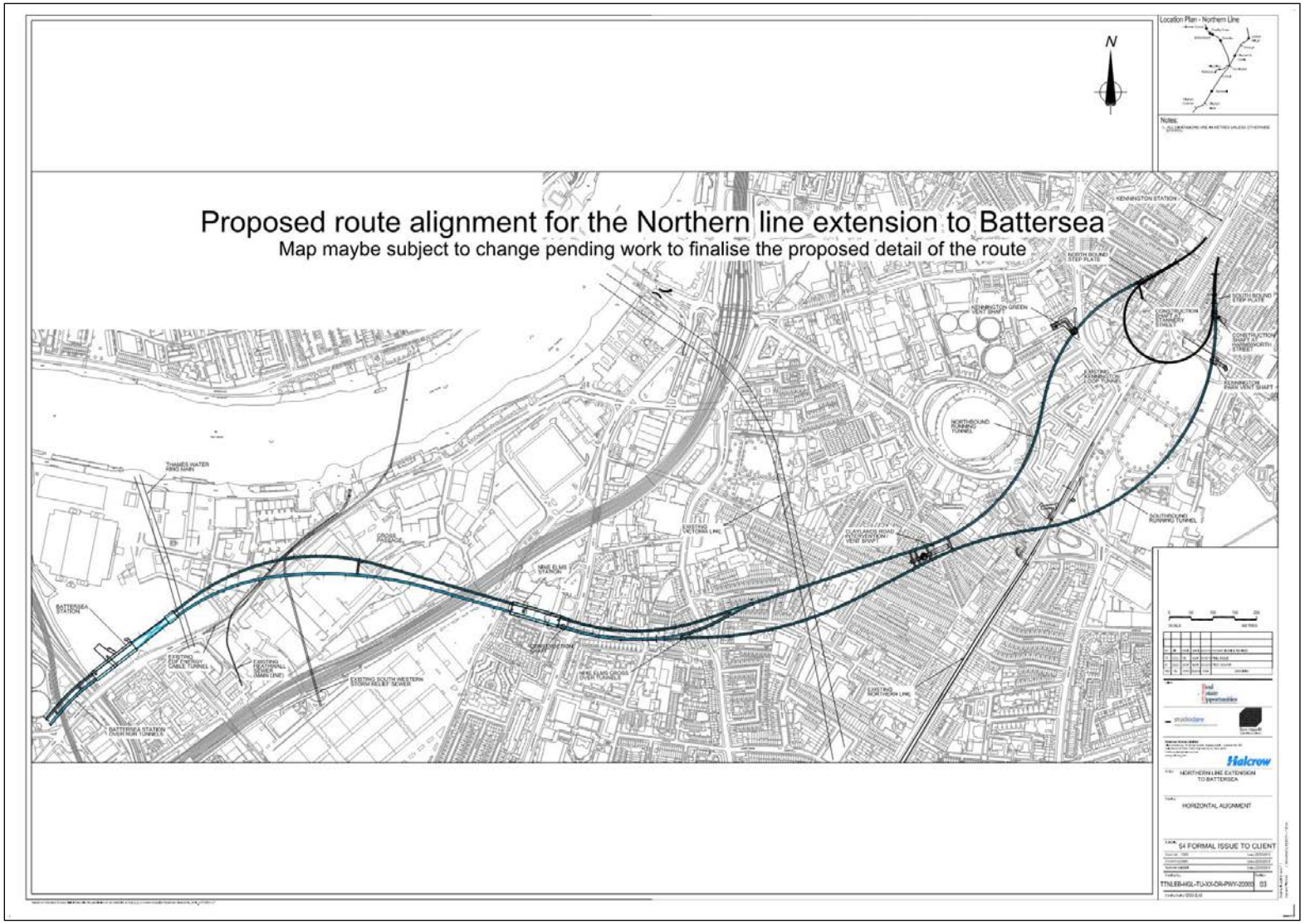
Vol 14 Plate N.2 Preferred route and proposed shaft locations of the Northern Line extension



N.2.4 The NLE would pass through the London Borough (LB) of Wandsworth, LB of Lambeth, and has a temporary shaft within LB of Southwark. It is also close to the City of Westminster, although it is separated by the River Thames.

N.2.5 A detailed proposed route alignment map can be seen in Vol 14 Plate N.3 below.

Vol 14 Plate N.3 Proposed route alignment



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N.2.6 A number of phasing scenarios are currently being considered by the NLE project as there are a number of uncertainties, including the development programme for the redevelopment of Battersea Power Station. However, the most likely scenario is that the NLE project would begin construction in late 2015/early 2016 and last about four years becoming operational in 2019. This is therefore assumed for the purposes of the Thames Tideway Tunnel EIA.

N.2.7 The current assumption for the NLE project (and therefore used for the Thames Tideway Tunnel EIA) is that inbound materials such as tunnel linings, would be brought in by road while excavated material would be removed by river.

N.2.8 To facilitate this, the project would use the Battersea Power Station jetty, which is anticipated to involve moving the existing cranes and installing a conveyor. It is estimated that 100m^3 (average) to 2000m^3 (maximum) of material would be transported in a 25 hour period (ie, over two tides).

