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

Creating a cleaner, healthier River Thames

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.21**

Volume 21: King Edward Memorial Park Foreshore appendices

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

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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 21 King Edward Memorial Park Foreshore 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

B.1 Model verification

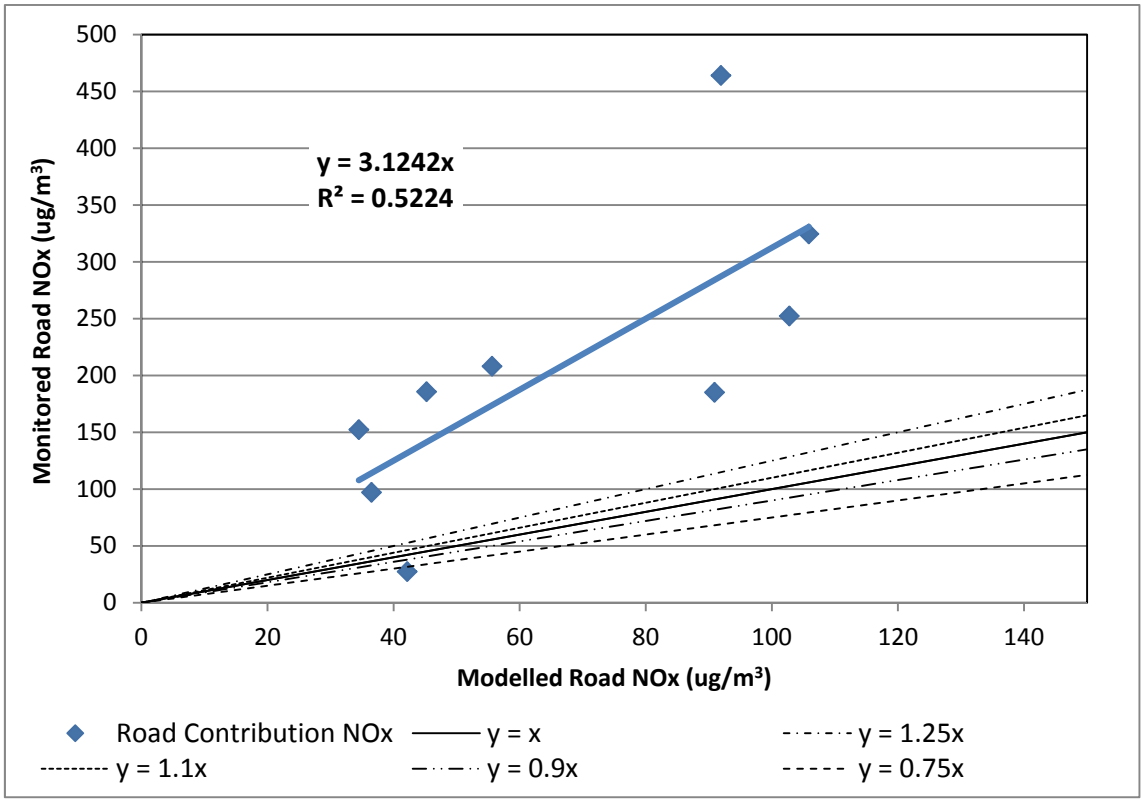
B.1.1 Modelled NO_2 concentrations have been plotted against monitored concentrations at nine diffusion tube sites (KEMM1-KEMM6, TH20, TH23 and TH35) as shown in Vol 21 Figure 4.4.1 (see separate volume of figures).

B.1.2 This showed that the modelled results underestimated NO_2 concentrations by between -10% and 54%. 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.

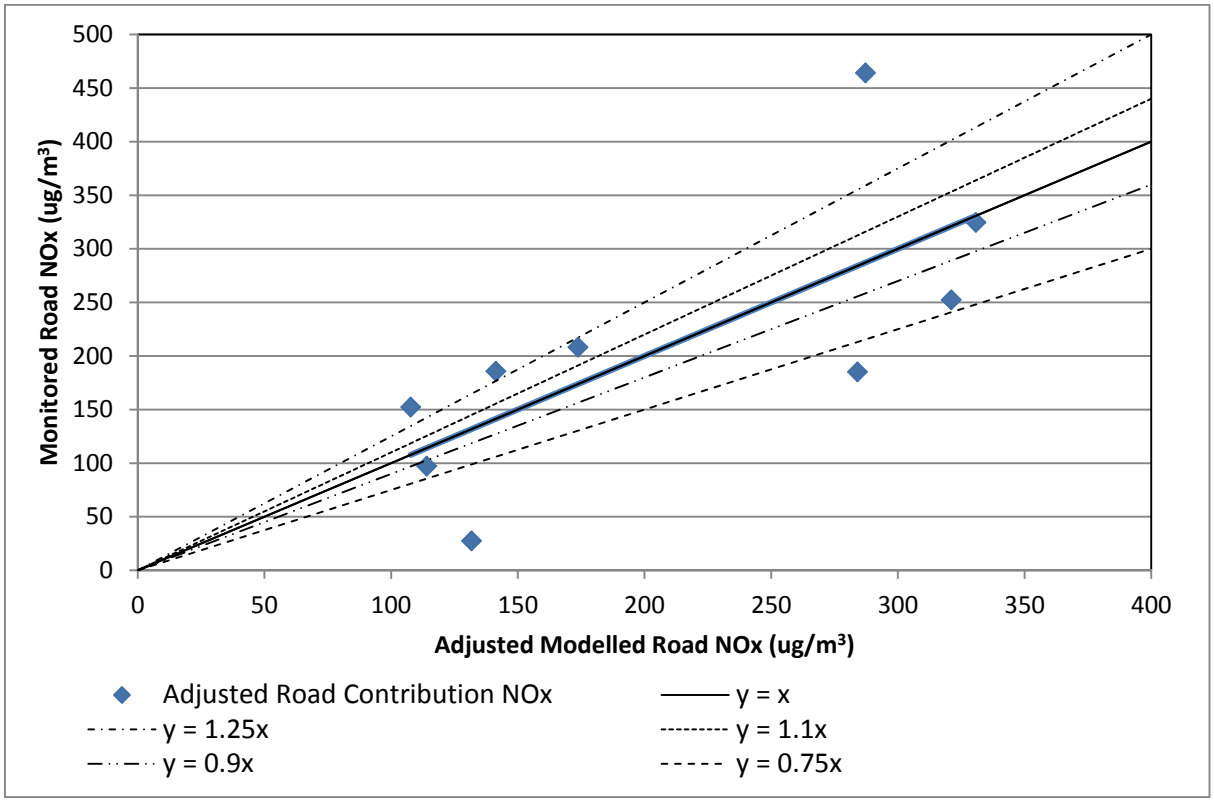
B.1.3 To derive the adjustment factor, modelled road NO_X concentrations were plotted against calculated monitored road NO_X concentrations (see Vol 21 Plate B.1 below). An adjustment factor of 3.12 was calculated for adjusting modelled roadside NO_X concentrations, in accordance with LAQM.TG(09)[1] and subsequently applied. This factor was also applied to the PM_{10} results as no local PM_{10} monitoring data were available for an area where traffic data were also available.

B.1.4 Applying the NO_X adjustment factor and then calculating NO_2 concentrations, as shown in Vol 21 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 21 Plate B.3, indicated that three of the nine modelled concentrations were within 10% of the measured value and that seven of the nine were within 25% of the modelled value.

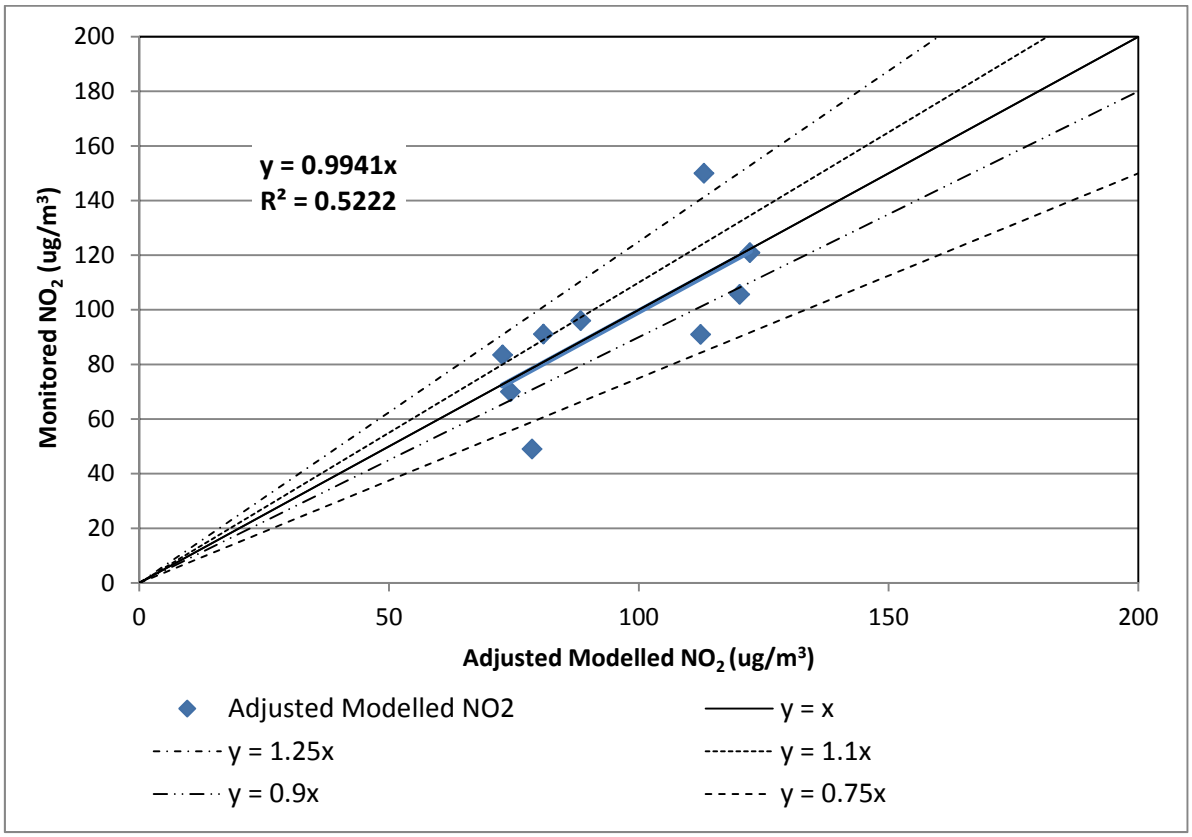
Vol 21 Plate B.1 Air quality - monitored road NO_X vs. modelled road NO_X



Vol 21 Plate B.2 Air quality – monitored road NO_X vs. adjusted modelled road NO_X



Vol 21 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 King Edward Memorial Park Foreshore site are shown in Vol 21 Table B.1.

Vol 21 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 construct-ion year AADT scheme construct-ion HGV (HGV >3.5t)	Peak construct-ion year develop-ment case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
ATC** 'direct'	Glamis Road	3610	11.9%	20	20.4	12.4%	4058	0	4058	11.9%
TfL Model	A1203 The Highway	53237	9.5%	30	21.4	12.4%	59837	0	59863	9.5%
ATC 'Indirect'	Glamis Road	1545	9.7%	20	20.4	12.4%	1736	0	1736	9.7%
TfL Model	A1203 The Highway	57753	9.0%	30	22.5	12.4%	64912	18	64953	9.1%
ATC 'Indirect'	Brodlove Lane	5102	3.5%	20	20.4	12.4%	5734	0	5734	3.5%
TfL Model	A1203 The Highway	62762	8.6%	30	22.5	12.4%	70543	18	70584	8.6%
TfL	A1203 The	59913	9.8%	30	13.3	12.4%	67340	18	67404	9.8%

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 construct-ion year AADT scheme construct-ion HGV (HGV >3.5t)	Peak construct-ion year developm-ent case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
Model	Highway									
TfL Model	Butcher Row	20961	7.2%	30	6.7	12.4%	23560	18	23604	7.2%
TfL Model	Limehouse Link	72177	8.7%	30	24.0	12.4%	81124	0	81190	8.7%
TfL Model	A101	26161	0.9%	30	20.7	12.4%	29404	0	29432	0.9%
ATC 'Indirect'	Cable Street	4616	3.5%	20	16.6	12.4%	5188	0	5188	3.5%
ATC 'direct'	Cable Street	437	8.2%	20	16.6	12.4%	491	0	497	8.1%
ATC 'Indirect'	Cable Street	3374	2.4%	20	16.6	12.4%	3792	0	3798	2.4%
TfL Model	Butcher Row	18040	7.1%	30	22.5	12.4%	20276	18	20324	7.2%
TfL Model	A13 Commercial Road	30854	9.4%	30	15.1	12.4%	34679	4	34703	9.4%

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 construct-ion year AADT scheme construct-ion HGV (HGV >3.5t)	Peak construct-ion year developm-ent case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
TfL Model	A13 Commercial Road	27017	8.8%	30	8.5	12.4%	30366	18	30388	8.9%
TfL Model	A13 Commercial Road	37422	6.5%	30	12.7	12.4%	42061	18	42100	6.6%

** 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 21 Table B.2 for the King Edward Memorial Park Foreshore site.

Vol 21 Table B.2 Air quality - tug assessment model inputs

Parameter	Value	Units
Total tugs	215	Tugs/year
Time per tug*	20	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***	3050	m^2
NO_X emissions per tug	1.8 x10x10-^{04}	$g/s/m^2$
PM_{10} emissions per tug	1.6 x10x10-^{05}	$g/s/m^2$

* 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 21 Table B.3 has been modelled for the peak construction year at the King Edward Memorial Park Foreshore site.

Vol 21 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	$3.8x10^{-07}$	$2.4x10^{-08}$
	Ground level behind hoarding	Generator - 200kVA	1	100	160	$1.2x10^{-06}$	$7.3x10^{-08}$
	Ground level behind hoarding	JCB with hydraulic breaker	1	50	67	$2.4x10^{-07}$	$1.5x10^{-08}$
	Ground level behind hoarding	Cutting equipment (diamond saw)	2	10	2.3	$8.5x10^{-09}$	$1.9x10^{-08}$
	Ground level behind hoarding	Telescopic handler / FLT**	1	30	60	$1.3x10^{-07}$	$8.2x10^{-09}$
	Ground level behind hoarding	Hiab*** lorry / crane	1	5	56	$2.0x10^{-08}$	$1.3x10^{-09}$
	Ground level behind hoarding	Well drilling rig	1	5	403	1.5×10^{-6}	9.1×10^{-8}
Demolition	Ground level behind hoarding	Service crane 25t mobile Crane	1	30	275	$6.0x10^{-07}$	$3.7x10^{-08}$
	Ground level behind hoarding	22t excavator complete with hydraulic hammer	1	30	122	$2.7x10^{-07}$	$1.7x10^{-08}$
	Ground level behind hoarding	Site dumper	1	30	81	$1.8x10^{-07}$	$1.1x10^{-08}$

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 ($g/s/m^2$)
	Ground level behind hoarding	Concrete crusher	1	80	172	$1.0x10^{-06}$	$6.2x10^{-08}$
	Ground level behind hoarding	Vibrating rollers	2	50	145	$1.1x10^{-06}$	$6.6x10^{-08}$
Cofferdam Construction	Ground level behind hoarding	400cfm compressor	1	50	104	$3.8x10^{-07}$	$2.4x10^{-08}$
	Ground level behind hoarding	150t crawler crane	1	60	240	$1.0x10^{-06}$	$6.5x10^{-08}$
	Ground level behind hoarding	Generator	1	100	28	$3.2x10^{-06}$	$3.0x10^{-07}$
	Ground level behind hoarding	Jack-up barge	1	100	104	$7.5x10^{-07}$	$4.7x10^{-08}$
	Ground level behind hoarding	Secant pile rig	1	60	150	$6.5x10^{-07}$	$4.1x10^{-08}$
	Ground level behind hoarding	25t excavator	1	80	125	$7.3x10^{-07}$	$4.5x10^{-08}$
	Ground level behind hoarding	Plate compactors	2	10	3	$1.1x10^{-08}$	$2.4x10^{-08}$
	Ground level behind hoarding	Vibrating rollers	2	50	145	$1.1x10^{-06}$	$6.6x10^{-08}$
Diaphragm wall construction	Ground level behind hoarding	Diaphragm wall rig (grab)	1	20	250	$3.6x10^{-07}$	$2.3x10^{-08}$
	Ground level behind hoarding	Diaphragm wall rig (hydrofraise)	1	80	250	$1.5x10^{-06}$	$9.1x10^{-08}$
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	223	$3.2x10^{-07}$	$2.0x10^{-08}$

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 ($g/s/m^2$)
	Ground level behind hoarding	Concrete pump	1	20	223	$3.2x10^{-07}$	$2.0x10^{-08}$
	Ground level behind hoarding	Compressor 400cfm	1	50	104	$3.8x10^{-07}$	$2.4x10^{-08}$
	Ground level behind hoarding	Dumper	1	50	81	$2.9x10^{-07}$	$1.8x10^{-08}$
	Ground level behind hoarding	150t crawler crane	2	50	240	$1.7x10^{-06}$	$1.1x10^{-07}$
Shaft excavation	Ground level behind hoarding	Long reach excavator	2	80	178	$2.1x10^{-06}$	$1.3x10^{-07}$
	Within shaft	20t excavator with breaker	2	50	73	$5.3x10^{-07}$	$3.3x10^{-08}$
	Ground level behind hoarding	25t excavator	1	80	125	$7.3x10^{-07}$	$4.5x10^{-08}$
	Ground level behind hoarding	Dumper	1	50	81	$2.9x10^{-07}$	$1.8x10^{-08}$
	Ground level behind hoarding	80t crawler crane	1	50	240	$8.7x10^{-07}$	$5.4x10^{-08}$
	Ground level behind hoarding	150t crawler crane	1	50	240	$8.7x10^{-07}$	$5.4x10^{-08}$

*Note: For the purposes of this assessment, the above listed equipment has been modelled for the peak construction year. The data assumes a 10-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

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 26 October 2010 at the King Edward Memorial Park Foreshore site as shown in Vol 21 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. 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.1.25). The final section provides an interpretation of the results (paras. D.1.26 to D.1.34). Figures referred to in this report are contained within Vol 21 King Edward Memorial Park Foreshore Figures (separate volume of 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, two locations were chosen for the installation of the remote recording devices as shown on Vol 21 Figure 6.4.3 (see separate volume of figures).

D.1.7 Location 1 is to the south of the site. This location was selected to record potential bat activity associated with roosting within the air shaft building, in addition to foraging and commuting along the tree-lines in this area and along the adjacent River Thames.

D.1.8 Location 2 is to the southeast of the site. This location was selected to record potential bat activity associated with foraging and commuting along the River Thames and vegetation in this area, and to record the movement of bats entering and leaving the site along this boundary.

D.1.9 The bat activity recorded during the remote recording surveys triggered the need for an additional dawn survey (see Vol 2 Methodology for bat triggering criteria). Therefore, a second stage of bat surveying was undertaken, comprising one dawn survey visit by four 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 21 Figure 6.4.3 (see separate volume of figures).

Wintering birds

D.1.10 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.

D.1.11 The survey area, as shown in Vol 21 Figure 6.4.4 (see separate volume of figures), comprises the intertidal foreshore of the River Thames and the King Edward Memorial Park. The foreshore consists of eroded building rubble, stones of various sizes and silt. Either side of the River Thames there are public footpaths on the embankments, which are well-used by pedestrians.

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 21 Figure 6.4.5 (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.1.26 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 21 Table D.1.

Vol 21 Table D.1 Terrestrial ecology - species found within 500m of the site between 2001 - 2011

Common name	Latin name	Record count
Birds		
Greylag goose	*Anser anser*	1
Greater scaup	*Aythya marila*	1
Red kite	*Milvus milvus*	1
Redwing	*Turdus iliacus*	1
Common tern	*Sterna hirundo*	1
Common kingfisher	*Alcedo atthis*	1
Sand martin	*Riparia riparia*	3
Hedge accentor	*Prunella modularis*	14
Common starling	*Sturnus vulgaris*	26
House sparrow	*Passer domesticus*	25
Amphibians		
Common frog	*Rana temporaria*	1

Bat surveys

Bat triggering (remote recording) surveys

D.1.16 The bat triggering (remote recording) surveys were undertaken over three nights between 3 and 5 May 2011 in suitable weather conditions (see Vol 21 Table D.2).

D.1.17 The remote recording surveys undertaken at this site recorded four species of bats using the site, common pipistrelle (*Pipistrellus pipistrellus)*, soprano pipistrelle (*Pipistrellus pygmaeus)*, noctule (*Nyctalus noctula)* and an unidentified bat species (most likely noctule or a mouse-eared species *Myotis sp.*).

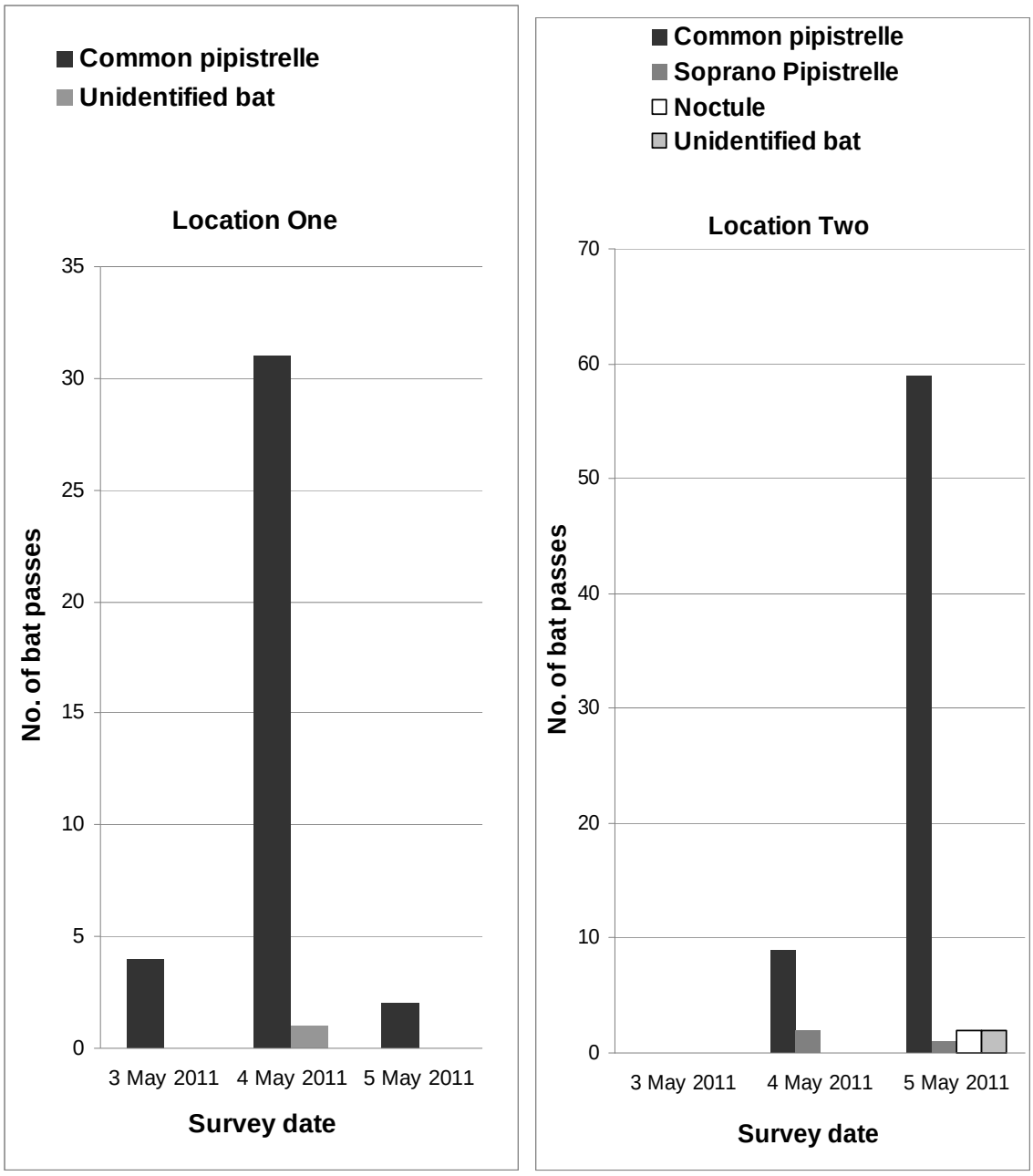
D.1.18 Common pipistrelle was the most commonly recorded species using the site with a maximum number of passes per night of 31 at location one and 59 at location two (see Vol 21 Plate D.1). Soprano pipistrelle bat passes were recorded in low numbers at location two only. Passes of noctule were recorded in low numbers at location two. An unidentified bat species (also likely to be a noctule recorded in the distance) was recorded in low numbers at both location one and location two.

Vol 21 Table D.2 Terrestrial ecology – bat survey weather conditions

Survey visit	Weather conditions
03 May 2011	6°C, moderate breeze, 100% cloud cover, dry
04 May 2011	6°C, gentle breeze, 100% cloud cover, dry

Survey visit	Weather conditions
05 May 2011	9°C, light breeze, 50% cloud cover, dry

Vol 21 Plate D.1 Terrestrial ecology – bat passes recorded during remote recording surveys at two locations at King Edward Memorial Park Foreshore site.



Bat activity (dawn) surveys

D.1.19 As there were high numbers of bats recorded during the remote recording survey and more than two species were recorded, 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 1 July 2011 in suitable weather conditions (14^{o}C, calm, 60% cloud cover,

dry). The bat activity survey results are shown on Vol 25 Figure 6.4.4 (see separate volume of figures).

D.1.20 Common pipistrelle bat were observed commuting along the River Thames with some foraging activity within the park focused on tree lines. Ten common pipistrelle passes were recorded, three of which were within an hour of dawn. No other bat species were recorded during the activity survey.

Wintering bird survey

D.1.21 A total of six survey visits were undertaken between December 2010 and March 2011, and during October and November 2011 by an experienced ornithologist (bird specialist). The survey visits were undertaken in suitable weather conditions (Vol 21 Table D.3). The main foraging and resting areas for wintering birds are indicated on Vol 21 Figure 6.4.4 (see separate volume of figures). The numbers of individuals of each species recorded in each month are provided in Vol 21 Table D.4.

D.1.22 A total of ten waterbird species were recorded within the survey area. Of these, six are of conservation importance and are included on the Birds of Conservation Concern 3 (RSPB, 2009)[1] Red or Amber List[i] and/or UK and London BAP as priority species. The six species of conservation importance are mallard (*Anas platyrhynchos),* black-headed gull (*Larus ridibundus),* common gull (*Larus canus),* lesser black-backed gull (*Larus fuscus),* herring gull (*Larus argentatus)* and great black-backed gull (*Larus marinus)*. These species were recorded foraging on the foreshore on site, and on the foreshore to the east and southwest, and on the foreshore on the opposite bank of the River Thames.

D.1.23 Large numbers of gulls were recorded during the December 2010, and January and February 2011 survey visits at this location as birds were being fed by the public from the park.

D.1.24 Moored barges at the pier to the northeast of the site were regularly used by resting gulls and cormorants.

Vol 21 Table D.3 Terrestrial ecology – wintering bird survey weather conditions

Survey visit	Weather conditions
17 December 2010	8^{o}C, moderate breeze, 80% cloud cover, dry

[i] The conservation status of all regularly occurring British birds has been analysed in co-operation 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.

Survey visit	Weather conditions
26 January 2011	6°C, light breeze, 60% cloud cover, dry
25 February 2011	10°C, calm, 25% cloud cover, dry
16 March 2011	9°C, moderate breeze, 80% cloud cover, dry
13 October 2011	14°C, calm, 60% cloud cover, dry
14 November 2011	10°C, moderate breeze, 80% cloud cover, dry

Vol 21 Table D.4 Terrestrial ecology - species and numbers of wintering waterbirds recording during wintering bird surveys

Species name	Latin name	Conservation designation[ii]	Monthly wintering waterbird counts					
			17 December 2010	26 January 2011	25 February 2011	16 March 2011	13 October 2011	14 November 2011
Cormorant	*Phalacrocorax carbo*	Green List	3	4	1	3	8	2
Canada Goose	*Branta canadensis*	Green List	-	-	-	-	-	1
Mallard	*Anas platyrhynchos*	Amber List	2	1	-	5	-	6
Moorhen	*Gallinula chloropus*	Green List	-	1	-	1	-	-
Coot	*Fulica atra*	Green List	-	2	2	6	-	-
Black-headed gull	*Chroicocephalus ridibundus*	Amber List	86	63	64	14	43	4
Common gull	*Larus canus*	Amber List	-	3	-	-	-	3
Lesser black-backed gull	*Larus fuscus*	Amber List	2	5	2	6	6	3

[ii] 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].

Species name	Latin name	Conservation designation[ii]	Monthly wintering waterbird counts					
			17 December 2010	26 January 2011	25 February 2011	16 March 2011	13 October 2011	14 November 2011
Herring gull	*Larus argentatus*	Red List UK BAP Priority List	8	3	3	8	2	2
Great black-backed gull	*Larus marinus*	Amber List	1	1	-	-	2	1

Invasive plants survey

D.1.25 The survey was undertaken by an experienced ecologist on 16 August 2011. The invasive plant species montbretia (*montbretia sp.)* was recorded on site along the proposed access road between the site compound and the foreshore works area. A small area of Himalayan cotoneaster *Cotoneaster simosii* was identified adjacent to the site to the northeast as shown on Vol 21 Figure 6.4.5 (see separate volume of figures).

Interpretation

Bats

D.1.26 There is the potential for bats to be commuting along the River Thames and foraging within King Edward's Memorial Park on and adjacent to the site.

D.1.27 During the remote recording surveys, the maximum number of common pipistrelle bat passes was recorded on the 5 May 2011 with 59 passes. Some of these records were from within one hour of sunset. Evidence from the dawn survey indicated that there is currently no common pipistrelle roost within the survey area. However, it is likely that there is a roost in close proximity to the survey area.

D.1.28 Soprano pipistrelle was only recorded at Location two with a total of three bat passes and was not recorded during the dawn survey. The survey results indicate the occasional use of the survey area by small numbers of soprano pipistrelle bats for foraging and/or commuting purposes.

D.1.29 Noctule was recorded using the site only on 5 May 2011 when two passes occurred and was not recorded during the dawn survey. This suggests the presence of an individual noctule bat using the site for foraging and/or commuting purposes and that the species is an occasional visitor to the site.

D.1.30 Two unidentified bat passes were recorded during the bat triggering surveys on 5 May 2011. These could be noctule or a mouse-eared bat (*Myotis* sp.). The data was not sufficient to allow identification to species level. It is likely that this species is an occasional visitor to the site, using it for foraging and/or commuting purposes.

Wintering birds

D.1.31 Of the ten waterbird species that were recorded within the survey area, six are of nature conservation importance because they are included in the Birds of Conservation Concern Red or Amber List and/or UK BAP Priority Species: mallard, black-headed gull, common gull, lesser black-backed gull, herring gull and great black-backed gull. The foreshore on site and adjacent foreshore are used for foraging by these species.

D.1.32 Feeding of birds at this site is likely to have skewed the results, by attracting an abundance of black-headed gull and other gull species to the site. This is indicated by the far lower numbers of these species present during visits where feeding did not occur.

D.1.33 Features within the survey area such as moored barges and anchored buoys providing resting habitat for a range of species, with gulls and cormorants observed during the surveys.

Invasive plants

D.1.34 Two species, monbretia and Himalayan cotoneaster listed on Schedule 9 of the Wildlife and Countryside Act 1981 were present on or within 10m of the site boundary. It is illegal to cause the spread of these species. Therefore, it would be necessary to control these species before works commence on site.

References

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

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.21**

Volume 21: King Edward Memorial Park Foreshore appendices

Appendix E: Historic environment

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

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Thames Tideway Tunnel

Environmental Statement

Volume 21 King Edward Memorial Park Foreshore 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 21 Table E.1 below, with their location shown on the historic environment features map (Vol 21 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**, eg, **HEA 1A**, **1B**, **1C**. References to assets outside the site but within the assessment area begin with **2** and continue onwards, eg, **HEA 3**, **4**, **5**.

Vol 21 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 site of the former Shadwell Market, first shown on Rocque's map of 1746 but believed to date from at least the late 17th century.	---
1B	Thames foreshore, to the southeast of King Edward Memorial Park. The remains of an 18th century drain, noted on the Thames Archaeological Survey (TAS) in the 1990s.	MLO70752 084007
1C	Thames foreshore, to the southeast of King Edward Memorial Park. The find spot of 19th century pottery and medieval pottery noted on the Thames Archaeological Survey (TAS) in the 1990s.	MLO70744 084002 MLO3957 081008
1D	Thames foreshore, to the southeast of King Edward Memorial Park. The location of a post-medieval river wall/flood defences.	MLO70743 084000
1E	Thames foreshore, to the southeast of King Edward Memorial Park. A surface/layer of large chalk blocks/crushed chalk – possibly a surface for a barge bed, observed during the Museum of London (MOLA) site visit in 2011.	MLO70742 083999
1F	Thames foreshore, to the southeast of King Edward Memorial Park. The remains of a post-medieval drain.	MLO70754 084008
1G	Thames foreshore, to the southeast of King Edward Memorial Park. A scatter of horizontal timbers to the east of the sewer outlet, observed during the MOLA site visit in	---

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	2011.	
1H	Thames foreshore, to the southeast of King Edward Memorial Park. A surface/layer of stone blocks was observed during the MOLA site visit in 2011.	---
1I	Thames foreshore, to the southeast of King Edward Memorial Park. The North East Storm Relief Sewer outlet, built by the London County Council from Hackney Road via Bethnal Green Road to Whitechapel and Shadwell/Wapping in 1921–1928. There is a wide cobbled apron in front of the outlet, which is probably contemporary.	---
1J	Thames foreshore, to the southeast of King Edward Memorial Park. A timber piled jetty of uncertain date was observed during the MOLA site visit in 2011.	---
1K	Thames foreshore, to the southeast of King Edward Memorial Park. A line of piled timbers (probably part of a post-medieval jetty) were observed during the site visit with a concrete (possibly later) slipway abutting to the east.	---
1L	Thames foreshore, to the southeast of King Edward Memorial Park. A line of piled timbers (probably part of a post-medieval jetty) were observed during the site visit with a concrete (possibly later) slipway abutting to the east.	---
1M	Thames foreshore, to the southeast of King Edward Memorial Park. A surface/layer of large chalk blocks/crushed chalk – possibly a surface for a barge bed, observed during site visit.	---
1N	Thames foreshore, to the southeast of King Edward Memorial Park. A layer/surface of stone observed during site visit.	---
1O	Thames foreshore, to the southeast of King Edward Memorial Park. The North East Storm Relief Sewer outlet, built by the London County Council from Hackney Road via Bethnal Green Road to Whitechapel and Shadwell/Wapping in 1921–1928.	---
1P	Thames foreshore, to the southeast of King Edward Memorial Park. A wide cobbled slipway opposite the North East Storm Relief Sewer outlet. Probably contemporary with the sewer outlet (1921–1928).	---
1Q	Thames foreshore, to the southeast of King Edward	---

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	Memorial Park. A timber piled jetty of uncertain date was observed during the site visit.	
1R	Thames foreshore, to the southeast of King Edward Memorial Park. A surface/layer of stone blocks was observed during the site visit.	---
1S	Thames foreshore, to the southeast of King Edward Memorial Park. A scatter of horizontal, post-medieval timbers to the east of the North East Storm Relief sewer outlet, observed during the site visit.	---
2	Thames foreshore, to the south of King Edward Memorial Park. A line of partially vertical timbers aligned northeast to southwest, adjacent to the river wall, was observed during the MOLA site visit. Possibly the remains of a medieval fish trap.	MLO70736 083993
3	Thames foreshore, to the south of King Edward Memorial Park. Post-medieval steps noted on the Greater London Historic Environment Record (GLHER).	MLO70732 083989
4	Thames foreshore, to the south of King Edward Memorial Park. The find spot of post-medieval dressed stone and the remains of an unspecified post-medieval structure noted on the GLHER.	MLO70734 083991 MLO70735 083992
5	Thames foreshore, to the south of King Edward Memorial Park. The remains of unspecified post-medieval structures, noted on the GLHER.	MLO70749 084005 MLO70751 084006
6	Thames foreshore, to the south of King Edward Memorial Park. The remains of an unspecified timber post-medieval structure, noted on the GLHER.	MLO70730 083988
7	Thames channel, to the south of the site. The remains of a post-medieval stake, noted on the GLHER.	083998
8	Thames (Rotherhithe) Tunnel. Underwater tunnel for human traffic. The tunnel was begun in 1825 and completed in 1843 by engineer Marc Isambard Brunel with assistance from Isambard Kingdom Brunel. The tunnel was constructed of brick bedded in Roman cement and faced with clay tiles and stucco. It is 1,200ft long. Segmental arches separating the two vaults 'rest' on Greek Doric half-columns with square abaci. Many of the arches have been filled in. Experimental attempts to construct a tunnel were made in 1805 by Robert Vazie and again in 1808 by Richard Trevithick. The present tunnel was constructed on a new line to a revised scheme	MLO93181

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	by Marc Brunel (1769–1849) using a tunnelling shield designed by him and patented in 1818. The tunnel remained a foot tunnel until 1865–1869 when it was converted for the East London Railway. It was later used by electric underground trains (East London Line) and is now as a London Overground line. It runs 23m below the high tide water surface.	
9	Ratcliff Dry Dock. Post-medieval dry dock, noted on the GLHER.	MLO63884 082974
10	Thames embankment, to the east of Atlantic Wharf. The site of a post-medieval market noted on the GLHER.	MLO72153 084291 MLO72152 084290
11	Thames foreshore, to the east of the site. The remains of an 18th century causeway and pottery scatter, noted on the GLHER.	MLO70715 083975
12	Thames foreshore, to the east of the site. 19th century drain, 18th century potsherd and an 18th century nail noted on the GLHER.	MLO70714 083974 MLO70726 083984
13	Chance find of a post-medieval buckle recorded by the Portable Antiquities Scheme (PAS).	LON-4CE818
14	Thames foreshore. The site of a possible shipyard. Four unclassified 18th century timber structures. Noted on the GLHER.	MLO70720 083979 MLO70721 083980 MLO70723 083982 MLO70724 083983
15	Roman road (The Highway) to the north of the site. The line of a Roman road thought to have run east from *Londinium* to Ratcliffe.	MLO3886 080882
16	Wapping Wall, to the west of the site. The site of a medieval watermill, noted on the GLHER.	MLO24604 081563
17	Shadwell Pierhead. The site of the medieval/post-medieval village of Shadwell, and an associated medieval/post-medieval shipyard.	MLO7744 080988 MLO8868 081584
18	Shadwell Basin (north bank). The find spot of two Saxon spearheads, noted on the GLHER.	MLO12936 080904
19	King Edward Memorial Park pavilion, 130–162 The	MLO77555

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	Highway. The remains of a prehistoric pit or post hole, noted on the GLHER.	
20	King Edward Memorial Park, The Highway. The find spot of 17th century slipware dish with brown slip bird, 2 basins, pipkin and wine bottle.	MLO12185 081041
21	Cable Street, Schoolhouse Lane. The site of the 17th century Friends Burial Ground.	MLO71218
22	Schoolhouse Lane. The site of the Coopers Almhouses, dating to the beginning of the 16th century.	MLO8143 081559
23	Chance find of post-medieval dividers and a post-medieval token recorded by the PAS.	LON-019862 LON-C161D6
24	St. Katherine's Road. The line of a medieval road, noted on the GLHER.	MLO9255 081602
25	Rotherhithe Street, south bank of the Thames. The remains of a post-medieval building and a dock / revetment.	MLO66070 092197 MLO66071 092198
26	Opposite Bellamy's Wharf, Thames channel, south bank. The find spot of a Neolithic hand-axe.	114042
27	London Hydraulic Power Company with number 37 Wapping Wall. Grade II* listed.	1242419 MLO65792–6 MLO65798 800025 800025/01–05
28	Pelican Stairs. Grade II listed.	1065814
29	Prospect of Whitby Public House. Grade II listed.	1357505
30	Shadwell Dock Stairs. Grade II listed. Old kerbed brick and stone slipway to river. Steps mostly covered with later surfacing.	1065138
31	Air shaft to the Rotherhithe Tunnel. Grade II listed 1904–1908, a circular red brick single storey 'drum' with Portland stone dressings, containing staircase down to tunnel and pedestrian footpath. Of identical design to the Surrey Shore air shaft on Rotherhithe Street	1260101
32	Free Trade Wharf. Grade II listed	1357841
33	Flagged Passage (Approaching stone stairs from The Highway). Grade II listed	1357842
34	Stone Stairs. Grade II listed	1065139

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
35	Wall closing north end of courtyard. Grade II listed Wall associated with Shadwell dock wall of same height and abutting churchyard retaining wall but with two large plain buttress-piers, stone coping broken forward over, and sharply curved return to doorway of No 1.	1242311
36	St. Paul's Terrace. Grade II listed No 1 to 3 of St Paul's Terrace. small stepped terrace of 2 storey one bay houses built of stock brick, giving onto a courtyard below east retaining wall of St Paul's Shadwell churchyard.	1260100
37	West Block with attached railings and gatepiers, Peabody Estate. Grade II listed. Part of estate built for the Peabody Trust in 1866 to the designs of Henry Darbishire. Four large blocks of similar appearance and materials, arranged so as to form a rectangular courtyard. Brick in English bond with hipped slate roofs and tall brick stacks. North Block with attached railings and gatepiers, Peabody Estate. Grade II listed. South Block with attached railings and gatepiers, Peabody Estate. Grade II listed. East Block with attached railings and gatepiers, Peabody Estate. Grade II listed.	1246619 1246616 1246617 1246618
38	Glasshouse Fields, Cable Street, land bounded by Brodlove Lane. An evaluation by the Museum of London Archaeology Service (MoLAS, now MOLA) in 1995 revealed a large east-west ditch of possible Roman date, quarries backfilled with waste from the manufacturing of glass at the Glass Houses to the south. Post medieval domestic structural remains were also recorded.	GHF95
39	Glasshouse Fields, Cable Street. An evaluation/excavation by MoLAS in 2004 recorded an early glassworks (furnaces, flues and waste), dating to the 17th/early 18th century. A series of work surfaces and hearths related to metalworking from the late 18th and 19th centuries was also uncovered, along with 19th/20th century brick structures, either related to later glassworks or metal works. One abraded, residual sherd of Roman pottery was recovered. The oldest standing building on the site, possibly constructed around 1800, was recorded before demolition. It contained traces of a brick vault, presumably a glass	GAF04

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	furnace, since dismantled.	
40	469–475 The Highway. An evaluation by Essex County Council Field Archaeology Unit in 2002 recovered sherds of abraded medieval pottery above alluvial deposits, and recorded 17th and 18th century domestic structural remains including cellars, cess pits and evidence of extensive fire damage. The building may have had a commercial use as the finds included fragments from more than one alembic and several glass phials. Traces of 19th century cultivation trenches were recorded in an area latterly occupied by a factory.	HGY02
41	Free Trade Wharf, Atlantic Wharf. A watching brief and building recording by MoLAS in 1994–1997 recorded the remains of an 18th century dock, and 19th century and later river walls and basemented buildings.	FTW94
42	165 Rotherhithe Street (south bank of the Thames). An excavation MoLAS in 2000 recorded a mid/late 17th century a timber waterfront revetment, possibly replacing an earlier waterfront. Land behind the revetment was reclaimed with dumps containing pottery wasters, kiln furniture, fragments of tobacco pipes and debris. In the second half of the 18th century the waterfront was advanced and a wet dock built within the site (the Woolcombe shipyard). Timber land-ties of the dock and several dockside structures were recorded. In the 19th century the site became part of the Beatson ship-breaking yard where the Temeraire ship was demolished in 1838.	ROZ00
43	Bellamy's Wharf, Rotherhithe Street. An evaluation/excavation by MoLAS in 1995 recorded a 17th century timber dock reusing earlier ships timbers, along wth levelling dumps with industrial and domestic waste material, especially kiln lining and delft pottery. In the 18th century a second dock was built to the west and in the 19th century a large building was constructed.	BEY95
44	Thames foreshore, to the southwest of the site and the Shadwell Basin entrance. The remains of a post-medieval structure; possibly the remains of a barge bed, consisting of several horizontal timbers.	FTH06 A110
45	Thames foreshore, to the southwest of the site and the Shadwell Basin entrance. The find spot of a scatter of post-medieval nails and a consolidation layer consisting of stone, metal and wood; perhaps shipyard remains.	FTH06 A106 A107 A108

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
46	Thames foreshore, to the southwest of the site and the Shadwell Basin entrance. A post-medieval scatter of nails, including cleats and eyelet bolts.	FTH06 A109
47	Thames foreshore, to the southwest of the site and the Shadwell Basin entrance. The approximate location of three grouped lines of stakes and timbers which may represent the remains of post-medieval barge beds.	FTH06 A111 A112 A113
48	Thames foreshore, to the southwest of the site and the Shadwell Basin entrance. The remains of a post-medieval barge bed.	FTH06 A114
49	Thames channel, immediately to the southwest of the Shadwell Basin entrance. The remains of a post-medieval timber wharf in front of the modern jetty.	FTH06 A121
50	Thames foreshore, to the west of the site. The approximate location of two groups of post-medieval timbers. One, consisting of vertical planks, may represent a crane base. The other may be the remains of a gridiron.	FTH07 A145 A146
51	Thames foreshore, to the west of the site. The remains of post-medieval timbers, angled towards the river.	FTH07 A134
52	Thames foreshore, to the east of the site. A scatter of post-medieval building material, including brick and tile.	FTH08 A114
53	Thames foreshore, to the east of the site. The remains of a possible post-medieval barge bed, consisting of two parallel lines of horizontal wooden planks.	FTH08 A126
54	Thames foreshore, to the south of King Edward Memorial Park. The remains of a 19th century drain, noted on the Thames Archaeological Survey (TAS) in the 1990s.	MLO70737 083994
55	Thorpes Yard, Wapping Wall. A watching brief in 1997 by Pre Construct Archaeology. 19th to 20th century made-up ground was recorded.	TYW97
56	Thames foreshore, Rotherhithe. The approximate central location of the remains of a post-medieval mooring feature, fronting Surrey Commercial Wharf, and a barge bed and mooring 'dolphin' in front of Bull Head Dock.	FSW04 A117 A121 A123
57	Thames foreshore, Rotherhithe. A scatter of post-medieval nails in front of a dock entrance.	FSW04 A128
58	Thames foreshore, Rotherhithe. The remains of a post-medieval mooring post, consisting of four vertical wooden posts.	FSW04 A126

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
59	Thames foreshore, Rotherhithe. The remains of a possible post-medieval mooring block and an associated crane.	FSW05 A113 A121
60	Thames foreshore, Rotherhithe. The remains of a barge bed, consisting of six timbers forming a curved line, and the base of a masonry mooring block.	FSW05 A110 A111
61	VOID	
62	VOID	
63	Thames foreshore, to the southwest of King Edward Memorial Park. A scatter of horizontal timbers was observed during the site visit.	---
64	Thames foreshore, to the southwest of King Edward Memorial Park. A scatter of ceramic rubble and building material was observed during the site visit.	---
65	Chance find of a post-medieval button, a post-medieval cufflink and a post-medieval coin recorded by the PAS.	LON-CDB855 LON-CD52E3 LON-A9DAE4
66	Thames foreshore, Rotherhithe. The location of a pile/post as identified by Seazone data.	SZID 485000007449563
67	Thames foreshore, Rotherhithe. The location of a pile/post as identified by Seazone data.	SZID 485000007449194
68	Thames foreshore, Rotherhithe. The location of a pile/post as identified by Seazone data.	SZID 485000007449074
69	Thames foreshore, Rotherhithe. The location of a pile/post as identified by Seazone data.	SZID 485000007449296
70	Thames foreshore, northeast of the site. The location of an unidentified obstruction – perhaps a mooring installation or buoy – located on the foreshore.	SZID 637000001106494
71	Thames channel, adjacent to the eastern boundary of the Rotherhithe Tunnel.	SZID 485000007450984
72	Thames channel, to the west of the Thames Channel.	SZID 485000007451010

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
73	Thames channel, adjacent to Rotherhithe riverbank. The location of an unspecified obstruction – perhaps a mooring installation or buoy – located within the Thames Channel.	SZID 637000001106491
74	Church of St Mary. Grade II listed.	1096892
75	Thames channel, adjacent to Rotherhithe riverbank. The location of an unspecified obstruction – perhaps a mooring installation or buoy – located within the Thames Channel	SZID 637000001106478
76	Thames channel, adjacent to Rotherhithe riverbank. The location of an unspecified obstruction – perhaps a mooring installation or buoy – located within the Thames Channel	SZID 637000001106493
77	Thames channel, adjacent to Rotherhithe riverbank. The location of an unspecified obstruction – perhaps a mooring installation or buoy – located within the Thames Channel	SZID 6370000011 6501
78	Thames channel, adjacent to Rotherhithe riverbank. The location of an unspecified obstruction – perhaps a mooring installation or buoy – located within the Thames Channel.	SZID 6370000011 6492
79	Chance find of a post-medieval token recorded by the Portable Antiquities Scheme (PAS).	LON-1B3006
80	Line of the Bazalgette Low Level Sewer.	---
81	The site of the 19th century Metropolitan Wharf.	MLO93237 411853 411854
82	The chance find of medieval bone tools and medieval to post-medieval pottery.	MLO12935 080941 MLO3984 081044
83	The chance find of a piece of Roman mosaic.	MLO100302
84	The site of the 19th century Jubilee Wharf.	MLO93238 441856
85	Evidence of a Palaeolithic forest. (note, the tree stumps and trunks are unlikely to be Palaeolithic, as the floodplain was not carved out in this period, but are likely to be of Mesolithic to Neolithic date, as found on the foreshore and below the floodplain alluvium nearby, in areas such as Erith)	MLO12925 080736
86	A Roman lead coffin and containing a few bones found by chance in 1858.	MLO11219 080807
87	Church of St Paul. Grade II* listed. 1817–20 by John Walters. Remodelling, mostly internally,	1357840

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	in 1848 by William Butterfield. E end remodelling 1931 by W C Waymouth. Built of stock brick, limestone plinth and parts of the spire, stucco dressings.	
88	Iron railings, wall and iron gates of St Paul's Church. Grade II listed. Early 19th century. Railed wall, railings with urn finials. Massive iron gates with square piers and individual lamp brackets above each one.	1065137
89	St Paul's Church, Church House. Grade II listed.	1065136
90	St Paul's Rectory. Grade II listed.	1242310

E.2 Site location, topography and geology

Site location

E.2.1 The site is located on the north bank of the River Thames, and within the southern half of the King Edward Memorial Park, with grassed areas, recreational seating and paths. The site lies within the ancient parish of St. Paul, Shadwell, formerly within the county of Middlesex.