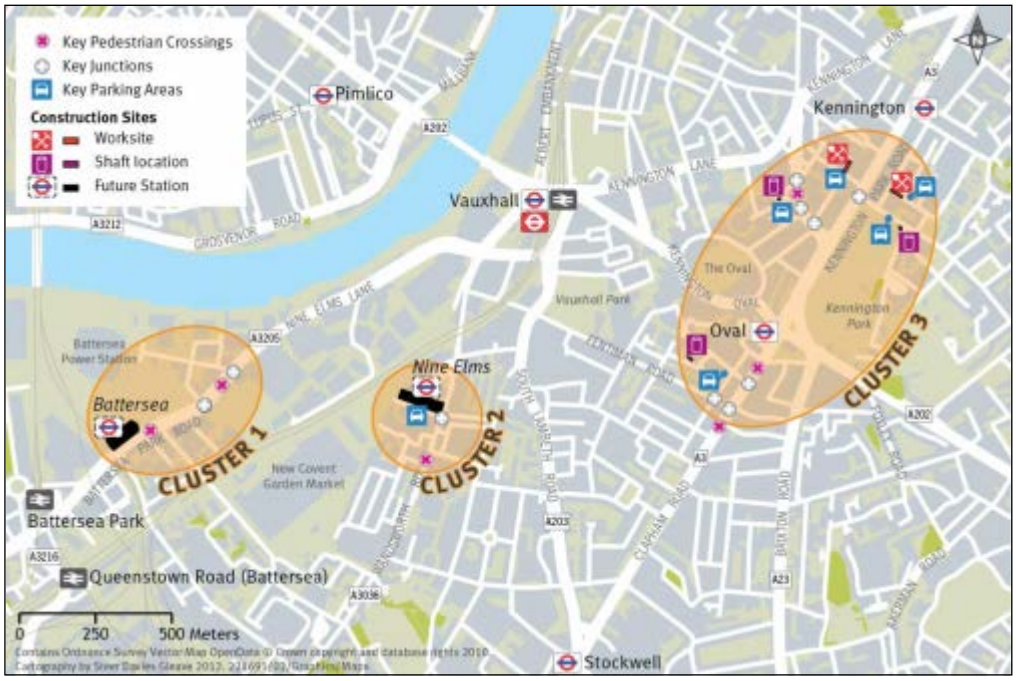
N.2.9 It is however noted that this remains subject to discussions with the Port of London Authority. Additionally, investigations are ongoing as to whether there can be greater use of rail and/or river, as well as the feasibility of on-site manufacturing.

N.2.10 TfL has produced a report outlining the proposed approach to transport and parking impact assessments, in which they break down the NLE construction sites into clusters as follows:

a. Cluster 1 – Battersea Park Road/Nine Elms Lane
    i Battersea Power Station
b. Cluster 2 – Wandsworth Road
    i Nine Elms Station (including Banham site)
c. Cluster 3 – Kennington Park Road
    i Claylands Road (Garages) intervention shaft
    ii Kennington Park (Old Lodge) ventilation shaft
    iii Kennington Green (Distillery) ventilation shaft
    iv Northern site (Radcot Street) temporary grouting shaft
    v Southern site (Harmsworth Street) temporary grouting shaft.

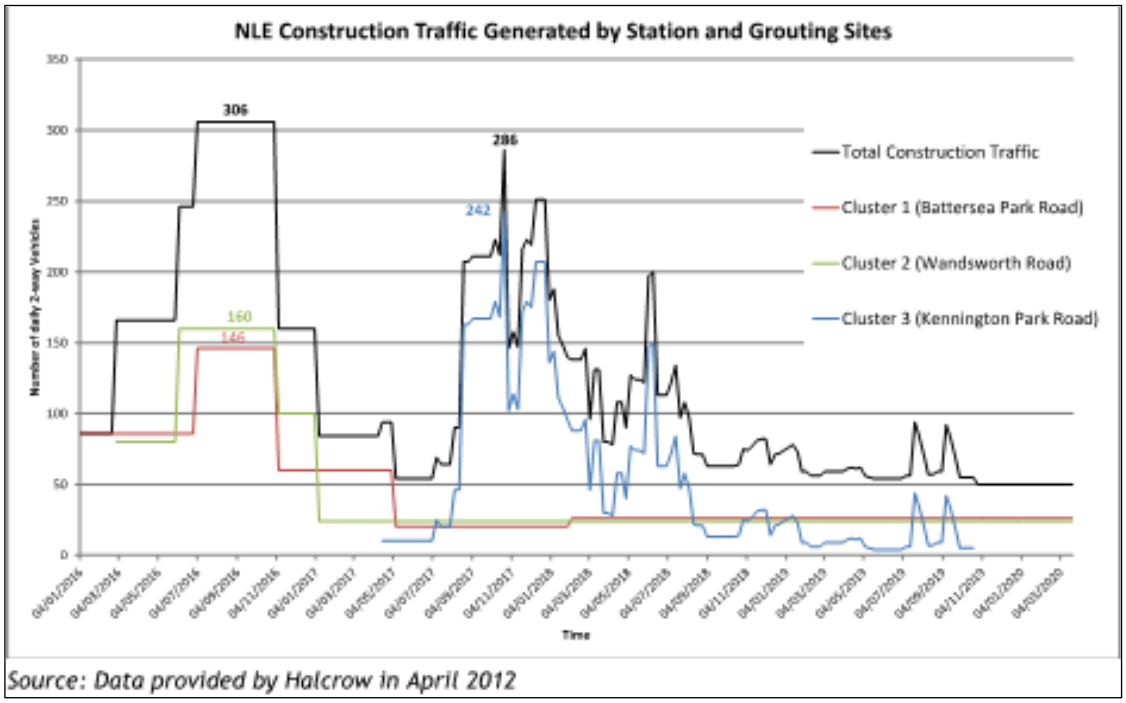
N.2.11 The aforementioned clusters are shown on Vol 14 Plate N.4 below:

Vol 14 Plate N.4 Northern Line Extension construction site clusters



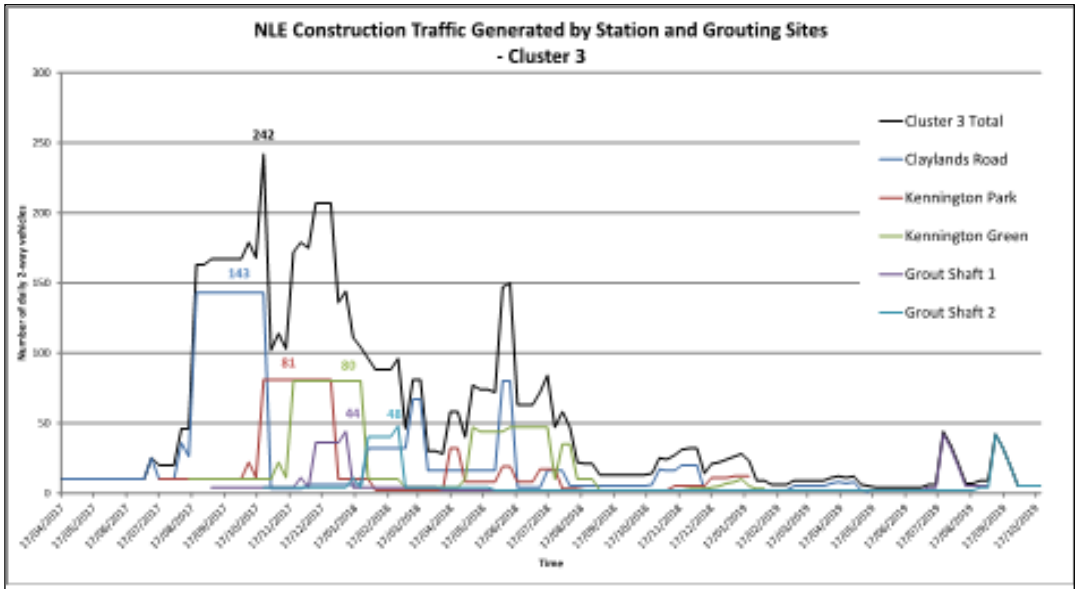
N.2.12 Daily two-way construction traffic, which includes all traffic going in and out of the construction sites in each cluster are shown in Vol 14 Plate N.5 below.

Vol 14 Plate N.5 Daily two-way construction traffic by all clusters



N.2.13 As cluster 3 includes five separate construction sites, Vol 14 Plate N.6 illustrates the traffic generated by each of these sites, both separately and in total.

Vol 14 Plate N.6 Daily two-way construction traffic in cluster 3



Source: Data provided by Halcrow in April 2012

N.2.14 It has been assumed in the above assessment that construction work would commence on 4 January 2016.

N.2.15 Peak construction activity in term of traffic generation is expected to occur between July and November 2016, with a total of 306 two-way vehicles generated every day.

N.2.16 A secondary peak of construction is expected to take place in November 2017, with a total of 242 two-way daily vehicles.

N.2.17 Of the total outgoing and incoming traffic from/to the construction sites, 30% would have an origin/destination in north London and 70% in south London.

N.2.18 All construction traffic would head to/from the M25 via the most easily accessible arterial routes located within the vicinity of each construction site.

N.2.19 During the construction period it is assumed that construction activity would take place for ten hours during the day, with construction traffic spread out equally across the day.

N.2.20 The main site at Battersea Power Station would not require any diversions, road closures, or parking suspensions; however Kirtling Street would be subject to a high number of vehicle movements.

N.2.21 Road closures/diversions would be required on two small residential streets in the vicinity of Kennington station in order to accommodate the temporary grouting shafts. Buses would be rerouted, and one bus lane may need to be removed in the vicinity of Kennington Green. A small but significant number of parking spaces would need to be suspended,

although this will be concentrated around the Kennington Road sites as well as by the proposed Nine Elms station on Wandsworth Road.

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Thames Water Utilities Limited
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