Topography

E.2.2 In the northern half of the site, in the park on the landward site of the riverwall, the ground slopes down gently towards the Thames to the south, from *c.* 107.0m ATD (above Tunnel Datum; the equivalent of 7.0–8.0m Ordnance Datum) to c. 105.5m ATD at the riverfront embankment edge, which is flat. Some areas of the central part of the park have been levelled, e.g. for a bowling green. There is drop of around 3m down into the park from the Highway to the north of the site, at 110.0m ATD, reflecting the edge of the higher terrace gravels and the Thames floodplain on which the site is located. It is possible that the road has built up artificially and/or the park terraced into a slope.

E.2.3 There is a drop of around 4.5m down from the top of the river wall to the foreshore in the southern half of the site. The top of the foreshore lies at 100.5m ATD. The lower part of the foreshore lies at c. 97.0–98.0m ATD. At low tide the foreshore is exposed c. 15–20m from the line of the river wall. The riverbed dips to 95.5m ATD in the southwest corner of the site to 64.0m ATD in the southwest.

Geology

E.2.4 The King Edward Memorial Park Foreshore site is situated entirely on alluvium of the River Thames floodplain[1], an area of alluvial silts and peats overlying sand and gravel deposits associated with a wide meander of the River Thames. The Taplow river terrace lies c. 40m to the north of the

site, and at the edge of the terrace it comprises of a thin spread of clayey gravel lying over London Clay at c. 99.0m ATD.

E.2.5 Borehole data provided by Thames Tideway Tunnel project for the site area is limited to one log, although coverage of the surrounding area is good. The logs however, with the exception of a group[2] c. 40m to the north of the site, are antiquated and low in detail with regards to the alluvial stratigraphy.

E.2.6 Borehole data just to the northwest of the site indicates an eroded gravel surface where gravels survive to 98.0m ATD[3]. These gravels are probably Shepperton Gravels, which underlie the present floodplain, banked up against the older river terrace. The Shepperton Gravels were deposited around 18,000–15,000 years ago, in a braided river environment, following the down-cutting by the Thames to its present floodplain at the end of the last cold stage. This left the Taplow Gravel as a river terrace, above the modern floodplain to the north. On the site the gravel has been eroded out by the river, and sands and peats deposited during the Holocene (from 10,000 BP). This is indicative of the infilling of former channels, which became abandoned through channel migration[4]. Bathymetric data shows the basal channel deposits slope down toward the deepest part of Thames c. 75m to the southeast of the site. The Shepperton gravels exist here as a thin layer at c. 93.0m ATD.

E.2.7 According to the only borehole record available for the site, 4.0m thick peats exist over 'loamy sands' at 93.4m ATD[5]. Peat is important for palaeoenvironmental reconstruction as it is an excellent medium for organic preservation, particularly plant macrofossil and microfossil preservation which enables an understanding the vegetation history of the local area, as well as for establishing a chronostratigraphic framework (the classification of stratigraphic units according to age) through radiocarbon dating. At these levels, the peats probably date to the Early Mesolithic period (c. 9000–7500 BP). The loamy sands underneath the peats in the borehole within the site could represent deposition of in-channel sediments within the freshwater meandering Thames, in which early soils might have developed as the channel migrated, possibly dating to the Loch Lomond Stadial (c. 13–11,000 BP), or the early Holocene (10,000 BP). The peats and underlying loamy sands within the site are therefore of considerable archaeological interest.

E.2.8 The existing borehole data suggests deposits of archaeological interest, dating from the Late Glacial or Early Holocene, might exist above about 93.0m ATD on the site. Only the deepest of these deposits are likely to survive towards the southern boundary of the site, where the riverbed dips from 95.5m ATD in the southwest to 94.0m ATD in the southeast and the overlying deposits have been removed (by river scour and dredging), Further up the foreshore/riverbed (beneath reclamation dumps that make up the existing riverfront), a thicker sequence of archaeological deposits (perhaps as much as 4m) are likely to survive, sandwiched between the Pleistocene and modern foreshore gravels.

E.2.9 The site walkover inspection carried out for the assessment noted evidence of attempts to consolidate the foreshore surface. Both upstream

and downstream of the access slipway, 40m to the west of the site (**HEA 30**), are large dumps of rubble, both within and without of timber revetments. The majority outside of the revetments comprise chalk which is likely to have constituted barge beds. Those within the revetments appear to comprise more general masonry and were probably deposited to protect the slipway. This would probably have entailed raising the foreshore surface rather than truncation. Several small and localised dumps of modern consolidation were noted on the foreshore within the site on the MOLA site visit.

E.3 Past archaeological investigations within the assessment area

E.3.1 In the 1990s, the Thames Archaeological Survey (TAS) 'Alpha Survey' of the adjacent areas of the foreshore to the southwest, at Shadwell, and to the northeast of the site, at Ratcliffe, noted structural remains and finds. These included nail scatters, consolidation layers and two possible barge beds at Shadwell, and timber scatters, a possible barge bed, metal stakes and ceramic scatters at Ratcliffe (**HEA 44–47, 52**, **53** and **55**). Observations made by the Thames Discovery Programme (TDP) as part of an informal survey of the foreshore to the west of the site, in 2010, identified no significant changes to the King Edward Memorial Park Foreshore site.

E.3.2 Within the assessment area, four archaeological investigations have been carried out c. 215–280m to the north and northeast (**HEA 38**–**41**); two c. 210–300m to the south, on the opposite bank of the Thames in Rotherhithe (**HEA 42** and **43**); and a one c. 225m to the southwest (**HEA 55**). Current understanding of the nature and extent of early human activity in the assessment area is limited. An undated prehistoric pit or posthole is noted by the Greater London Historic Environment Record (GLHER), c. 25m to the east of the site (**HEA 19**). For the Roman period, discoveries comprise a large ditch discovered during an evaluation at Glasshouse Fields, c. 225m to the north of the site, in 1995 (**HEA 38**).

E.3.3 In contrast, previous investigations have uncovered a substantial quantity of remains dating from the later medieval and post-medieval periods, which relate to the industrial development of the waterfront. The closest investigation to the site was an evaluation carried out at Free Trade Wharf (**HEA 41**) c. 215m to the northeast, which revealed traces of an 18th century dock, 19th century and later river walls, and buildings with basements.

E.3.4 In 1995 and 2004, investigations at Glasshouse Fields, c. 225m to the north of the site (**HEA 38** and **39**), revealed extensive 17th–19th remains associated with glass working (**HEA 38**). An evaluation at The Highway (**HEA 40**), c. 265m northeast, revealed 17th century and later domestic and industrial activity, including fragments of several alembics (glass vessels used for distillation) and glass phials.

E.3.5 To the south, on the opposite bank of the Thames, archaeological investigations on Rotherhithe Street (**HEA 42** and **43**) recorded the

remains of 17th–19th century waterfronts, docks, land reclamation dumps, and the remains of timber structures. 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 scheme, 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 The site is located on the edge of the Thames floodplain and such areas were targeted for exploitation by prehistoric and later people, as the resources of the intertidal marshes and river were accessible from the high, dry, gravel river terrace adjacent.

E.4.3 There are no known archaeological remains dated to this period within the site. The GLHER records remnants of prehistoric forest (**HEA 85**), c. 170m to the west of the site which is probably of Mesolithic to Neolithic date, as recorded elsewhere below the floodplain and exposed on the foreshore at Erith and elsewhere at low tide. Within the Shadwell Basin c. 50m to the southwest of the site, the remains of a forest containing the remains of elm, oak and fir trees dating to the prehistoric period was discovered during the construction of the docks. This forested area may have included parts of the site. Within the assessment area, the remains of a possible prehistoric (otherwise undated) pit or post hole (**HEA 19**), was discovered in King Edward Memorial Park, c. 25m to the east of the site, although the GLHER has no additional information on this discovery. A Neolithic hand axe (**HEA 26**) was recovered from within the Thames channel, c. 300m to the south of the site, close to the Rotherhithe foreshore.

E.4.4 During the early prehistoric period the site lay within the mosaic of freshwater pools, streams, marshes and islands that existed on the floodplain, but within easy reach of the adjacent river terrace. Later in prehistory, it lay within intertidal marshes, to the south of an area of high ground. The forest remains to the northwest reveal that areas of drier land existed in the vicinity of the site, which became submerged (and thus preserved) by rising river levels. The presence of peat in a borehole within the site indicates the likelihood of survival of similar organic remains within the alluvium. Artefacts, structures and environmental evidence for reconstructing the nature of the prehistoric landscape might be preserved.

E.4.5 Although there are few known finds, the marshland would have provided predictable resources of food (fish/game) and water as well as a means of communication and transport. It is probable, despite the lack of archaeological evidence (this would be deeply buried within the alluvium), that the site and its immediate vicinity were exploited for food and building materials such as reed and willow, although conditions may not have been suitable for settlement. Given the proximity of dry ground on the river terrace, there is a potential for timber trackways and platforms constructed to exploit the wetland resources exist within the alluvial deposits on the site.

Roman period (AD 43–410)

E.4.6 The site is located c. 1.8km to the east of *Londinium*, within low-lying intertidal marshland which was probably frequently flooded. The gravel terrace close to the northern edge of the site, may have been used for farming, comprising part of the *territorium* (the wider economic area, including agricultural land) of the Roman city; the eastern extent of which may have been defined by the River Lea, lying c. 3.5km to the east of the site (Lakin et al., 2002)[6].

E.4.7 The line of an east-west Roman road (**HEA 15**) is thought to have run from *Londinium*, situated c. 1.6km to the west of the site, towards Ratcliff and possibly further to the east, along the present line of The Highway, c. 85m to the north of the current foreshore (adjacent to the northwestern boundary of the site). In line with Roman law, the burial grounds of *Londinium* were situated outside the city walls along the main approach roads. Several extra-mural cemeteries developed from the first century AD, including a major burial area on the east side of the city (Barber and Bowsher, 2002)[7], were excavated on the south side of the Roman road that followed the Highway, c. 750m to the northwest of the site (outside the assessment area). An inhumation within a coffin was discovered in 1858 (**HEA 86**) just to the south of the Highway, beside St. Paul's Shadwell, c. 115m to the west of the site, which may indicate an isolated roadside burial or possibly a roadside cemetery. The extent of the cemetery is currently unknown, but it is unlikely that it extended into the site as the site would have been set back from the road.

E.4.8 A large east-west Roman ditch was discovered cut into natural gravels during an evaluation carried out at Glasshouse Fields (**HEA 38**), c. 225m to the north of the site, in 1995, and an abraded pot sherd dating from the 1st–4th century was uncovered in a further evaluation at Glasshouse Fields in 2004 (**HEA 39**), c. 215m to the northeast of the site. This suggests that low level activity, probably of an agricultural nature, may have been carried out to the north of the King Edward Memorial Park Foreshore site. Excavations carried out in 2002, c. 650m to the northwest of the site (outside the assessment area) revealed a sequence of activity from the 1st to the late 4th century. Brickearth quarry pits were discovered, dating to the 1st and 2nd century, followed by the deposition of cremation burials in the 2nd century. Clay and timber buildings, including a large building with a hypocaust, and pits and boundary ditches parallel to the Highway were revealed, dating to the mid-3rd century. The

excavated area was used in the 4th century for an industrial process such as tanning, and lined tanks and leather artefacts were discovered. The excavations suggest the presence of a high status farm or settlement at Shadwell (Lakin et al., 2002)[8].

E.4.9 Elsewhere within the assessment area, the GLHER records the chance find of a piece of Roman mosaic (**HEA 83**) from the foreshore c. 325m to the southwest of the site, during an open day held by the Thames Explorer Trust.

E.4.10 The Roman finds and features recovered from the assessment area indicate that the site probably lay c. 650m to the southeast of an area of high status farms and/or settlement in Shadwell, and may have been part of the wider *territorium* of the Roman city of *Londinium*.

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

E.4.11 The site was situated within the manor (estate) of Stepney. The manor was extensive and encompassed much of the land on the eastern side of the city, roughly corresponding to the modern Borough of Tower Hamlets. The place name derives from the Old English Stybba's hythe (*Stebenhythe*) indicating a landing place (Victoria County History, 1971)[9]. This was possibly located at Ratcliff Cross, c. 600m to the northeast of the site, where a small settlement is thought to have developed. The name Shadwell is probably also of Saxon origin, derived from 'St. Chad's Well' or a shallow well or spring. In 952, the church of St Dunstan was constructed c. 900m to the northeast of the site, possibly on the site of an earlier wooden church (Cherry, O'Brien and Pevsner, 1994)[10]. It is thought that the main settlement had by this time shifted northwards from Ratcliff Cross to Stepney Village, c. 880m to the north of the site.

E.4.12 There are no known archaeological remains dated to this period within the site, which lay within the intertidal marshland of Wapping marsh and would have been prone to flooding. Although unsuitable for occupation, it is likely that the resources of the marshland were exploited for a range of economic activities, including grazing for sheep, reeds, and fishing. A 'medieval' fish trap or similar structure (**HEA 2**), was recorded by the GLHER on the foreshore at low tide adjacent to the west of the site. This may date to the early medieval period (Vol 21 Plate E.9). It comprised a row of partially upright wooden stakes/posts on a parallel alignment to the foreshore (northwest to southeast).

E.4.13 Within the remainder of the assessment area, two Saxon spearheads (**HEA 18**) was discovered c. 70m to the west of the site, on the northern bank of the Shadwell Basin.

Later medieval period (AD 1066–1485)

E.4.14 In the 13th century, much of the area belonged to the Canons of St. Paul's, who were granted an estate in Shadwell in 1228 (Weinreb and Hibbert, 2008)[11]. This included a mill (Victoria County History, 1971)[12]. By the late 13th century the manor was in the possession of Brice of Shadwell. The site was probably located just beyond the eastern boundary of the main settlement of Shadwell village (**HEA 17**) which has

been located approximately by the GLHER in the area of the present Shadwell Pierhead, c. 35m to the south of the site. The manor house was located on the north side of the main road (The Highway), to the north of the site. Much of the surrounding area was largely uninhabited.

E.4.15 The marshland along the riverfront, in which the site was situated, began to be drained and reclaimed in this period and river walls constructed. This proved difficult, with a number of floods occurring in the 14th and 15th centuries (Milne, 2001)[13]. The living environment of people living near the edge of the marshes would have greatly improved. With the reclamation, London's shipyards gradually shifted eastwards along both sides of the River Thames, and on the north bank extended into Ratcliffe and Shadwell (Milne, 2001)[14]. A wharf is known to have existed at Ratcliffe by 1349 (Kerrigan, 1982)[15]. The GLHER notes the site of a medieval shipyard (**HEA 17**), c. 35m to the south, and wharf at Bell Wharf, adjacent to the northern boundary of the site. A medieval north-south road, St. Katherine's (**HEA 24**), adjacent to the northernmost boundary of the site, becoming a main road in this period.

E.4.16 The GLHER records a sherd of 'medieval' pottery (**HEA 1C**) within the site. A medieval fish trap or similar structure was also noted, just 20m to the west of the site (**HEA 2**; discussed above; Vol 21 Plate E.9), and may date to this period. The GLHER notes the site of a medieval watermill, c. 265m to the west of the site, a few sherds of abraded pottery discovered during an evaluation at 469–475, The Highway (**HEA 40**), and medieval bone tools and pottery (**HEA 82**), c. 300m to the southwest of the site.

Post-medieval period (AD 1485–present)

E.4.17 There are a number of remains dated to this period within both the site and assessment area, reflecting rapid commercial development from the 16th century onwards, which led to the riverfront being transformed into an industrial area of roperies, tan yards, breweries, wharves, smiths and taverns. Away from the riverfront, much of the area was still open country (Weinreb and Hibbert, 2008)[16].

E.4.18 Previous investigations have revealed extensive post-medieval waterfront remains to the east and the west of the site along the foreshore, attesting to the development of a marine-centred economy (Weinreb and Hibbert, 2008)[17]. The GLHER identified an unspecified post-medieval structure (**HEA 1E**), a drain (**HEA 1F**), a river wall/flood defence (**HEA 1D**) and dump deposits (**HEA 1G** and **1H**) of uncertain date within the site. These are probably contemporary with 18th–20th goods movement and possible shipbuilding activity.

E.4.19 During the site walkover survey it was observed that a large part of the foreshore within the site was occupied by horizontal timbers lying in an east to west alignment, some of which appeared to be re-used ships' timbers (Vol 21 Plate E.10). It was not clear in every case how much of the timber was residual or part of a structure. They included a scatter of wooden planks within the northeastern part of the site (**HEA 1G**; Vol 21 Plate E.10). Two timber piled jetties, (**HEA 1L & HEA 1J**; Vol 21 Plate E.12 and Vol 21 Plate E.13), in the western and eastern parts of the site

respectively, and a cobbled outfall apron beneath the 1920s North East Storm Relief Sewer outlet (**HEA 1I**; Vol 21 Plate E.16). A surface of crushed chalk and stone, located in the middle of the site, probably represents a former barge bed (**HEA 1E**; Vol 21 Plate E.14). Scatters of broken stone blocks (**HEA 1J**, Vol 21 Plate E.15; and **HEA 1H**), presumably consolidation layers and ceramic rubble (Vol 21 Plate E.16), probably post-medieval in date, were also noted, along with scatters of nails.

E.4.20 It is likely that the construction of river walls and flood defences, as well as land reclamation, consolidation and the extension of any earlier (medieval) walls, continued throughout this period. Buildings were also constructed along the riverfront between Wapping Marsh and Ratcliffe, and by the very beginning of the 17th century Stow described the area, including the riverfront adjacent to the site, as 'a continual street… with alleys of small tenements…' (Kerrigan, 1982)[18] Remains of a 16th century riverfront revetment c. 10m inland from the modern riverbank, along with 16th and 18th century riverfront buildings were recorded at Old Sun Wharf, c. 500m to the east of the site (outside the assessment area). In 1670, the local population ad grown and the St. Paul Shadwell parish, in which the site lies, was created, centred on the Church of St. Paul's, c. 265m to the northwest.

E.4.21 Faithorne and Newcourt's pictorial map of 1658 (Vol 21 Plate E.1) shows the eastern part of the site within the Thames channel, and the northwest part of the site within an area of densely packed buildings behind a river wall. Beyond and to the north of the rows of riverfront buildings, (lying two or three rows deep and interspersed with gardens), lay open pasture and agricultural fields.

E.4.22 Morgan's map of 1682 (Vol 21 Plate E.2) is not detailed but shows the eastern part of the site in the area of the foreshore/Thames channel, and the western part straddling the 17th century river wall with a number of individual land plots along the riverfront, some of which probably include docks or wharfs. By this time Shadwell was developing into a market centre, and the map shows that the built up area extended into the northern part of the present King Edward Memorial Park. The northern part of the site lies across an area of terrace buildings and narrow streets. A market (**HEA 1A**) existed within the northern part of the site until the construction of the park in 1910–1922.

E.4.23 Part of the industrial character of the area has been revealed by archaeological investigations. Morgan's map labels the 'Glass House Yard' in the present area of Glasshouse Fields, which is today occupied by a modern glassworks c. 225m to the north of the site. Archaeological investigations here in 1995 (**HEA 38**) and 2004–2006 (**HEA 39**), discovered glass manufacturing waste, yard surfaces and hearths related to metalworking. Fragments of glass alembics (used in distillation) and phials were discovered during an evaluation at 469–475 The Highway (**HEA 40**), c. 265m to the northeast of the site.

E.4.24 Riverfront activity dating to the 17th century has been recorded on the opposite bank of the Thames, in Rotherhithe. At Bellamy's Wharf (**HEA**

43), c. 295m to the south of the site, the remains of a 17th century dock and a revetment constructed of reused ship timbers were recorded. Levelling dumps included industrial and domestic waste material, kiln lining and Delft pottery. At 165 Rotherhithe Street (**HEA 42**), c. 210m to the south of the site, a mid–late 17th century timber revetment supported by land-ties formed of reused ships' keels. Here too, reclamation deposits consisted of waste pottery, kiln furniture and fragments of pipes and other debris.

E.4.25 In 1665, the Plague spread to Shadwell. A plague pit was dug within St. Paul's churchyard, c. 115m to the west of the site. The Society of Friends burial ground (**HEA 21**) is also believed to date to the 17th century, and is located c. 245m to the north of the site, although it is not marked on Morgan's 1682 (or Faithorne and Newcourt's 1658) maps.

E.4.26 Rocque's map of 1746 (Vol 21 Plate E.3) shows the riverfront within the eastern part of the site projecting outwards slightly, in comparison to the curve of the embankment to the west, and the straighter line to the east, towards Ratcliffe, and includes industrial docks and wharfs. The map shows the southeastern part of the site within the Thames channel. Located within the southeastern boundary of the site are the former Coal Wharf, Coal Wharf Stairs, Timber Wharf, Bell Wharf and Bell Wharf Stairs. The southwestern part of the site runs roughly along Lower Shadwell Road and includes part of the New Street and Labour in Vain Street. The northernmost part of the site is shown running along (within) the eastern boundary Shadwell Market (**HEA 61**), and north-south along Griffin Street, which is situated within the approximate location of the present Glamis Road, and Market Hill, adjacent to the east. Manufacturing areas had spread northwest of the riverfront, with a number of timber and coal yards located beside and just inland from the waterfront. A large timber yard is also located adjacent to the site, immediately to the west of Griffin Street).

E.4.27 Horwood's more detailed map of 1799 (Vol 21 Plate E.4) shows no major changes to the site itself, although the timber yards formerly adjacent to Griffin Street, to the west, are now occupied by several smaller warehouses, onto which rows of terrace cottages back. The map also shows the spread of housing to the north of the site. The riverfront to the east and west is still predominantly occupied by docks and commercial buildings, including Ratcliffe Dry Dock (**HEA 9**), called 'Horns Dock', 210m to the east of the site.

E.4.28 The site contains an 18th century drain (**HEA 1B**), and possible contemporary remains of uncertain date (see above). To the east of the site, along the foreshore are the remains of an 18th century causeway/stairs (**HEA 11**), potsherd (**HEA 13**) and four unclassified 'structures' including a possible shipyard (**HEA 14**) and the crushed chalk surface of possible barge beds (**HEA 53**), as well as the remains of revetments, docks and associated structures, c. 180–245m to the east of the site. The remains of structures (**HEA 3**–**6**), including stairs (**HEA 3**), located on the foreshore to the west and within 80m of the site, may also date to the 18th–19th centuries.

E.4.29 The 1st edition Ordnance Survey (OS) 25" scale map of 1862 (Vol 21 Plate E.5) shows the majority of the southeastern part of the site on the foreshore. Landward side of the riverwall are industrial warehouses and foundry buildings. The southwestern part of the site occupies a mixed industrial and residential area and includes part of a dust yard, warehouses and sheds to the south and west of Labour in Vain Street and New Road (constructed in the early 19th century). The northwestern part of the site is occupied by Market Hill and Glamis Road, with terrace houses at the very northern extent of the site. Shadwell Market (**HEA 61**) has been cleared.

E.4.30 Two major developments had taken place in the vicinity. The Thames (Rotherhithe) Tunnel (**HEA 8**) (which is not shown on OS maps until 1909–1920) was constructed just west of the site in 1825–1843. Initially a foot tunnel, it was purchased by the East London Railway Company in 1865, becoming a rail tunnel now used by London Underground (Kerrigan, 1982)[19]. Shadwell Old Basin was constructed in 1828–1832, as part of the London Docks (now known as London Docklands), with an entrance c. 100m to the southwest of the site. The basin connected the East Dock with the Thames, allowing ships to access the docks. In the 1850s Shadwell New Basin, with larger locks, extended this structure to the west, requiring the acquisition of the eastern part of St. Paul's churchyard (LB of Tower Hamlets, 2007)[20]. The remains of possible barge beds and shipyard debris (**HEA 44**–**48**), close to the Basin entrance, 100m to the south of the site, probably date to this period. Land reclamation for the extension of the docks reduced the population of Shadwell from 12,000 to 9,000 in 1851 (LB of Tower Hamlets, 2007)[21]. The dock is shown on the map surrounded by warehouses and workers' cottages, whilst the former open fields to the north have been developed for terrace houses and industrial works.

E.4.31 The OS 2nd edition 25" scale map of 1898 (Vol 21 Plate E.6) shows the majority of the eastern half of the site in the foreshore and the northeastern half within a new industrial complex of refrigeration works and a fish market, making up the 'Shadwell Fish Market Estate', with a large pontoon occupying the centre of the foreshore within the site. In 1882, an Act of Parliament had been obtained to establish the fish market and clear the slum housing occupying the land necessary for its construction (Tower Hamlets website, 2011)[22]. The Bell Wharf stairs extend c. 20m onto the foreshore in the southeastern part of the site. Within the northern and western parts of the site, several former terraces and a yard have been cleared. The remains of a drain (**HEA 1C**) and 19th century pottery (**HEA 1S**) were identified within the site by the GLHER.

E.4.32 The OS 3rd edition 25" scale map of 1909 (Vol 21 Plate E.7) shows no major changes to the site itself, although the Thames (Rotherhithe) Tunnel (**HEA 8**) is now marked on the map, including the Grade II listed air shaft (**HEA 31**), constructed in 1904–1908, adjacent to the site.

E.4.33 In 1910, a committee was formed by the Lord Mayor of London to develop projects commemorating King Edward VII. The land on which the Shadwell Fish Market Estate and nearby housing were located was

chosen as the site for a memorial park and was sold to the committee by the City of London Corporation. The First World War interrupted its construction and the project was not completed until 1922 by London County Council (Tower Hamlets Council, 2007)[23]. Establishing the park entailed demolishing the existing fish market and housing, as well as landscaping and planting.

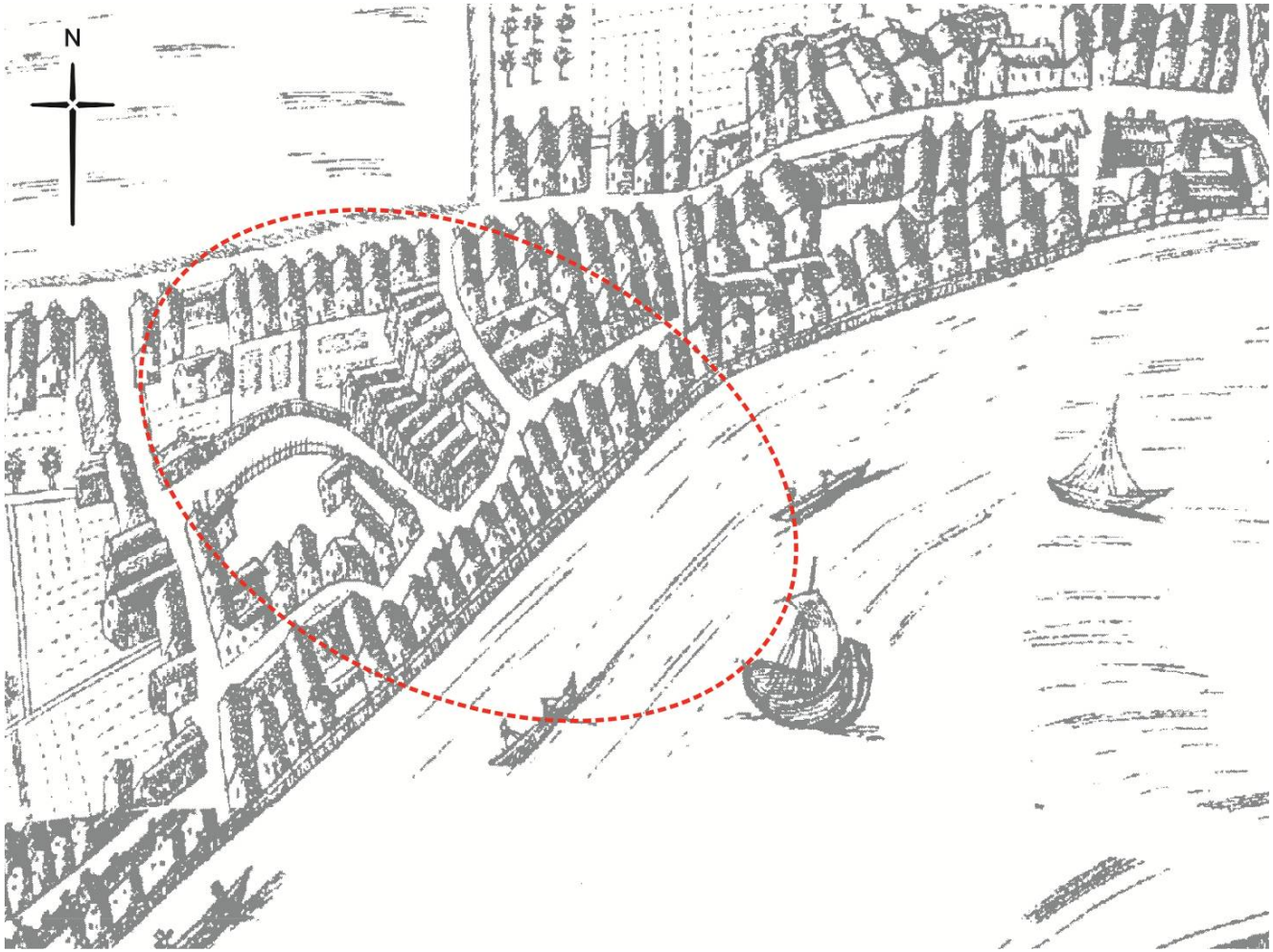
E.4.34 The OS 25" scale map of 1947 (Vol 21 Plate E.8) shows the former commercial/residential area adjacent to the northwest of the site as having been cleared for the King Edward Memorial Park. The embankment adjacent to the site, to the west, was built outwards opposite the Rotherhithe Tunnel air shaft, and the rest of the embankment wall within the site straightened, so that the embankment no longer projects outwards within the site. In the 1920s, the North East Storm Relief sewer outlet (**HEA 1I**; Vol 21 Plate E.16) was also incorporated into the embankment wall and is located in the southeastern part of the site, set c. 10m into the wall, beneath the Thames Walk.

The current site

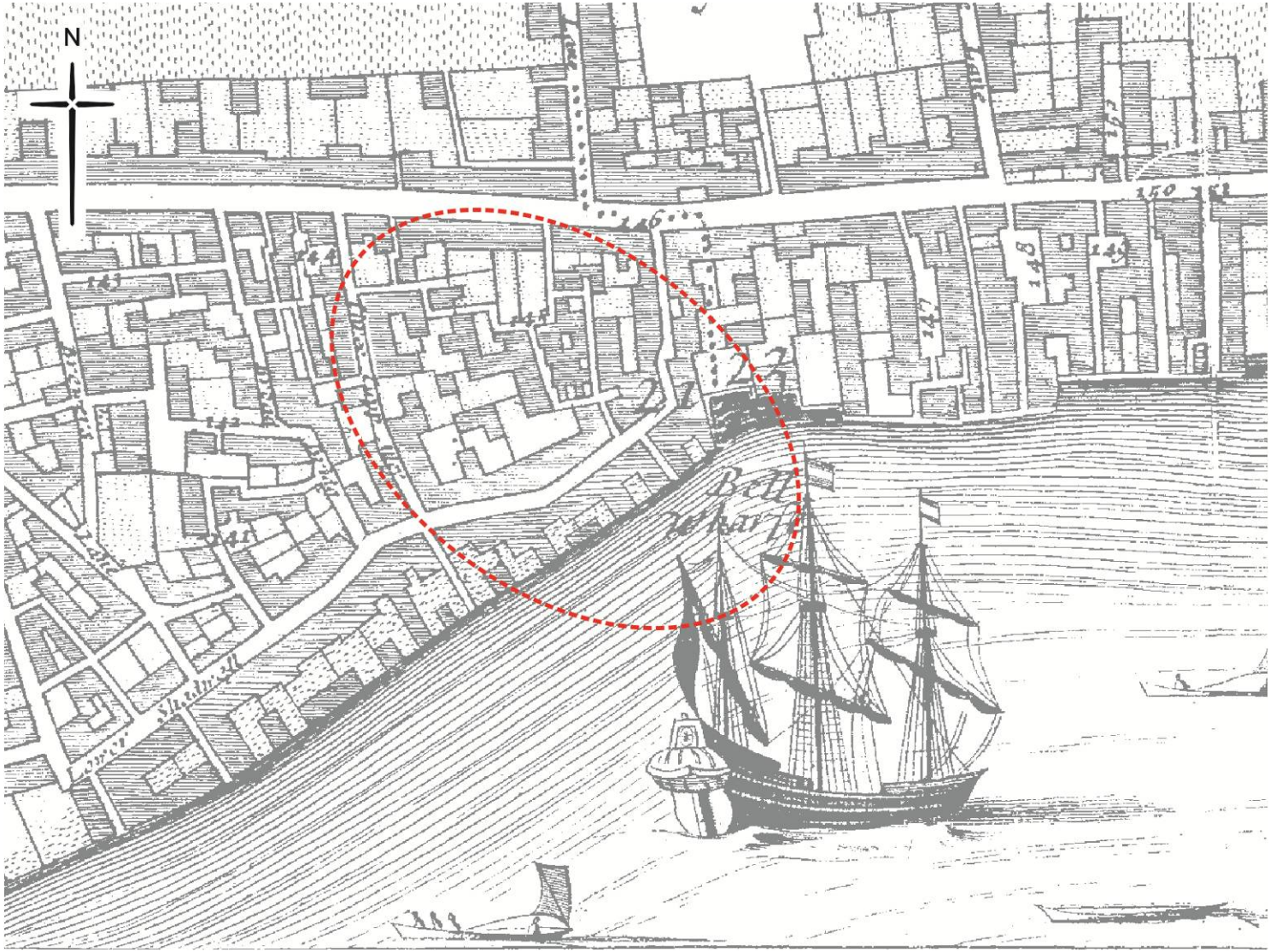
E.4.35 The eastern of the site, which lies on the foreshore, is currently undeveloped. A Grade II listed slipway, (**HEA 30**), c. 35m to the southwest of the site is used for access to the foreshore by the Shadwell Basin Outdoor Activity Centre. The King Edward Memorial Park, which partially comprises the central section of the site, lies adjacent to (landward of) the riverwall, and is used as a green space and recreational area. The northwestern part of the site comprises a section of Glamis Road, from Shadwell Pierhead to the junction of Glamis Road with The Highway.

E.5 Plates

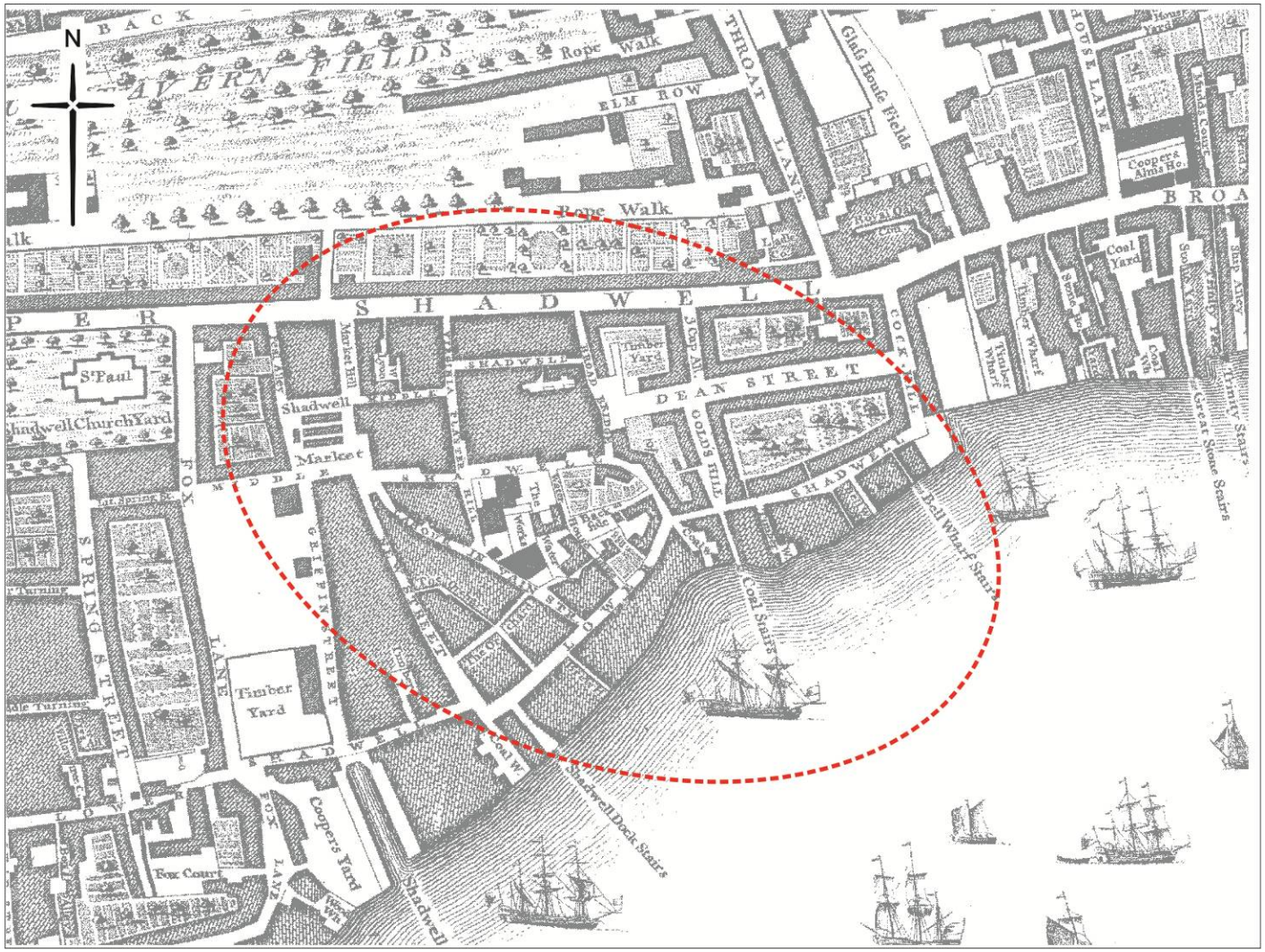
Vol 21 Plate E.1 Historic environment - Faithorne and Newcourt's map of 1658



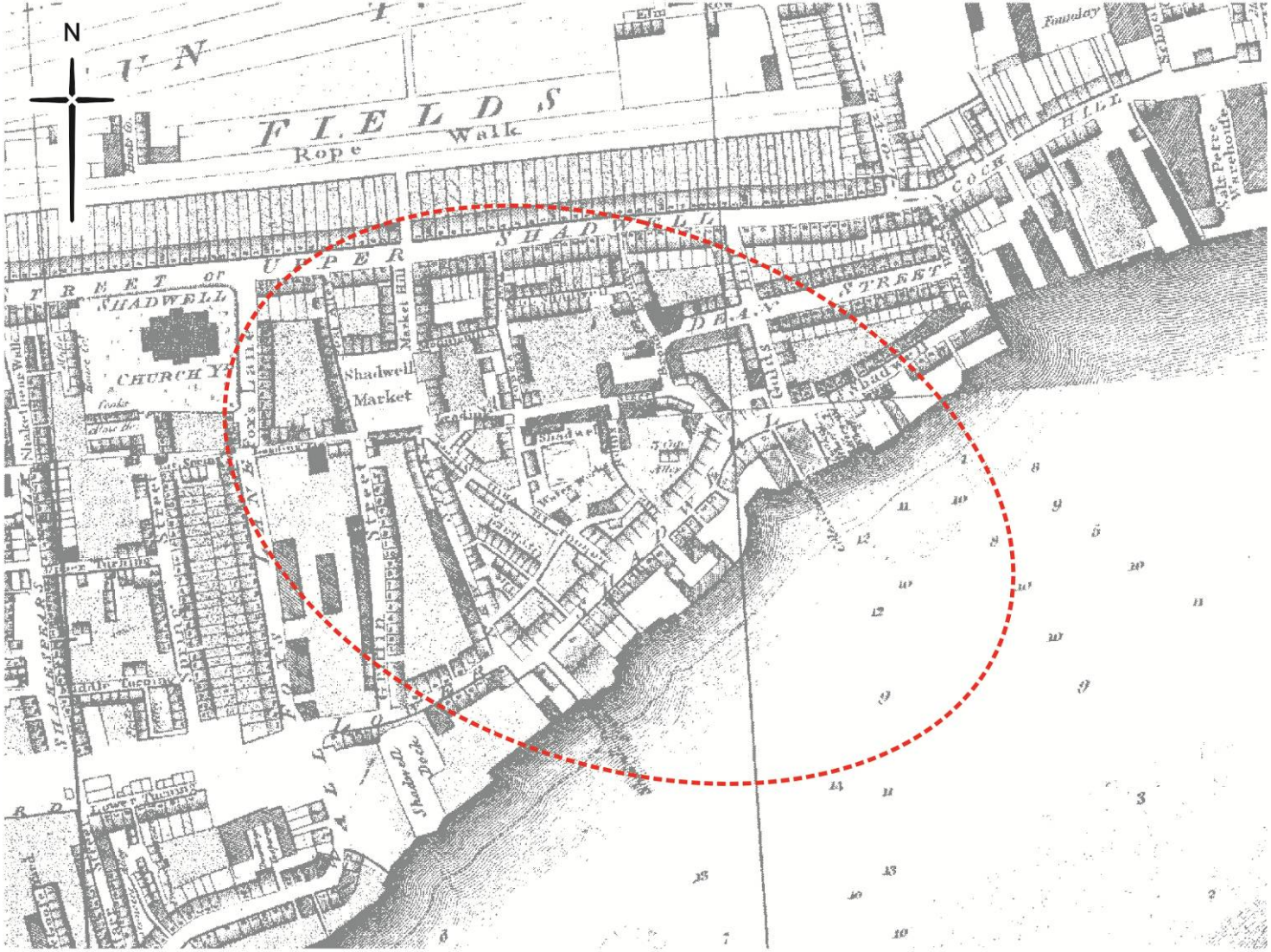
Vol 21 Plate E.2 Historic environment - Morgan's map of 1682



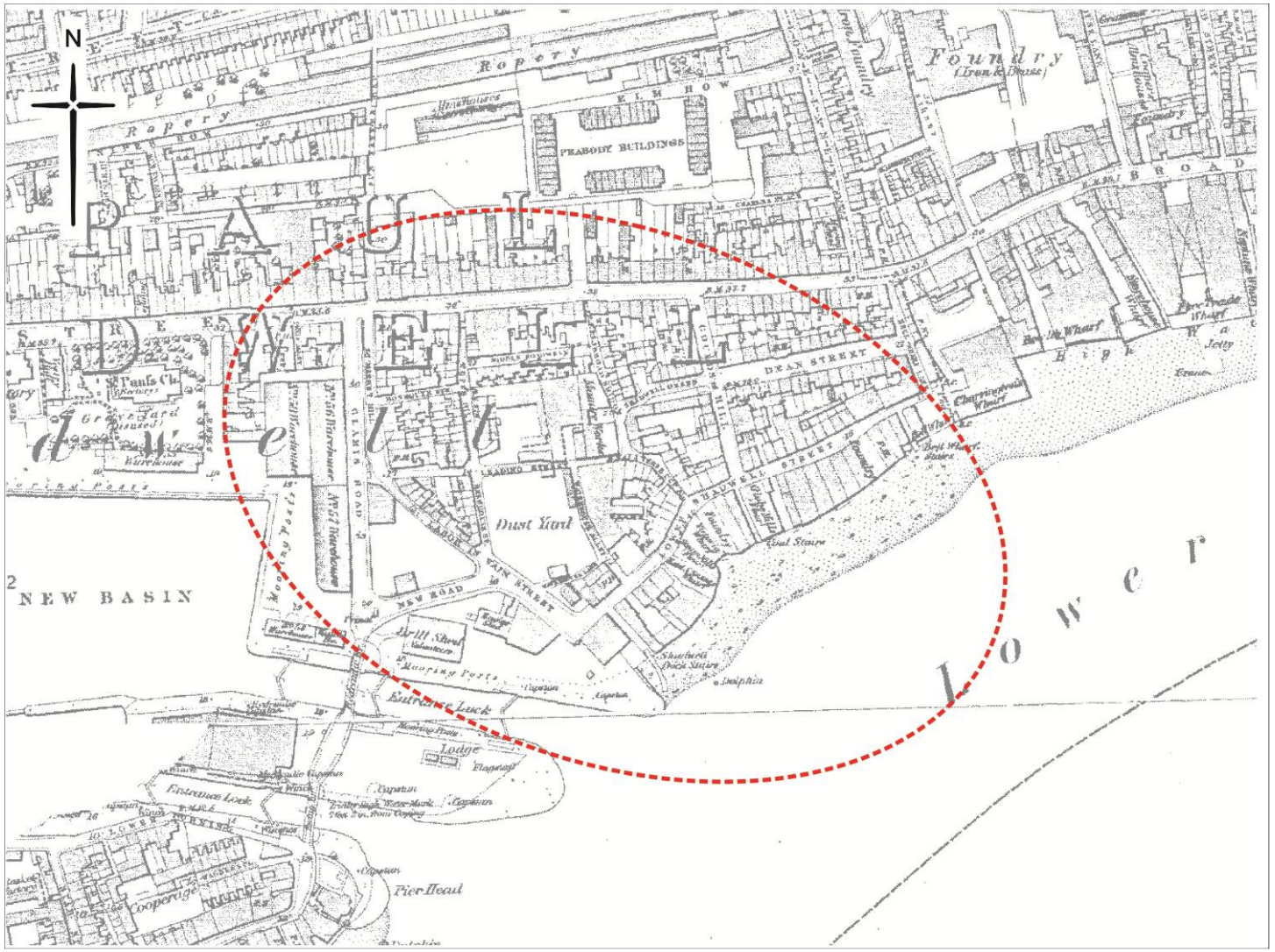
Vol 21 Plate E.3 Historic environment - Rocque's map of 1746



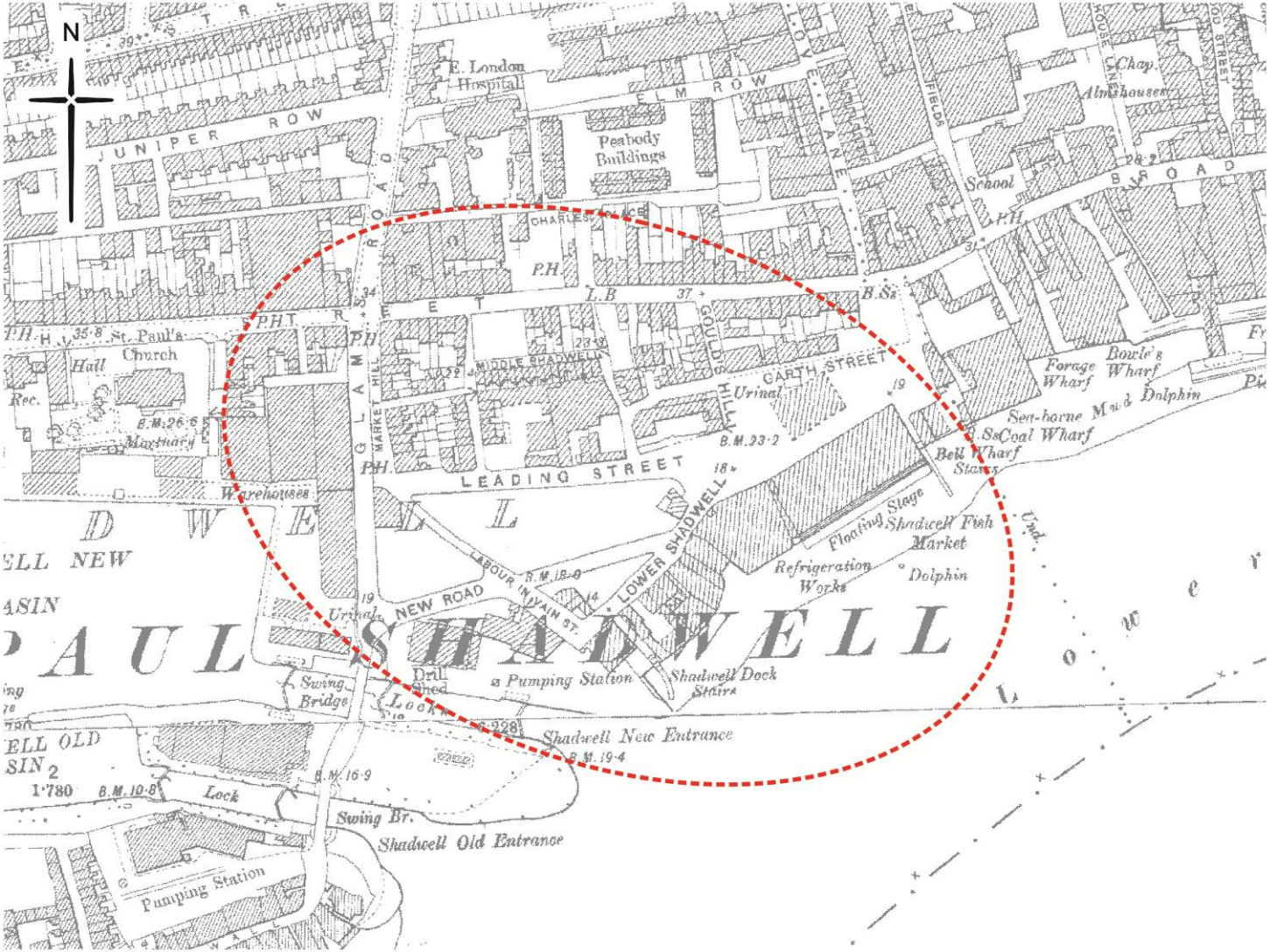
Vol 21 Plate E.4 Historic environment - Horwood's map of 1799



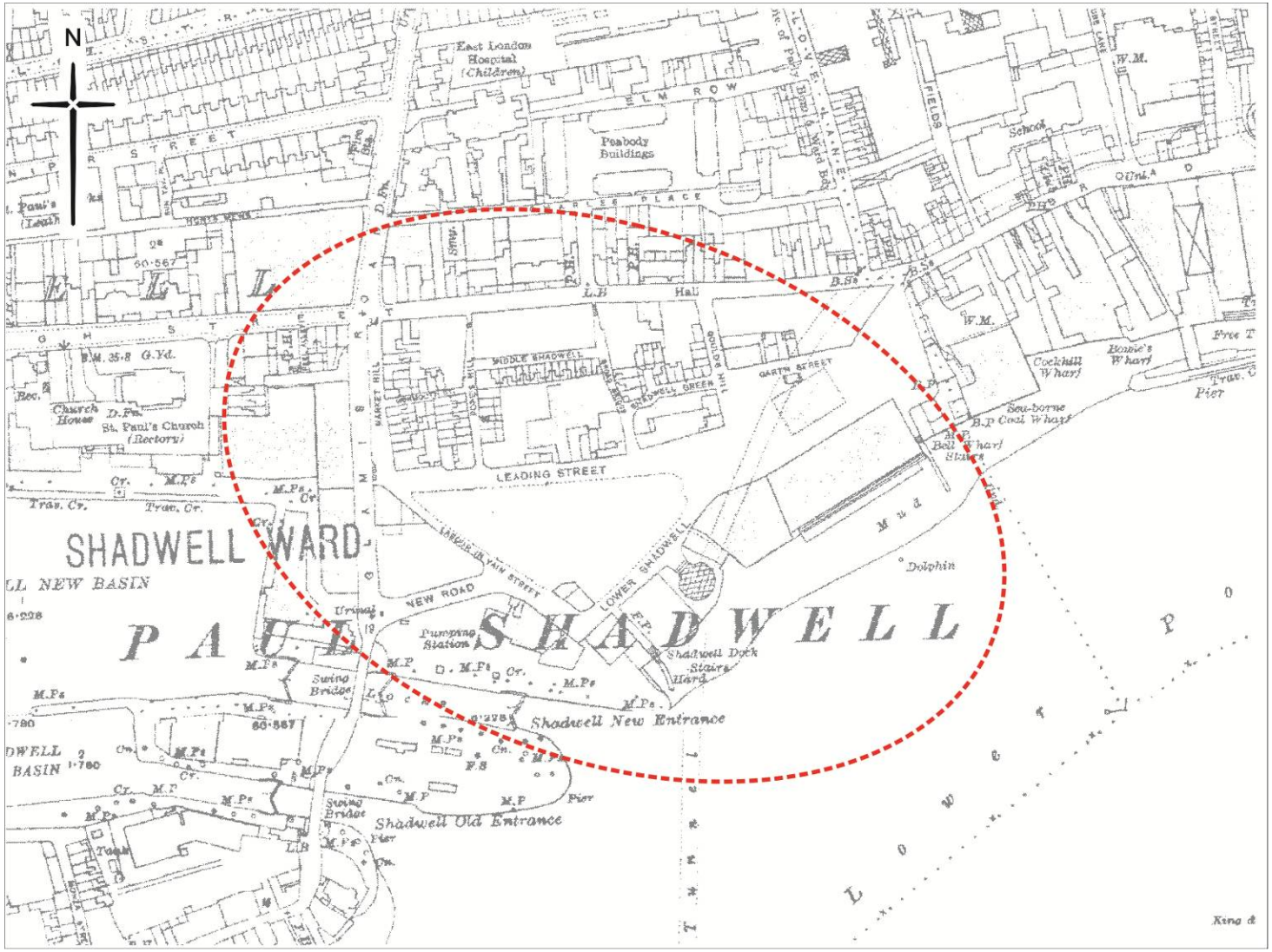
Vol 21 Plate E.5 Historic environment - OS 1st edition 25” scale map of 1862 (not to scale)



Vol 21 Plate E.6 Historic environment -OS 2nd edition 25" scale map of 1898 (not to scale)



Vol 21 Plate E.7 Historic environment - OS 3rd edition 25" scale map of 1909 (not to scale)



Vol 21 Plate E.8 Historic environment OS 25" scale map of 1947 (not to scale)

Vol 21 Plate E.9 Historical environment - partially upright timbers possibly the remains of a medieval fish trap

Standard lens; MOLA; 4th April 2011

Vol 21 Plate E.10 Historic environment - a re-used ship's timber

Standard lens; MOLA; 4th April 2011

Vol 21 Plate E.11 Historic environment - horizontal flat timbers

Standard lens; MOLA; 4th April 2011

Vol 21 Plate E.12 Historic environment - the remains of a timber piled slipway or jetty

The southwestern part of the site; standard lens; MOLA; 4th April 2011

Vol 21 Plate E.13 Historic environment - the remains of a timber piled slipway or jetty

The southeastern part of the site; standard lens; MOLA; 4th April 2011

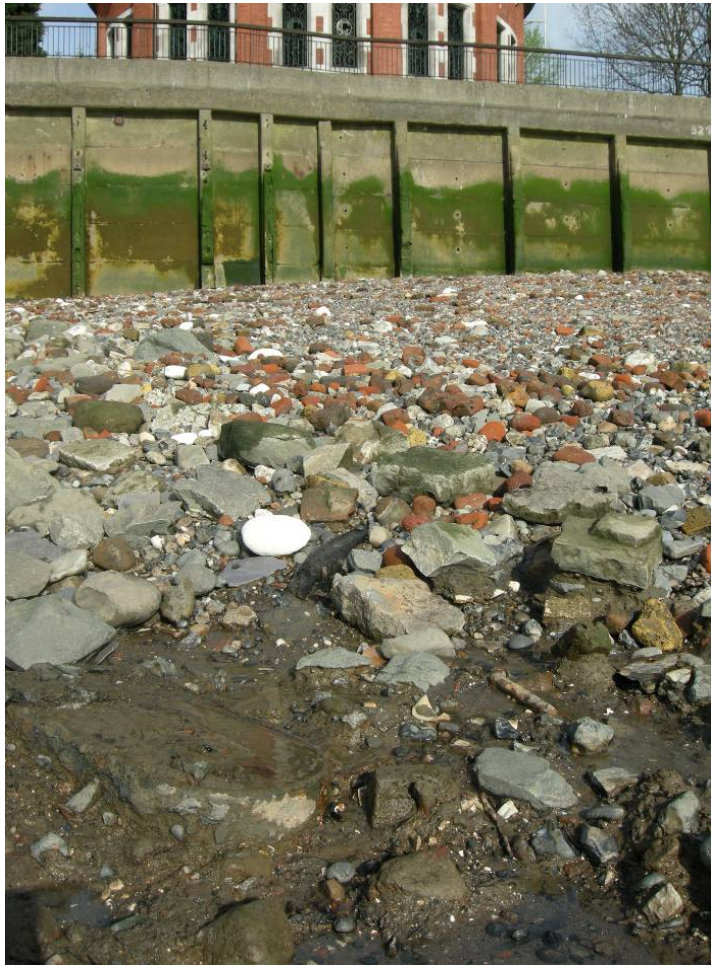
Vol 21 Plate E.14 Historic environment - a chalk surface

On the foreshore in the southeastern part of the site; standard lens; MOLA; 4th April 2011

Vol 21 Plate E.15 Historic environment - a surface of stone blocks, probably a foreshore consolidation layer

Located in the centre of the foreshore on the site; standard lens; MOLA; 4th April 2011

Vol 21 Plate E.16 Historic environment - a layer of crushed ceramic



Located in the foreshore in the western part of the site; standard lens; MOLA; 4th April 2011

Vol 21 Plate E.17 Historic environment - North East Storm Relief Sewer outfall gates

Located in the eastern part of the site, beneath the embankment, dated to the 1920s; standard lens; 4th April 2011

Vol 21 Plate E.18 Historic environment – general view of the riverfront and bandstand

Looking east; standard lens; 4th April 2011

Vol 21 Plate E.19 Historic environment - statutorily designated Grade II listed air vent constructed 1904-1908

Located to the northeast of the site, looking northeast; standard lens; 4th April 2011

Vol 21 Plate E.20 Historic environment - memorial stone

Dedicated to navigators in the late sixteenth century, constructed in 1922; looking northwest; standard lens; 4th April 2011

Vol 21 Plate E.21 Historic Environment - view of the foreshore in front of the air vent

Showing shuttered concrete; looking northeast; standard lens; 4th April 2011

Vol 21 Plate E.22 Historic Environment - view of foreshore looking northeast

Standard lens; 4th April 2011

References

[1] British Geological Survey digital data.

[2] British Geological Survey borehole ref. SR1033.

[3] British Geological Survey borehole ref. TQ38SE59.

[4] British Geological Survey borehole ref. TQ38SE76.

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[9] Victoria County History. *Middlesex* xi, (1971), 15.

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[11] Weinreb B and Hibbert C (eds). *The London encyclopaedia.* Macmillan. London (2008), 831.

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[14] Milne G. See citation above.

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[16] Weinreb B and Hibbert C. See citation above, 802, 831.

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[22] Tower Hamlets History Online website (THHOL). *Tower Hamlets Local History Library and Archives.* Available at: http://www.mernick.org.uk/thhol/main.html. Accessed April 2011.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.21**

Volume 21: King Edward Memorial Park Foreshore 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 21 King Edward Memorial Park Foreshore 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.1.2 A site walkover was undertaken on the 9th November 2010.

F.1.3 The aim of the walkover survey was to inspect the condition of the site and surrounding areas in order to identify evidence of historic or ongoing contamination sources, as well as any nearby sensitive receptors.

F.1.4 The foreshore area consists of sand and gravel whilst the park comprises landscaped area and a tunnel shaft building.

F.1.5 No potential contaminative sources were identified during the survey and no tidal outflows were visible within the river wall at the time of the survey.

F.1.6 Detailed site walkover notes are provided in Vol 21 Table F.1 below.

Vol 21 Table F.1 Land quality – site walkover report

Item (Site ref: PTH1X, King Edward Memorial Park Foreshore)		Details
Date of walkover	9th November 2010	
Site location and access	The proposed work site is located on and around King Edward Memorial Park and Glamis Road, located on the eastern boundary of the park. Main entrances to the park are located on The Highway (A1203). The site is within close proximity to Shadwell Pierhead and New Basin. Access across the entirety of the site.	
Size and topography of site and surroundings	Record elevation in relation to surroundings, any hummocks, breaks of slope etc.	The memorial park is relatively large, well maintained and landscaped. As well as the gardens, the site comprises an area of playground and a storage area located adjacent to the playground believed to store park waste from vegetation works and associated vehicles.
Neighbouring	North	The nearest road (The Highway,

Item (Site ref: PTH1X, King Edward Memorial Park Foreshore)		Details
site use (in particular note any potentially contaminative activities or sensitive receptors)		A1203) bordering the site is set back on the northern edge of the park. The surrounding properties to the site are predominantly residential.
	South	The Rotherhithe Tunnel Shaft is located adjacent to the boundary of the proposed worksite. This road tunnel crosses beneath the River Thames and connects the Ratcliff District on the northern side of the river to Rotherhithe on the south side of the river. Shadwell Basin activity centre and Shadwell entrance are located to the south/southeast. Pre-school (Pier head Preparatory Montessori School) is also located south
	East	Thames Path and residential properties.
	West	Shadwell New Basin, Shadwell Dock and Pierhead. In addition to residential properties situated around the basin.
Site buildings	Record extent, size, type and usage. Any boiler rooms, electrical switchgear?	None observed
Surfacing	Record type and condition	The foreshore area consists of sand and gravel. The remainder of the site consists of hardstanding associated with the Thames Path and footpaths around the park, the playground, in addition to hardstanding on Glamis Road.
Vegetation	Any evidence of distress, unusual growth or invasive species such as Japanese Knotweed?	None observed
Services	Evidence of buried services?	None observed
Fuels or chemicals on-site	Types/ quantities?	None observed
	Tanks (above ground or	Nond observed

Item (Site ref: PTH1X, King Edward Memorial Park Foreshore)		Details
	below ground)	
	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.	None observed
Waste generated/stored onsite	Adequate storage and security? Fly tipping?	Area of storage on site believed to be associated with park maintenance, site is fenced off.
Surface water	Record on-site or nearby standing water	River Thames/Shadwell Basin/Dock.
Site drainage	Is the site drained, if so to where? Evidence of flooding?	No tidal outflows were visible within the river wall at the time of the survey.
Evidence of previous site investigations	Eg trial pits, borehole covers.	None observed
Evidence of land contamination	Evidence of discoloured ground, seepage of liquids, strong odours?	None observed
Summary of potential contamination sources		Rotherhithe Tunnel Shaft, Shadwell Dock and on-site storage area adjacent to the playground.
Any other comments	Eg access restrictions/ limitations	No

Review of historical contamination sources

F.1.7 Historical mapping (dated between 1875 and 1995) has been reviewed to identify potentially contaminating land-uses at the site and within the 250m assessment area.

F.1.8 Vol 21 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 the table below are also shown on Vol 21 Figure F.1.1 (see separate volume of figures). In addition, figures illustrating the historical environment of the site and surrounding area as received from stakeholder consultation are provided in Section F.2 along with figures provided in Vol 21 Appendix E.

Vol 21 Table F.2 Land quality – potentially contaminating land-uses

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
On-site			
1	Dust yard	c1875	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
2	Wharves and foundries	c1875	
3	Refrigeration works	c1896-c1899	PCBs, heavy metals, oils, greases, ammonia, chlorinated hydrocarbons, volatile organic compounds (VOCs), fluorinated solvents
4	Airshaft for Rotherhithe Tunnel	c1916-present	Dusts, particulates, heavy metals, PCBs, oils, greases
16	Garage	c1948-c1949	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic
17	Garage	c1948-c1949	

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
			hydrocarbons, organolead compounds, heavy metals and asbestos
Off-site			
5	Wharves (adjacent east)	c1875-present	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
6	Brewery (225m east)	c1875-c1882	VOCs, total petroleum hydrocarbons (TPHs), heavy metals, ethanol/methanol, ammonia, chlorinated alkalis, benzene, toluene, ethylbenzene and xylenes
7	Iron and brass foundry (165m northeast and 175m north)	c1875-c1882	Heavy metals, PCBs, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons
8	Warehouses (adjacent west)	c1875-c1970	Uses unknown
9	Warehouses (90m west)	c1875-c1970	
10	Warehouses (160m west)	c1875-c1995	
11	Warehouses (15m south)	c1875-c1995	
12	Warehouses (70m	c1875-c1995	

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
	west)		
13	Airshaft for Rotherhithe Tunnel (210m northeast)	c1916-present	Dusts, particulates, heavy metals, PCBs, oils, greases
14	(a) Leather works (115m west)	c1948-c1970	Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs, dyes, inks
	(b) Paper works (115m west)	c1948-c1970	
15	Pumping station (110m southwest)	c1896-c1950	Heavy metals, arsenic, nitrates, ammonium, phosphates, sulphates, sulphides, asbestos, oil/fuel hydrocarbons, chlorinated aliphatic hydrocarbons, chlorinated aromatic hydrocarbons, PCBs, pathogens
18	Hospital (20m north)	c1896-c1965	Pathogens, radioactive substances, heavy metals, oil/fuel hydrocarbons
19	Warehouses (40m west)	c1896-c1970	Uses unknown
20	Warehouses (65m south)	c1948-c1982	
21	Warehouses (180m southwest)	c1948-c1995	
22	Warehouses (210m southwest)	c1948-c1975	
23	Warehouses (45m south)	c1875-c1975	

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
24	Biscuit factory (70m west)	c1948-c1955	Heavy metals, arsenic, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
25	Hospital (125m northeast)	c1948-c1950	Pathogens, radioactive substances, heavy metals, oil/fuel hydrocarbons
26	Engineering works (80m northeast)	c1948-c1965	Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs
27	Glass works (195m north)	c1948-c1950	Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs
28	Box factory 165m north)	c1950-c1962	Heavy metals, arsenic, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
29	Depot (95m northeast)	c1962	Heavy metals, asbestos, TPHs, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
30	Works (190m northeast)	c1962-recent	Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs
31	Depot (230m northeast)	c1962	Heavy metals, asbestos, TPHs, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons
32	Depot (185m northeast)	c1962	
33	Oil depot and tanks (165m southwest)	c1962-c1975	Oil/fuel hydrocarbons, monoaromatic hydrocarbons, benzene, toluene, ethylbenzene and xylenes, PAHs, n-alkanes (C5-C20), lead
34	Viaduct (225m north)	c1882-present	PAHs, heavy metals, phenols, sulphates, fuel/oil, lubricating oil, greases, PCBs, solvents, asbestos, chlorinated aliphatic hydrocarbons
35	Gasometers (165m and 180m north)	c1875	Benzene, toluene, ethylbenzene and xylenes, phenols, PAH, cyanide, ammonia, sulphur compounds, arsenic, chromium
36	(a) Warehouse (160m north)	c1955	Use unknown
	(b) Garage (160m north)	c1989	Oil/fuel hydrocarbons, aromatic

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
			hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds, heavy metals, asbestos
37	Dry Dock/wharf (225m southeast)	c1875-c1982	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons

On-site

F.1.11 The historical mapping has identified no contaminative on-site uses within the operational area of the proposed development (foreshore area) at King Edward Memorial Park Foreshore site.

F.1.12 Within the construction area of the proposed development (situated within the park itself) historically, there has been a dust yard, garages, wharves and refrigeration works.

F.1.13 There are no notable ongoing sources of contamination on or in the immediate vicinity of the site.

Off-site

F.1.14 King Edward Memorial Park was formerly a mixed residential and industrial site which was gradually cleared during the late 19th century and early 20th century and then subsequently redeveloped as the existing park which opened in 1922.

Geology

F.1.15 Data from the Thames Tideway Tunnel project ground investigation indicates the anticipated geological succession, as summarised in Vol 21 Table F.3 below.

Vol 21 Table F.3 Land quality – anticipated site geology (foreshore)

Geological Unit/ Strata	Description	Approximate depth below ground level (m)
River Terrace Deposits	Medium dense to dense sand and gravel (predominantly quartz sand and flint gravel).	0.00-2.50
London Clay	Expected to be slightly sandy clay	2.50-2.80
Lambeth Group (Upper Mottled Beds)	The Lower and Upper Mottled Beds can be described as mottled or multicoloured, stiff or very stiff fissured clay, compact silt, and dense or very dense sand deposited in overbank (fine-grained) or channel (sand) settings. The Lower Shelly Clay is a dark grey to black clay with abundant shells but may also be Shelly sand. Where shells predominate, thin limestone bands are formed. The Laminated Beds consists of thinly interbedded fine- to medium-grained sand, silt and clay, with locally more extensive sand bodies and thin shell and lignite beds. The Upper Shelly Clay is mainly a grey shelly clay, and occasionally sand dominated unit and shelly limestone.	2.80-6.00
Lambeth Group (Laminated Beds)		6.00 – 7.40
Sand Unit		7.40 -8.40
Lambeth Group (Lower Shelly Beds)		8.40-11.40
Lambeth Group (Lower Mottled Beds)		11.40-13.6
Lambeth Group (Lower Mottled Beds-Gravel)		13.6-15.2
Lambeth Group (Upnor Formation)		15.2-21.0
Thanet Sand Formation	Generally dense glauconitic silty fine sand with occasional rounded flint gravel. The base of the formation is marked by the Bullhead Beds - a thin bed of green stained gravel and cobbles of flint.	21.0-32.6
Chalk Group	Weak fine grained limestone with nodular and tabular flints.	32.6 - unproven

Unexploded ordnance

F.1.16 During World Wars I and II, the London area was subject to bombing. In some cases bombs failed to detonate on impact. During construction works Unexploded Ordnance (UXO) are sometimes encountered and require safe disposal.

F.1.17 A desk based assessment for UXO threat was undertaken at the King Edward Memorial Park Foreshore site (see Vol 21 Appendix F.3). The report reviews information sources such as the Ministry of Defence (MoD), Public Records Office and the Port of London Authority (PLA).

F.1.18 The report identified that two high explosive bombs were recorded as falling within 150m of the site boundary and 11 recorded as falling within 250m. No strikes were recorded within the site or within 50m, however there is possibility that they may have landed in the River Thames. In addition, there has been no post war development within the site area and as such buried UXO items are unlikely to have been removed.

F.1.19 Taking into account the findings of this study and the known extent of the proposed works at the King Edward Memorial Park site, it was considered that there was an overall high threat from UXO.

Thames Tideway Tunnel ground investigation data

F.1.20 This section summarises the ground investigation undertaken by the Thames Tideway Tunnel project.

F.1.21 As part of the project-wide ground investigation boreholes were drilled in the immediate vicinity of the King Edward Memorial Park Foreshore site, Vol 21 Figure F.1.2 (see separate volume of figures) identifies the location of the boreholes in relation to the site. Due to their proximity to the site and the similar site history they are discussed here to provide some context on soil quality in the immediate area.

F.1.22 Soil contamination data from five boreholes (borehole reference SR1033A, SR1033H, PR1034A, SR1034A and SR2029) were reviewed. Vol 21 Figure F.1.2 (see separate volume of figures) also identifies a number of other boreholes excavated in vicinity of the site, these are not considered relevant to the contamination status of the site, either due to their distance from the proposed drop shaft location or because certain boreholes were excavated purely for geotechnical purposes.

Soil contamination testing

F.1.23 From the boreholes located in the park itself a total of seven samples of soils (comprising three samples of Made Ground, one sample of alluvium, two samples of London Clay and one sample of the deep Thanet Sand) were sent for laboratory analysis.

F.1.24 The soils encountered in the boreholes was not described as having any obvious visual or olfactory indicators of contamination although it is noted that Made Ground in SR1033H was locally recorded to contain ash and clinker which is commonly a source of PAHs.

F.1.25 The laboratory analysis comprised a suite of common contaminants, including those that may be associated with the former land uses in the surrounding area.

F.1.26 The testing suite included the following contaminants: heavy metals and metalloids, PAHs, TPH, VOCs, phenols, cyanide, ammoniacal nitrogen, pH, soil organic matter content.

F.1.27 The testing recorded no contaminants above light industrial/commercial land use human health screening values[3,4].

F.1.28 In view of the more sensitive park land use, the results of the analysis were also compared to residential soil screening values [5,6].

F.1.29 The testing identified the PAH compound benzo(a)pyrene to be elevated in comparison with the more stringent residential screening value of between 0.8 to 1.0mg/kg. Concentrations of 3.1mg/kg and 1.5mg/kg were recorded in the samples retrieved from 4.0m and 6.0m bgl respectively. The sample, from 1.0m bgl, at this location was found to be below the screening value.

F.1.30 No other samples recorded exceedances of the residential values for the contaminants tested for (there are no published screening values for parks, however these screening values provide some context to concentrations recorded by the testing).

F.1.31 Refer to Volume 2 Environmental assessment methodology for full guidance on the benchmarks used.

Soil gas testing

F.1.32 No soil gas testing was undertaken within the boreholes drilled at King Edward Memorial Park Foreshore site.

Groundwater contamination data

F.1.33 The baseline groundwater quality data shows elevated concentrations of aluminium, ammonia, aromatics (C6-7), arsenic, calcium, chloride, chromium, cypermethrin, lead, magnesium, nickel, sodium, sulphate, and zinc within borehole SR1033A and elevated levels of nitrate, sulphate, aromatics C6-C7 and chloride within borehole SR1034A.

F.1.34 Within borehole SR1033H and PR1034A, the groundwater data found elevated concentrations of ammonia, chloride, magnesium and sodium and aromatics C6-7, chloride and magnesium, respectively,

F.1.35 Refer to Section 13 Water resources – groundwater of this volume for further information.

Sediment quality testing

F.1.36 Sediment samples retrieved from borehole SR2029 were analysed for a suite of metal and PAH contaminants. The results were compared against the Threshold Effect Levels (TEL) and Probable Effect Levels (PEL) to assess potential risk to aquatic life, in accordance with the PLA Approved Sediment Quality Guidelines.

F.1.37 The results of the analysis showed that four contaminants were recorded as having levels above the TEL, these were lead, copper, benzo(a)pyrene and naphthalene. Lead was the only contaminant recorded as having a contaminant value above PEL.

F.1.38 These contaminants reflect the former industrial nature of the river and are present as they tend to bind with soils. The results are not elevated in terms of risk to human health but slightly elevated over PLA approved

sediment quality guideline. See Volume 2 Environmental assessment methodology for full guidance on the benchmarks used.

Third party ground investigation data

F.1.39 No third party ground investigation data was available to review for the King Edward Memorial Park Foreshore site.

Other environmental records

F.1.40 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 21 Table F.4. Pertinent records are discussed in further detail below.

F.1.41 The location of these records is shown on Vol 21 Figure F.1.3(see separate volume of figures).

Vol 21 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	3
LA pollution prevention and control	0	0
Licensed waste management facility	0	0
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	12
Registered waste transfer site	0	1
Registered waste treatment or disposal site	0	0

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

F.1.42 Inspection of the data has identified areas both on-site and within 250m of the King Edward Memorial Park Foreshore site that are classified as being of past potential contaminated industrial use.

F.1.43 From an analysis of the historical mapping data, it can be inferred that the past potential contaminated industrial uses could be attributed to former wharves, as highlighted on Vol 21 Figure F.1.1 (see separate volume of figures). Common contaminants associated with such land-uses are identified in Vol 21 Table F.2.

F.1.44 Within 250m of the King Edward Memorial Park Foreshore site, inspection of the data shows that there are three historic landfill sites located to the west of the site in Shadwell New Basin and Shadwell Old Basin.

F.1.45 In addition, there are 12 pollution incidents to controlled water within the 250m assessment area, the majority located in and around Shadwell Entrance and Shadwell New Basin, two of the incidences are recorded within the River Thames. Some of 12 entries are likely to relate to the CSO discharges (although not all discharges are recorded by the EA).

F.1.46 One registered waste transfer site has been recorded east if the site at the junction of King David Lane and The Highway.

Land quality data from local authority

F.1.47 Consultation with the London Borough (LB) of Tower Hamlets was undertaken as part of the baseline data gathering.

F.1.48 The LB of Tower Hamlets undertook a desk based search of their own Geographical Information System (GIS) based records as shown in Section F.2 and gave the site a contaminated land risk rating of six out of seven.

F.1.49 This is a rating system that is unique to the LB of Tower Hamlets and ranges from three to seven (seven being the highest or greatest risk), although it is not clear what each risk level relates to or to the specific concern relating to contamination at the site.

F.1.50 The rating appears to be given due to the variety of previous contaminative uses historically present in the nearby area which are discussed previously.

Summary of contamination sources

F.1.51 Following the review of the baseline data, the following sources of on-site contamination which may impact on the construction of the proposed development have been identified:

a. historic contamination from PAHs and metals of foreshore sediments within the operational area

b. residual soil and groundwater contamination of the construction site area from previous historic activities (refrigeration works, wharves, dust yard) – the main potential contaminants of concern are likely to be, metals, oils, PAHs, and VOCs. Relatively low levels of the PAH compound benzo(a)pyrene have been recorded in the made ground at depth within the adjacent park.

c. elevated ground gases
d. CSO discharge – sewage (bacteriological) contamination of sediments
e. potential for UXO.

F.2 Local authority consultation

Communities, Localities & Culture
Environmental Health,
Environmental Protection

Mulberry Place (AH)
PO Box 55739
5 Clove Crescent
London E14 1BY

Enquiries:
Contact: Sarah Chowdhury
Tel: 020 7364 6761
Fax: 020 7364 6831
Flare Ref:
Your Ref:
E-mail:
environmental.health@towerhamlets.gov.uk

Date: 18 January 2011

Mott McDonald Lits.
Mott McDonald House
8-10 Sydenham Road
Croydon
Surrey
CR0 2EE

Dear Mr D Giordanelli,

Contaminated Land Search for King Edwards Memorial Park, The Highway, London

Please find enclosed the contaminated land search as per your recent request. The report outlines previous historical land use, which could indicate the possibility of contamination. Attached also are maps which spatially reference these sites, for easy identification. A separate map is included for each source map time period.

Please note that the Ordnance Survey base map data included within this publication is provided by the London Borough of Tower Hamlets under licence from the Ordnance Survey in order to fulfil its public function under Part IIA of the Environmental Protection Act 1990. Persons viewing this map should contact Ordnance Survey copyright for advice where they wish to licence Ordnance Survey mapping/map data for their own use.

This search has cost you £73.00 (seventy-three pounds sterling). In order to keep costs down, please send a cheque in the name of London Borough of Tower Hamlets to the above address when you receive the invoice from us.

If you have any queries regarding the contents of this search, then please do not hesitate to contact me.

Yours sincerely

Miss S. Chowdhury,
Contaminated Land Technical Officer

Search Details

Date of Search: **16 December 2010**

Search Completed By: **Sarah Chowdhury, Contaminated Land Technical Officer**

Site Under Search: King Edwards Memorial Park
The Highway
London

Contaminated Land Register

Part IIA of the Environmental Protection Act 1990, inserted by Section 57 of the Environment Act 1995 and associated Statutory Guidance (DETR Circular 2/2000) required each local authority in England and Wales to identify potentially contaminated land within its borough.

In accordance with this, in June 2001 LBTH adopted its 'Strategy for the Identification of Contaminated Land'. The Strategy has been implemented using Risk Model Software and a Geographical Information System developed by W.S. Atkins on behalf of the Council.

In the initial stages of this process, sites were prioritised by applying the risk model according to the risk associated with a site's historic land use and the sensitivity of its current land use to the effects of contamination. The result was a score or risk rating of sites where there is a potential pollutant linkage.

Following the completion of this stage of the process, each site identified was allocated a risk ranking, from 3, being the lowest risk site, to 7, being the highest risk site (and our highest priority).

In this case, the subject site has been allocated a risk rating of **6**. However, it should be noted that the raw data used in the risk model needs to be refined using the results of a Desk Study and observations collected during a Walkover Survey which have not yet been completed for this site.

The final stage of the process would be to undertake an intrusive investigation at the site, if considered necessary based on the results of the Desk Study and Walkover Survey, to confirm the presence of an actual pollutant linkage. *Only after this will a decision be taken as to whether the site should be entered on the Contaminated Land Register, and consideration given to whether any remediation is deemed necessary. This information will be made accessible to the general public when it is available.*

Please note:
It is reasonable to assume that some degree of "contamination" may have occurred on the site under search over the years.

"Contamination" simply means the presence of one or more potentially harmful substances in or on land. It is not a judgement as to whether the contamination of a harmful substance is sufficient to mean the land is causing or is likely to cause significant harm to human health or the environment and cannot therefore, be used for a given purpose. The onus is on you, the enquirer, to assess whether the land is suitable for your intended use of it.

The reply is given on the understanding that the London Borough of Tower Hamlets does not warrant the accuracy of any reply and on the basis that neither the Borough nor any officer or servant or agent of the Borough is legally responsible, in any way whatsoever, for any inaccuracies, errors or omissions whether arising from incomplete data, inadvertence, negligence, errors or any other cause whatsoever.

Land Use History within 250m of Site:
Total number of records: 64

NOTE: If the Time Period shows "0" then the source date is unknown.

ID (See Map)	Description	DoE Class	Time Period
C00412	Manure Works & oil works: (source: 1875 1:1056 OS sheet VII 79).	C7	0
C00413	Boat Building Yard: (source: 1875 1:1056 OS sheet VII 79, gone by 1894/6).	C14	0
C00417	Foundry: (source: 1873 1:1056 OS sheet VII 79, gone by 1894/6 edition).	C4	0
C00531	Wapping Basin & London Docks Landfill	C15C	0
C00885	Iron Foundry: (source: 1873, expanded in 1894/6, & 1922 & 1937 1:1056 OS sheet VII 69).	C4	0
C00887	Railway Viaduct, from Hardinge Street eastwards to Limehouse where it splits to north for British Rail and to south for LDDC hornby gauge.	C14	0
C00899	Glass Works since 1621 on Glasshouse Street: (source: OS sheet VII 69). Currently T. & W. Ide Ltd. see also site F27	C6	0
C00903	Glass & Iron Foundry: (source: see detail for F26 & F25). Glass & Engraving/Etching factory - T. & W. Ide Ltd: (source: 1994 unknown).	C4	0
C00906	Iron & Brass Foundry: (source: 1869 - 1873). Preserve Provision	C4	0

ID (See Map)	Description	DoE Class	Time Period
	Manufactory: (source: unknown, 1919). Historically probably glass on this site too.		
C00914	Ropery on Sun Tavern Fields: (source: 1868-1875 OS sheet VII 78 1:1056).	C12	0
C00921	Foundry: (source: 1873 1:1056 OS sheet VII 79). site un-named on 1894/6 OS sheet.	C4	0
C00940	Chemical Factory at 44-48 Broad Street Ratcliffe: (source: 1876 Kelly's Directory, product F, paints). Also part of Marine Brewery Site.	C7	0
C00942	Engineering Works - Glasshouse Fields off Love Lane (now Brodlove lane): (source: 1894/6 & 1937 1:1056 OS sheet VII 79). The Glass manufacturing area since 1621!!	C8	0
C00943	Leather Works at St. Paul's Juniper Row - 1894 - 1922 : (source: 1894/6 OS sheet VII 78 1:1056 & 1922 OS map sheet)	C12A	0
C00950	Biscuit Factory: (source: 1896 & 1922 OS sheet VII 78, 1:1056)	C9	0
C00955	Chemical Manufactory - Mrs S. Poulson 135 St. George's Street (currently 417 The Highway): (source: 1876 Kelly's Directory, product F).	C7	0
C00958	Gas Works - Stepney Gas Works	C3	0

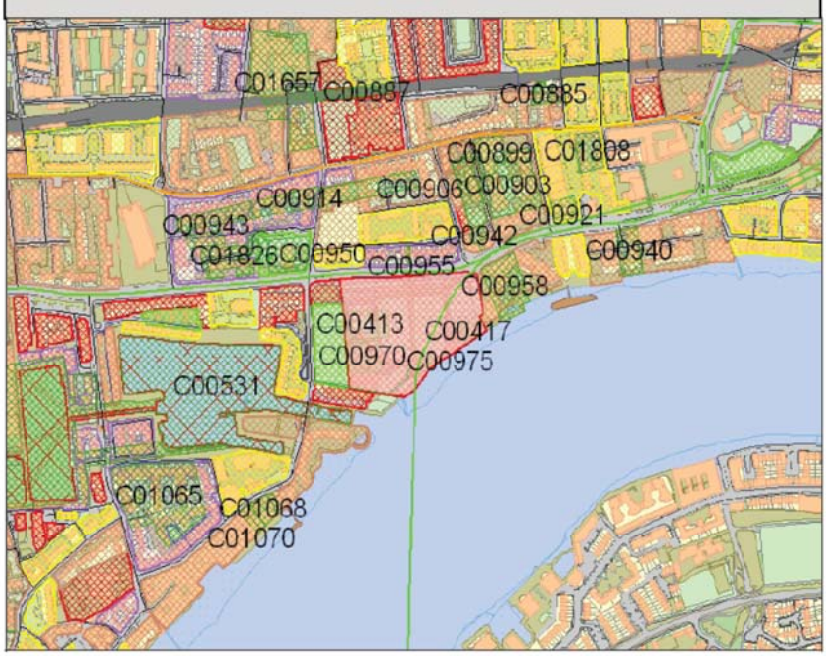
ID (See Map)	Description	DoE Class	Time Period
	on Wharf at Cock Hill, SchoolHouse Lane: (source: British Gas Records, operated 1825 to 1855). Also site of Coal Wharf		
C00970	Dust Yard: (source: 1873 & 1875 1:1056 OS sheet VII 59).	C15	0
C00975	Foundry: (source: 1873 1:1056 OS sheet VII 79, gone by 1894/6 edition).	C4	0
C01065	Animal Charcoal Works between Milk Yard & New Gravel Lane: (source: 1868 25 & 1894/6 OS Map).	C7	0
C01067	Lead Wharf: (source: 1875 OS sheet VII 78). Unspecified Use: (1894/6 OS sheet).	C4	0
C01068	Engineering works: (source: 1894/6 LDDC No. 462). see also E35	C8	0
C01070	Engineering Works: (source: 1875 OS sheet VII 78, extended eastwards by 1894/6 to incl. site E36)	C8	0
C01657	Gas Works - Sun Tavern on Cale Street: (source: Built 1817, Cross's Map 1947 & 1975 OS Sheet VII 68). Site split by Commercial Railway in 1937. Closed 1875 & built over by 1894. (ck dates).	C3	0
C01808	Blacksmiths	C4	0
C01826	Biscuit Factory	C9	0
C00016	Extractive Industry: Coal storage and depot	C2Ai	1882
C00018	Infrastructure: Transport support &	C14B	1882

ID (See Map)	Description	DoE Class	Time Period
	cargo handling		
C00019	Infrastructure: Transport support & cargo handling	C14B	1882
C00020	Infrastructure: Transport support & cargo handling	C14B	1882
C00021	Extractive Industry: Oil, petroleum & gas refining & storage	C2Aiii	1882
C00159	Infrastructure: Railways	C14A	1882
C00166	Infrastructure: Railways	C14A	1872
C01425	Infrastructure: Transport support & cargo handling	C14B	1882
C01566	Production of Metals: Metal casting/foundries	C4B	1882
C01567	Food processing industry: Brewing & malting	C9F	1882
C00053	Infrastructure: Transport support & cargo handling	C14B	1899
C00182	Infrastructure: Railways	C14A	1898
C00194	Infrastructure: Railways	C14A	1898
C01505	Infrastructure: Transport support & cargo handling	C14B	1898
C01506	Miscellaneous: Hospitals	C16D	1898
C00084	Miscellaneous: Airshafts	C16E	1920
C00215	Infrastructure: Railways	C14A	1920
C00219	Infrastructure: Railways	C14A	1920
C01409	Infrastructure: Transport support & cargo handling	C14B	1920
C01411	Miscellaneous: Hospitals	C16D	1920
C01459	Infrastructure: Transport support & cargo handling	C14B	1920
C00102	Miscellaneous: Airshafts	C16E	1938
C00251	Infrastructure: Railways	C14A	1938
C00311	Infrastructure:	C14A	1938

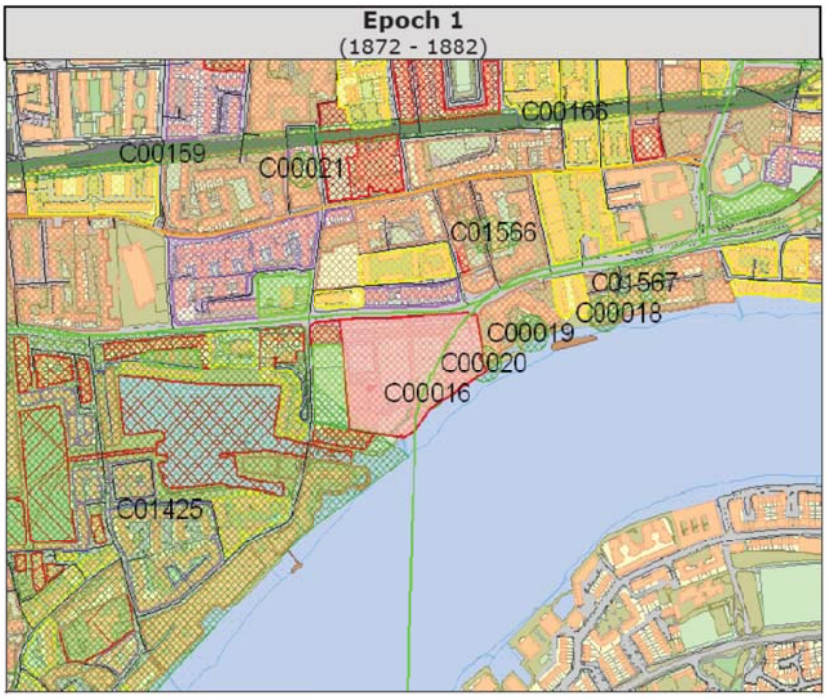
ID (See Map)	Description	DoE Class	Time Period
	Railways		
C00522	Infrastructure: Transport support & cargo handling	C14B	1938
C01353	Infrastructure: Transport support & cargo handling	C14B	1938
C01355	Miscellaneous: Hospitals	C16D	1938
C00115	Miscellaneous: Airshafts	C16E	1951
C00338	Infrastructure: Railways	C14A	1949
C00356	Infrastructure: Railways	C14A	1951
C00998	Infrastructure: Transport support & cargo handling	C14B	1949
C01001	Miscellaneous: Hospitals	C16D	1951
C01318	Infrastructure: Transport support & cargo handling	C14B	1951
C00003	Waste Disposal: Unknown Filled Ground (Pit, quarry etc)	C15Civ	1995
C00372	Infrastructure: Railways	C14A	1995
C00445	Infrastructure: Railways	C14A	1995
C01278	Infrastructure: Transport support & cargo handling	C14B	1995
C01286	Infrastructure: Transport support & cargo handling	C14B	1995

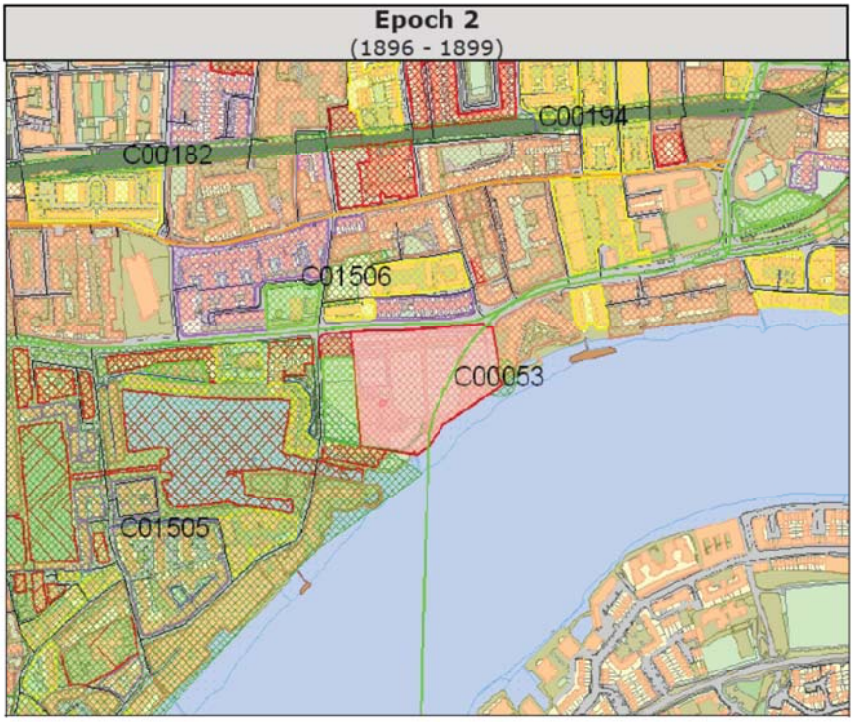
Site and Sources Maps (per Epoch)
(See below for a description of the maps)

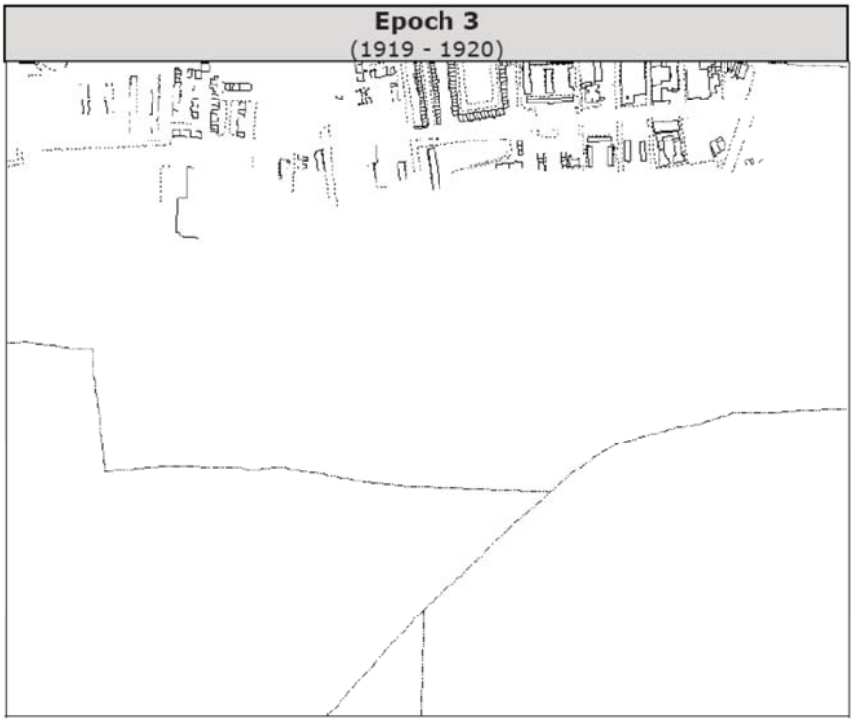
Epoch *unknown*

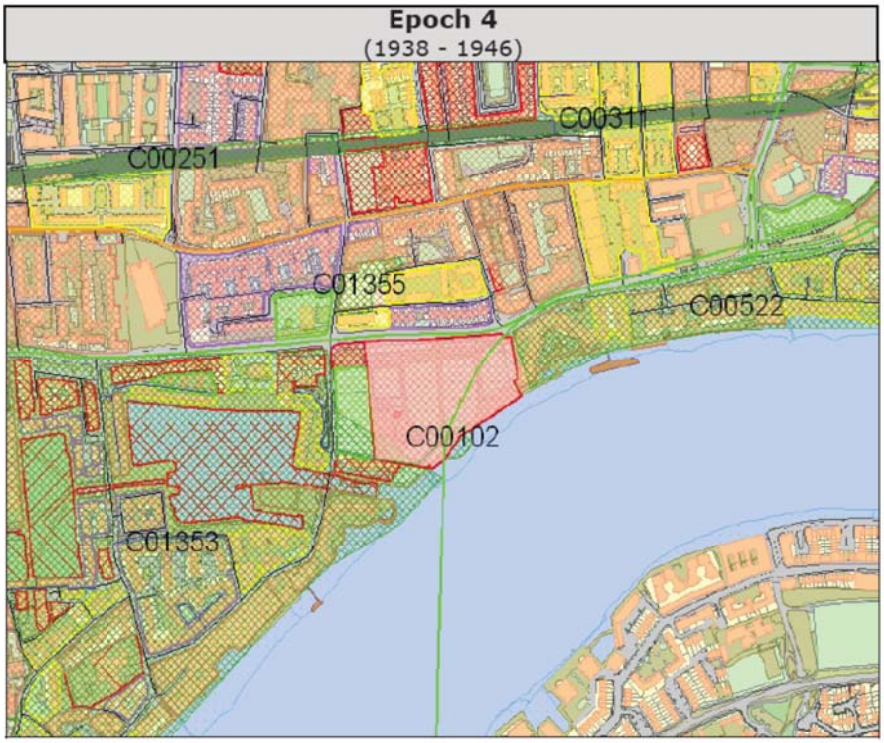


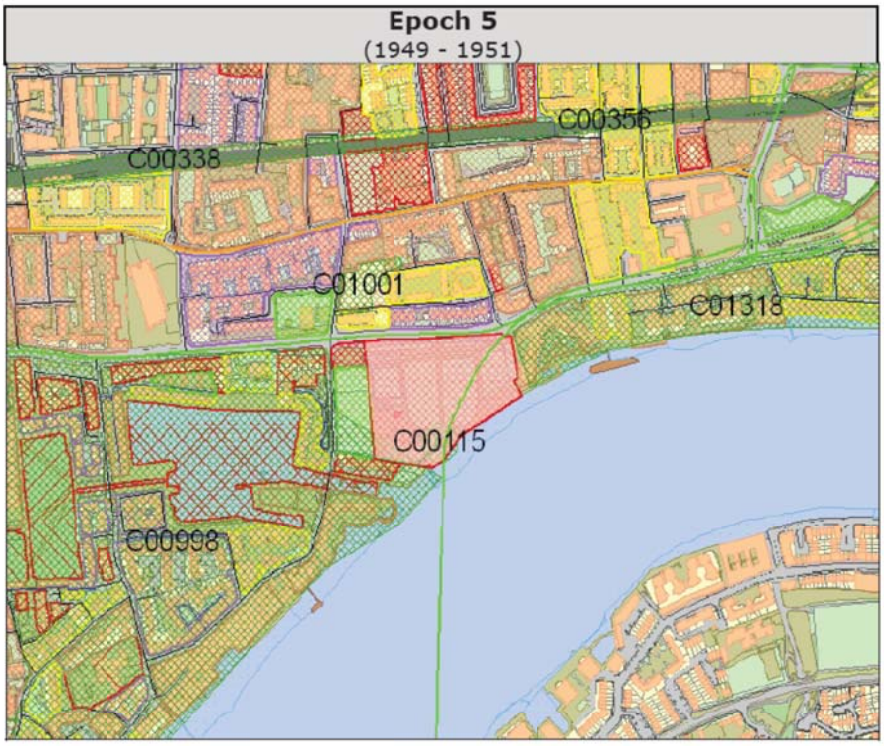
Epoch 1
(1872 - 1882)

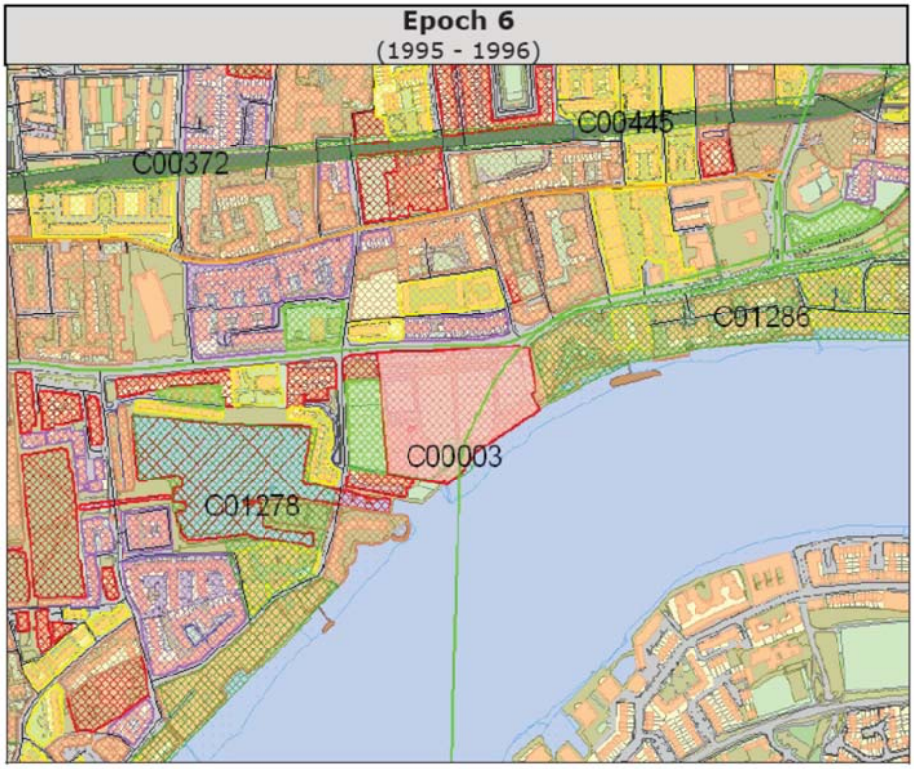


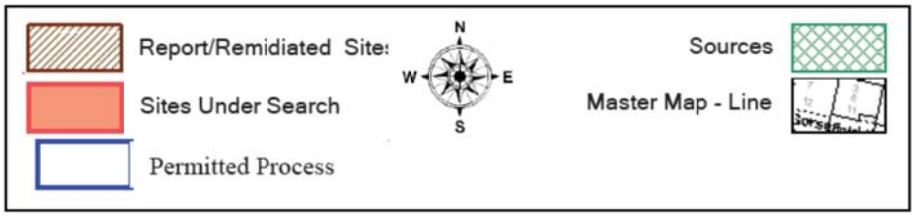

Epoch 2
(1896 - 1899)
C00194
C00182
C01506
C00053
C01505


Epoch 3
(1919 - 1920)


Epoch 4
(1938 - 1946)
C00311
C00251
C01355
C00522
C00102
C01353


Epoch 5
(1949 - 1951)
C00356
C00338
C01001
C01318
C00115
C00998





These maps have been automatically produced using the Council's advanced Contaminated Land software and the data are drawn from the Council's vast collection of various datasets. See the legend for a graphical description of the different datasets used in these particular maps.

Generated on: 18 January 2011

-- END OF REPORT --

F.3 Detailed Unexploded Ordnance (UXO) risk assessment

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Camberley, Surrey
GU16 7ER

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F: +44(0) 1276 804 676
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Detailed Unexploded Ordnance (UXO) Risk Assessment

Study Site: Work Area PTH1X
Client Name: Thames Water
6 Alpha Project Number: P3049_R79_V2.0
Document Number: 336-RG-TPI-PTH1X_000001
Date: 18th October 2012

Originator: CR
Quality Review: GW
Released by: SC

Contents

Figures

EXECUTIVE SUMMARY

Study Site	The Client has specified the Study Site as "Work Area PTH1X in the London Borough of Tower Hamlets". Works are to be located within the foreshore/main channel of the *River Thames* and through parts of the *King Edward Memorial Park* and *Glamis Road*. 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.	
Potential Threat Source	The threat is predominately posed by *Second World War* (WWII) *German* High Explosive (HE) bombs and to a lesser extent, *British* Anti-Aircraft Artillery (AAA) projectiles, which were used to defend against *German* bombing raids.	
Risk Pathway	If Unexploded Ordnance (UXO) is encountered by a site investigation (or subsequent construction method) that generates significant kinetic energy (e.g. of the sort generated by cable percussion boreholes or drilling activities), then UXO might be initiated.	
Key Findings	The Study Site, Work Area PTH1X, is located within the *London Borough of Tower Hamlets*, a region that experienced high levels of bombing during WWII. The site is situated between two Primary *Luftwaffe* bombing targets, *Surrey Quay* (300m to the South) and *Shadwell Basin* (150m to the West). This is potentially the reason why numerous HE bombs are recorded as falling within 250m of the Site boundary. No HE bombs are recorded as landing on Site, however during six years of *Luftwaffe* bombings eleven bombs were recorded as landing within the 50m assessment area. Two HE bombs are recorded as landing in the *Thames* within 150m of the Site. There is also a possibility that Unexploded Bombs (UXBs) may have landed in the *River Thames* and gone unnoticed and therefore, unreported. 6 Alpha Associates has assessed that the resultant UXO/UXB risk on site is classed as HIGH, this is based on the following facts: • Eleven HE bombs are recorded as landing 50m from the Site boundary. • Two HE bombs are recorded as landing in the *River Thames* within 150m from the Site. • Heavy bomb damage is recorded to buildings surrounding the Study Site. • There has been no post WWII development within the work area. • The construction site is located within the *River Thames*. There is a high possibility of UXBs/ordnance landing within the banks of the *River Thames* and going unnoticed/unrecorded.	
Risk Level	**HIGH**	
Risk Mitigation	Cofferdam Installation and Caisson Construction	There is a potential risk from UXO during both operations, therefore mitigation is required. The most efficient and cost effective method of survey is to implement non-intrusive methodologies. However, given the environmental conditions and the expected scrap metal on the riverbed, any non-intrusive survey is likely to be significantly hindered. Whilst an intrusive survey is possible it is likely to be expensive, slow and it may not deliver the required results (because of the presence of buried scrap metal). In light of this 6 Alpha recommend a meeting with the key stakeholders to develop a method of mitigation to lower the risk to ALARP. This may involve a scrape or trawl dredge of the riverbed followed by a non-intrusive and/or intrusive magnetometer survey.
	Marine Piling	Conduct an intrusive magnetometer survey ahead of the pile positions.
	Tunnelling	6 Alpha have assessed that tunnelling will be conducted at depths in excess of the maximum bomb penetration capacity, thus there is a negligible UXB risk associated with this activity.
	Excavations and Access Road Construction	1. Documentary procedures/actions to be taken in the event of a suspicious find; 2. Brief all personnel involved with the intrusive works on the potential risk of an associated UXO discovery; 3. Engage an UXO Specialist to monitor excavations down to the maximum bomb penetration depth.

ASSESSMENT METHODOLOGY

Approach	The UXO related risk on the site has been assessed using the process advocated by the *Construction Industry Research & Information Association* (CIRIA) best practice guide (UXO – A Guide for the Construction Industry), which has been endorsed by the *Health & Safety Executive* (HSE). Potential UXO hazards have been identified through investigation of Local and National archives covering the site, *Ministry of Defence* (MoD) archives, local historical groups, historical mapping and contemporaneous aerial photography, wherever 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 has been cross-referenced within this document, whilst less significant data has been set aside, however, it is available upon request. The assessment of 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 to the hazard at the moment of encounter. Wherever a significant UXO risk has been identified, 6 Alpha will design and recommend methods of risk mitigation to "reasonably and sufficiently" reduce them, not only to an acceptable and tolerable level but also in accordance with the As Low As Reasonably Practicable (ALARP) principle. In this way we ensure that any risk mitigation solutions we design, delivers the Client the most cost effective solution. We believe that 6 Alpha's holistic and intelligent application of the ALARP principle to UXO risk management is a critical and differentiating factor in our approach, because; it provides a transparent means for assessing the tolerability of risk; and it ensures that if the cost of reducing a risk outweighs the benefit, then the risk may be considered "tolerable". This is considered especially pertinent, because the potential to reduce UXB risk to zero, is *de facto* unnecessary and prohibitively expensive.
Important Notes	Although this report is up to date and accurate, the databases are continually being populated as and when additional data becomes available. 6 Alpha have exercised all reasonable care, skill and due diligence in providing this service and producing this report. The assessment levels have been generated from historical data and third party sources. Wherever possible 6 Alpha have sought to verify the accuracy of all data, but cannot be accountable for inherent errors that may exist in third party data sets (e.g. National Archive or other library sources). 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 the Threat & Preliminary Risk Assessment Report (*P1087_Version 3*). Although 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 PTH1X in the London Borough of Tower Hamlets". 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. See *Figure 1* for Site location.
Location Description	The Site is located on the *River Thames* at *Shadwell Dock Stairs*, in the *London Borough of Tower Hamlets.* The site is over the southern part of the *King Edward Memorial Park* and *Glamis Road*, with the *Shadwell Basin* 150m to the West. The site is situated within the shores of the *River Thames.* The *Rotherhithe Tunnel* is situated within 40m of the Northwestern site boundary. The region that the site is located in is predominately parkland, with commercial with residential properties on the periphery. See *Figure 2* for a current aerial photography.
Proposed Works	The following works will be conducted at this location, please note that this may not represent the full scheme but are those activities that may be affected by UXO Risk: • Creation of a new access road and *Thames* path; • A 20m internal diameter shaft 60m deep. The shaft is anticipated to be constructed by diaphragm wall methods with an in-situ concrete lining. Ground treatment or dewatering will be required; • A concrete interception chamber, located close to the outlet of the existing storm relief sewer; • A culvert from the interception chamber to the drop shaft, including a valve chamber near the drop shaft; • A control kiosk containing equipment to operate a penstock; • Construction of an 'Overflow Chamber' (which adjoins the culvert from the interception chamber to the drop shaft). These structures will all be incorporated into a single area of foreshore reclamation. The main site working area is 20,489 m^2. Outside of this area there is a smaller short term working area, which will be used to facilitate construction of the temporary cofferdam. The work will include construction of a temporary cofferdam within the foreshore that will be filled to provide a working area. The area of the cofferdam and camp sheds (within the foreshore) is approximately 5500m^2 – excluding smaller temporary working area to construct the cofferdam. A possible alternative will be to create a temporary working area in the river with decking on piles, in which case only the permanent land take in the river will be constructed by filling a cofferdam.
Ground Conditions	*Thames Water* have informed 6 Alpha that the ground conditions for this preferred site are expected to be: • **Made Ground (MG)** – Riverbed level to 2.70m below ground level (bgl); • **River Terrace Deposits** – 2.70m to 4.20m bgl; • **London Clay** – 4.20m to 14.90m bgl; • **Lambeth Group** – 14.90m to 35.10m bgl; • **Thanet Sand** – 35.10m to 47.10m bgl; • **Seaford Chalk** – 47.10m to unproven depth bgl. It is assumed that the alluvium will contain various items of scrap metal and other man-made elements that may affect or interfere with any UXO risk mitigation.

STAGE ONE – SITE LOCATION AND DESCRIPTION (…continued)

Ground Conditions in the Foreshore

The Client has supplied the following anticipated ground conditions for the foreshore area of this Study Site:

Table 1.1 Generalised geological succession at main site

Stratum		Base of Stratum (m ATD)	Thickness (m)	No. of boreholes
Superficial Deposits	Made Ground	107.07 to 94.52 (100.88)	1.68 to 10.06 (4.19)	28
	Alluvium	102.03 to 92.57 (96.29)	0.5 to 7.93 (4.16)	21
	River Terrace Deposits	104.57 to 90.66 (94.61)	0.31 to 7.77 (3.2)	16
London Clay Formation		93.67 to 89.3 (91.14)	0.2 to 14.0 (5.57)	18
Lambeth Group	Upper Mottled Beds	88.8 to 83.88 (86.75)	3.0 to 7.92 (4.73)	17
	Upper Mottled Bed Sand Channels	85.1 to 84.95 (85.03)	1.22 to 2.44 (1.83)	2
	Laminated Beds	85.47 to 81.76 (83.38)	1.07 to 5.03 (3.26)	12

(these are taken from document 100-RG-GEO-PTH1X-000005-AA).

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. London County Council WWII Bomb Damage Mapping; 2. Home Office WWII Bomb Census Maps; 3. WWII & post-WWII Aerial Photography; 4. Official Abandoned Bomb Register; 5. National Archives at Kew; 6. 33 Engineer Regiment (Explosive Ordnance Disposal) at Carver Barracks, Wimbish.	
WWII Historical Data	**WWII Site Usage**	During WWII the site was undeveloped foreshore, which was situated along the Northern bank of the *River Thames*.
	WWII Bombing Targets	The work site is nestled between two Primary *Luftwaffe* targets; *Shadwell Dock* basin located 150m to the West and *Surrey Quay* located 300m to the South, both areas were bombed heavily throughout WWII.
	HE Bomb Strikes (*Figure 3*)	There are high explosive (HE) bomb strikes recorded consistently across the area. In total, eleven HE bomb strikes are recorded as landing within a 50m radius, two additional HE strikes are recorded as landing in the *River Thames* within 150m of the study site boundary.
	WWII HE Bomb Density (*Figure 4*)	The site is covered by the administrative district of *Stepney*, which recorded 647 HE bombs per 1,000 acres.
	WWII Bomb Damage (*Figure 5*)	*London County Council* (LCC) Bomb Damage mapping indicates that no bomb damage occurred within the assessment boundary, however, as the site was undeveloped and the area immediately on shore was open parkland, the probability of damage being recorded was minimal. The area immediately North of *The King Edward Memorial Park* (North of the study site) and *Shadwell Basin* to the East, suffered considerable damage ranging from “minor damage” to “total destruction”. The area of *Surrey Quay* (a large port facility), on the adjacent Southern bank of the *River Thames* also suffered heavy bombing during WWII and extensive damage was recorded ranging from “minor blast damage” to “total destruction”.
	Abandoned Bombs	There are no abandoned bombs recorded at this location.

STAGE THREE – DATA ANALYSIS	
Is there a reason to suspect that the immediate area was a bombing target during WWII?	Yes, this area of *Tower Hamlets* where the study site is situated was subjected to high levels of bombing throughout WWII. This is due to it being in close proximity to two *Luftwaffe* Primary targets, *Surrey Quay* to the South and *Shadwell Basin* to the West.
Is there firm evidence that ordnance landed on site?	There is no evidence of bombs landing on site, although it is entirely conceivable that ordnance and/or UXB could have landed in the river unnoticed.
Would an UXB entry hole have been observed and reported during WWII?	Given that the majority of this site is within the banks of the *River Thames*, it is considered unlikely that any bomb entry hole(s) would have been witnessed during a post raid survey. Moreover, as the study site is within the banks of the *River Thames* it is unlikely to have warranted specific attention following a raid, as a UXB at this position would not have presented a significant threat to either personnel or industry, at that time.
Was the ground undeveloped during WWII?	Yes, the area that the study site is located in is primarily undeveloped foreshore and the main river basin.
Is there any reason to suspect that Live Firing or military training may have occurred at this location?	There is no evidence to support that live firing took place on the site.
Is there any reason to suspect that other activities on site may have resulted in ordnance and / or explosives being present?	No, there is no evidence to support other activities on site involved ordnance or explosives of any type.
Would previous earthwork have removed the potential for UXO to be present?	Unlikely, according to historical mapping there is no evidence of post WWII development within the work area.

STAGE FOUR – RISK ASSESSMENT	
Threat Items	The threat is predominately posed by *Second World War* (WWII) *German* High Explosive (HE) bombs and to a lesser extent, *British* Anti-Aircraft Artillery (AAA) projectiles used to defend against *German* bombing raids.
Maximum Penetration	After reviewing the site-specific geotechnical data and the likely threat items, the maximum Bomb Penetration Depth (BPD) for a 500kg *Luftwaffe* bomb is assessed to be 4.5m below ground level (m bgl).
Risk Pathway	Given the type of munitions that may be present on site, all types of aggressive intrusive engineering activities may generate a significant risk pathway.
Consequence	Consequences of a UXB initiation include: 1. Kill and/or critically injure personnel; 2. Severe damage to plant and equipment; 3. Blast damage to nearby buildings; 4. Impact on London Underground; 5. Rupture and damage underground services. Consequences of UXO discovery include: 1. Delay the project; 2. Disruption to local community/*River Thames* traffic/Tunnel Closure; 3. Incurring of additional costs.

UXO RISK CALCULATION			
Activity	**Probability** (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Access Road Construction	2x2=4	2x3=6	4x6=24
Cofferdam to include Piling	2x3=6	2x3=6	6x6=36
Caisson Construction	2x2=4	2x3=6	4x6=24
Tunnelling	2x1=2	1x2=2	2x2=4
Excavations	2x2=4	2x3=6	4x6=24
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** – Unlikely to be effective, as any magnetometer results would be affected by Ferro-magnetic contamination. It is expected that the banks and bed of the *River Thames* will contain scrap metal and other ferrous items, which could mask any buried items of UXO. The riverbed would have to be scraped or dredged prior to a successful non-intrusive survey. **Intrusive Methods of Mitigation** – Possible, but the deployment methodology should be carefully considered to ensure it is conducted in the most efficient and effective manner.

MITIGATION MEASURES TO REDUCE RISK TO 'ALARP'		
Activity	**Risk Mitigation Measures**	**Risk Rating (Post Mitigation)**
Cofferdam Installation and Caisson Construction	There is a potential risk from UXO during both operations, therefore mitigation is required. The most efficient and cost effective method of survey is to implement non-intrusive methodologies (because the maximum bomb penetration depth is expected to be within range of these techniques). However, given the environmental conditions and the expected scrap metal on the riverbed, any non-intrusive survey is likely to be significantly hindered. Whilst an intrusive survey is possible it is likely to be expensive, slow and it may not deliver the required results (because of the presence of buried scrap metal). In light of this 6 Alpha recommend a meeting with the key stakeholders (i.e. *Thames Water* and Principal Contractor), to develop a method of mitigation to lower the risk to ALARP. This may involve a scrape or trawl dredge of the riverbed followed by a non-intrusive and and/or intrusive magnetometer survey.	ALARP
Marine Piling	Conduct an intrusive magnetometer survey ahead of the pile positions.	
Tunnelling	6 Alpha have assessed that tunnelling will be conducted at depths in excess of the maximum bomb penetration capacity, thus there is a negligible UXB risk associated with this activity.	
Excavations and Access Road Construction	1. Documentary procedures/actions to be taken in the event of a suspicious find; 2. Brief all personnel involved with the intrusive works on the potential risk of an associated UXO discovery; 3. Engage an UXO Specialist to monitor excavations down to the maximum bomb penetration depth.	
This assessment has been conducted based on the information provide by the Client, should the proposed works change then 6 Alpha should be re-engaged to refine this risk assessment.		

Report Figures

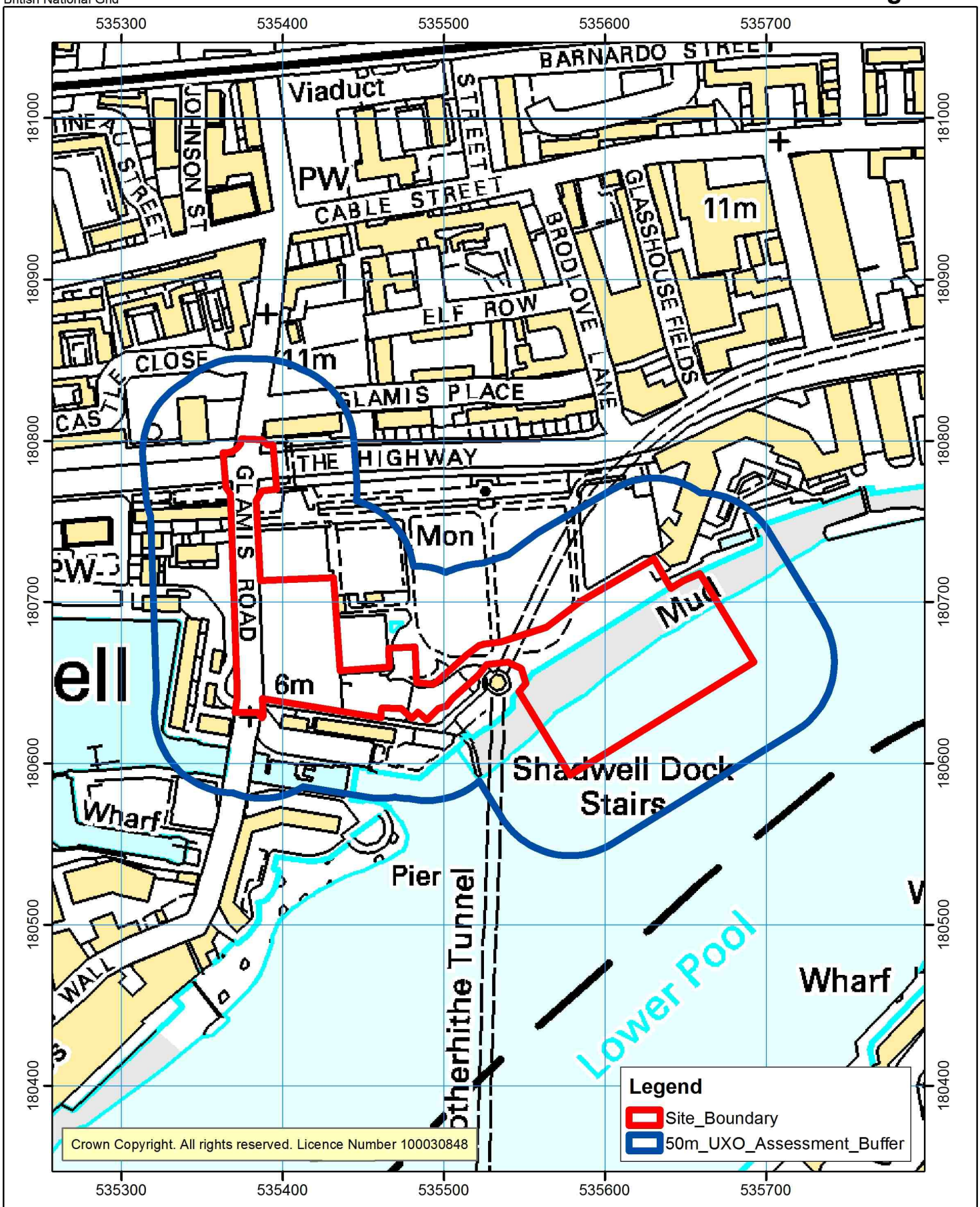
Figure One

Work Area Location Plan

Thames Tideway Tunnel - Work Area PTH1X
Site Boundary

Figure 1

British National Grid



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Checked by: Graeme Warden

Date: 16th October 2012

Figure Two

Current Aerial Photography

Thames Tideway Tunnel - Work Area PTH1X
Current Aerial Photography

Figure 2

British National Grid

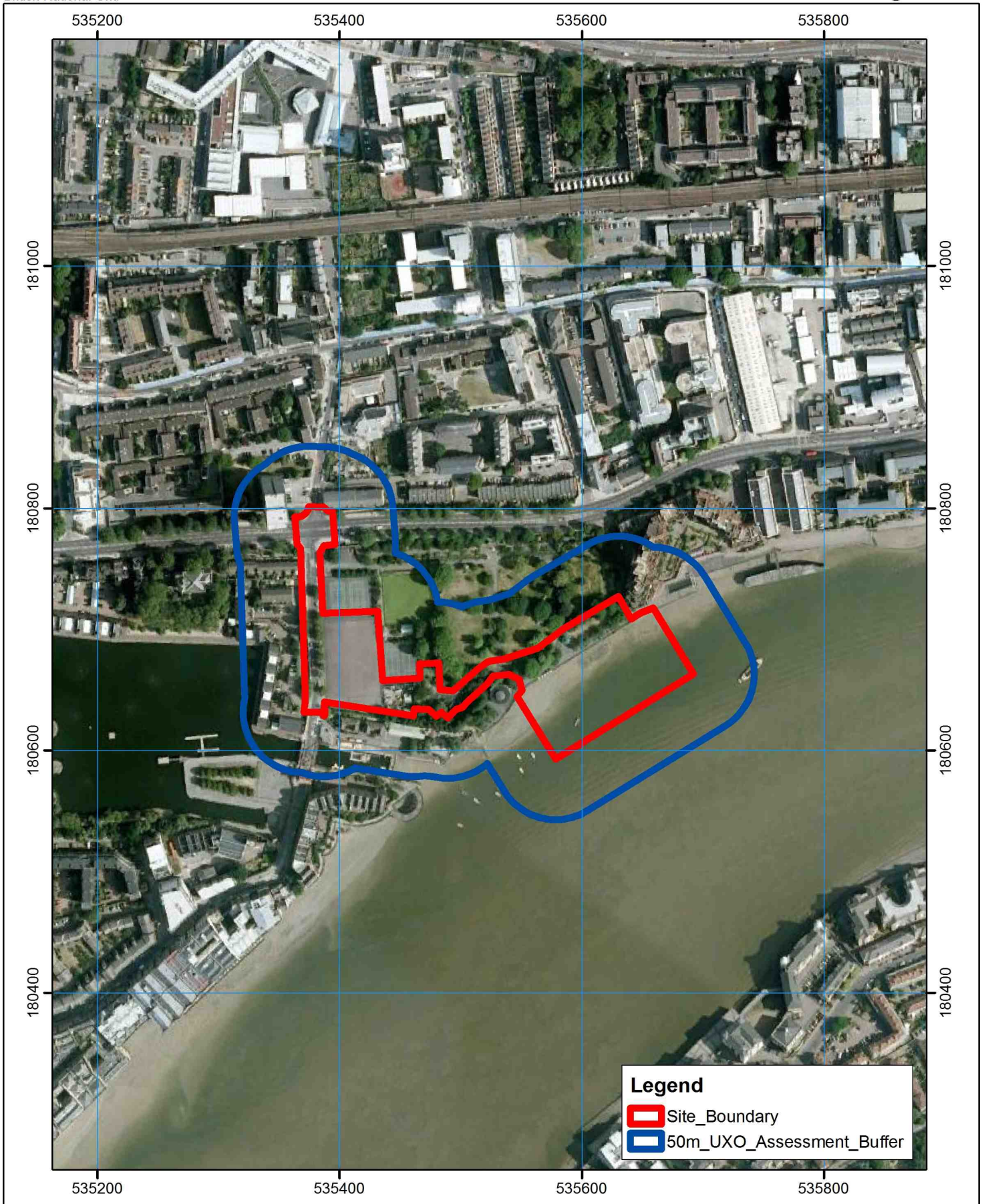

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Figure Three

Location of WWII High Explosive Bomb Strikes

Thames Tideway Tunnel - Work Area PTH1X
WWII High Explosive Bomb Strikes

Figure 3

British National Grid

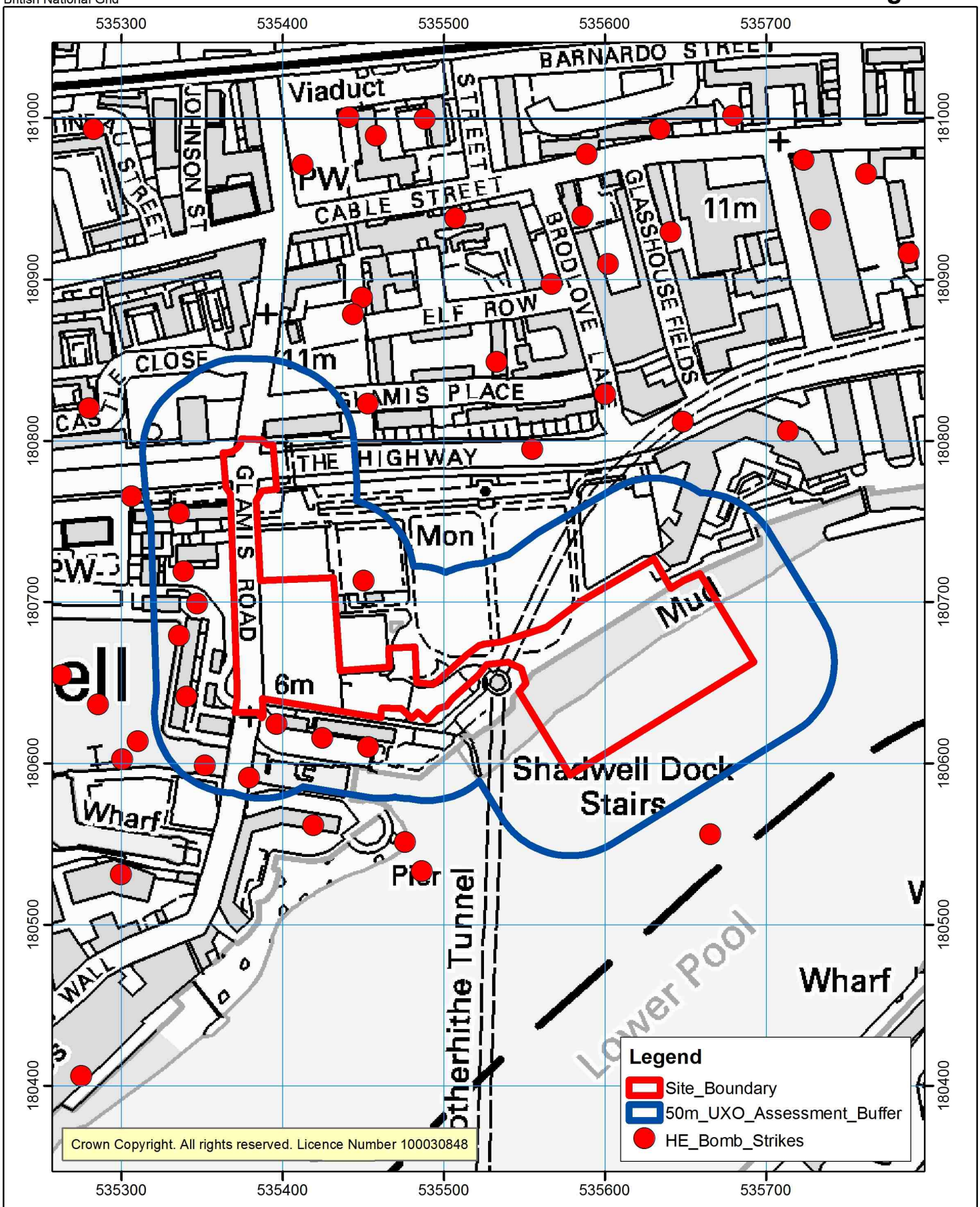

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Figure Four

WWII High Explosive Bomb Density

Thames Tideway Tunnel - Work Area PTH1X
WWII High Explosive Bomb Density

Figure 4

British National Grid

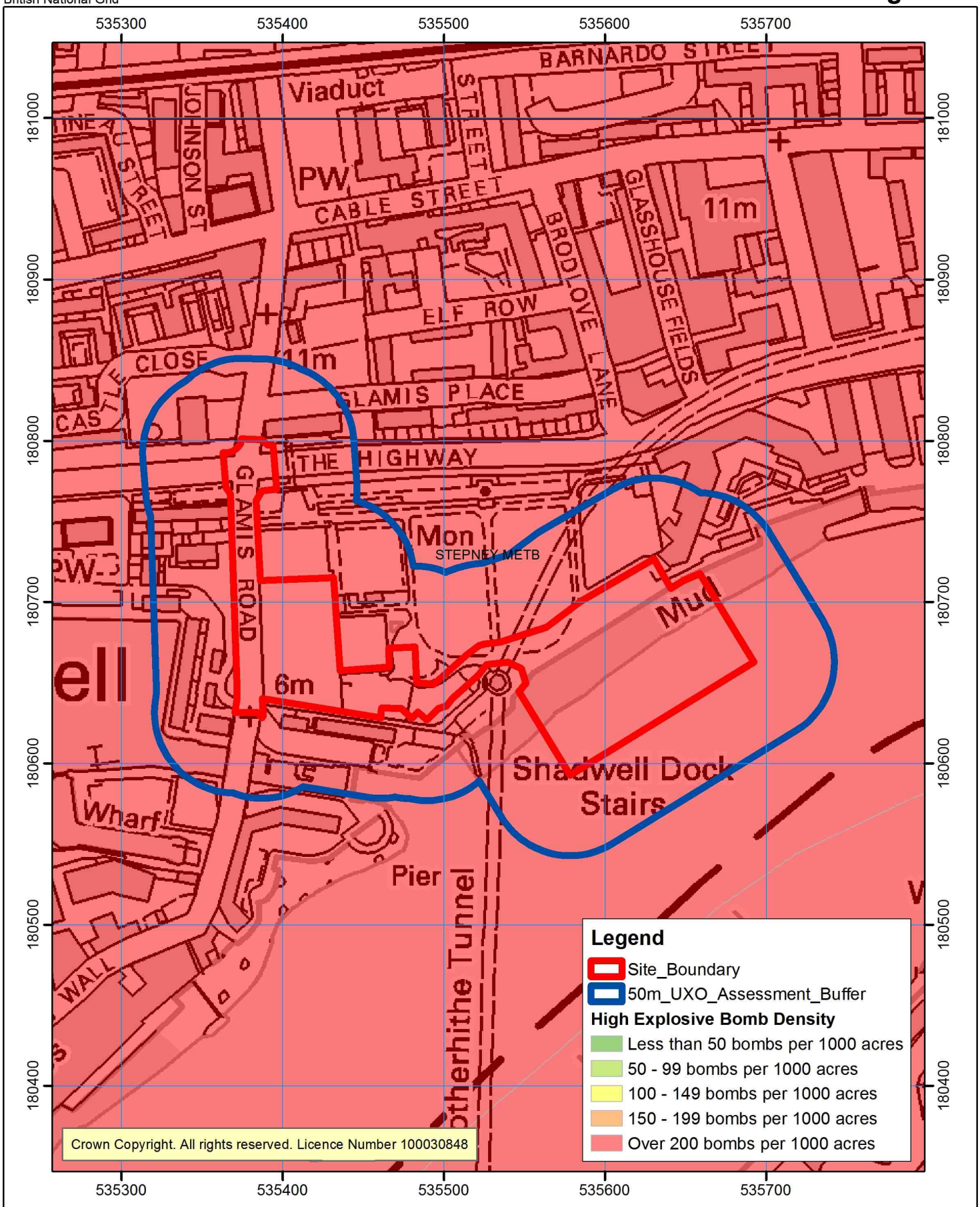

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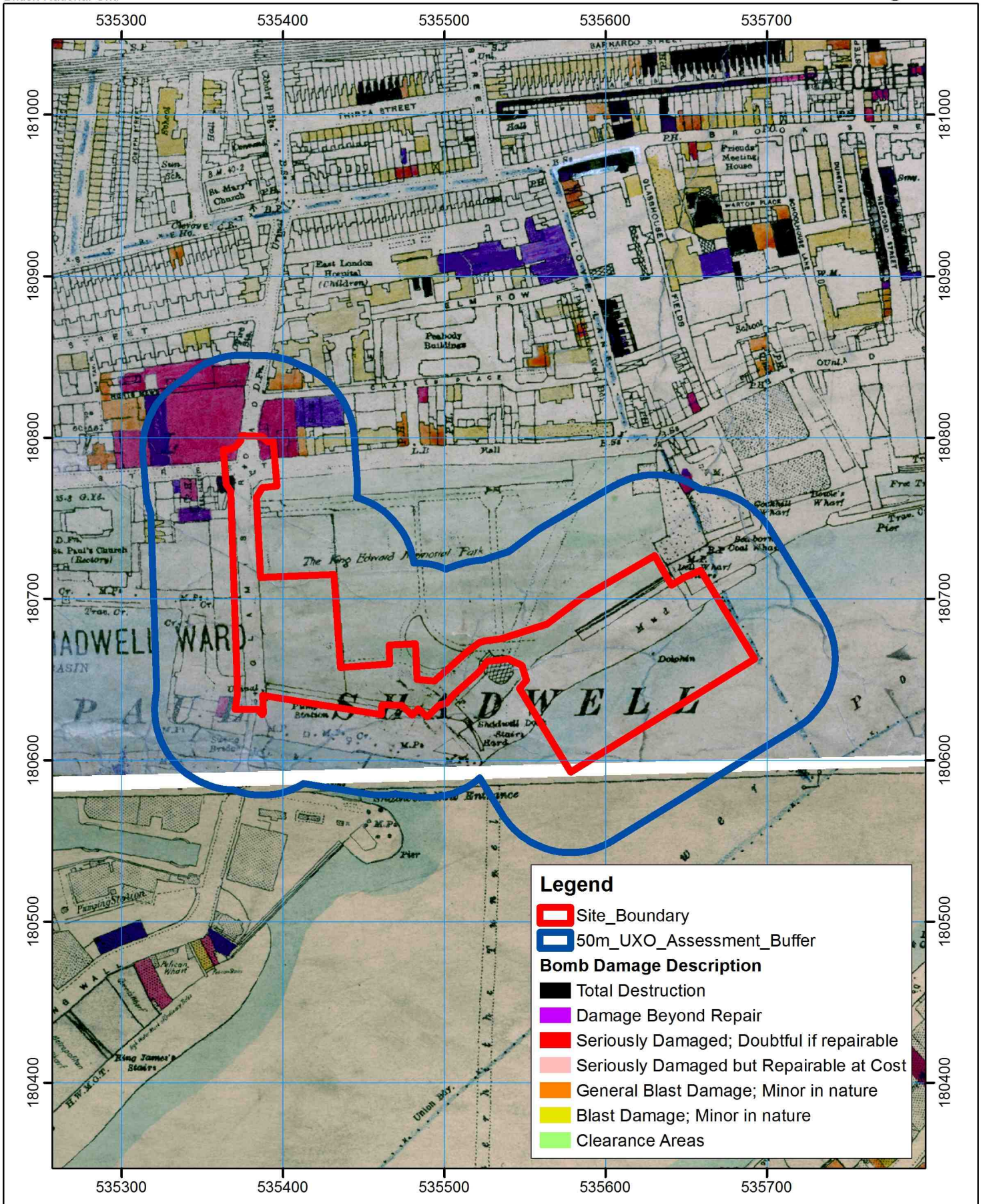
Figure Five

London County Council Bomb Damage Mapping

Thames Tideway Tunnel - Work Area PTH1X
London County Council Bomb Damage Map

Figure 5

British National Grid



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Checked by: Graeme Warden

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References

[1] Department for the Environment, Food and Rural Affairs and The Environment Agency, *CLR8: Potential Contaminants for the assessment of land,* Environment Agency (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] DEFRA/EA, *Soil Guideline values for industrial and light commercial land use*, (2009).

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

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.21**

Volume 21: King Edward Memorial Park Foreshore appendices

Appendix G: Noise and vibration

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 21 King Edward Memorial Park Foreshore 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 King Edward Memorial Park Foreshore are the residential dwellings surrounding the park (ie Free Trade Wharf, Glamis Place, Glamis Road and Shadwell Pier Head), the park itself and Shadwell Basin outdoor centre.

Survey methodology

G.1.3 The London Borough (LB) of Tower Hamlets 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 22nd to 24th July, 2011. Additional baseline data was collected on 24th November 2011, 18th to 21st December, 2011 and 22nd March, 2012. The baseline surveys comprised continuous unattended monitoring at two locations and short term attended measurements taken during the daytime at two locations.

G.1.5 For the continuous monitoring, data was collected for a typical weekday and typical weekend day.

G.1.6 Short term attended monitoring was completed at two locations. Measurements were undertaken during the interpeak periods of 10:00-12:00 and 14:00-16:00 on a typical weekday so that the baseline data is representative of the quieter periods where any disturbance from construction would be most noticeable.

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

Table G.1 Noise – survey equipment

Item	Type	Manufacturer	Serial Number(s)	Laboratory Calibration Date
Initial Baseline Survey: 22nd - 24th July, 2011				
Hand-Held Analyser	2250	Brüel & Kjær	2506362	25/05/2011*
½ " Microphone	4189	Brüel & Kjær	2519772	12/05/2011*
B&K Sound Calibrator	4231	Brüel & Kjær	2445811	14/10/2010*
Additional Baseline Surveys: 24th November and 18th - 21st December, 2011				
Hand-Held Analyser	2250	Brüel & Kjær	2626232	15/02/2010**
½ " Microphone	4189	Brüel & Kjær	2621211	15/02/2010**
B&K Sound Calibrator	4231	Brüel & Kjær	2619375	12/01/2011**
Additional Baseline Survey: 22nd March, 2012				
Hand-Held Analyser	2250	Brüel & Kjær	2626233	23/01/2012**
½ " Microphone	4189	Brüel & Kjær	2621211	20/01/2012**
B&K Sound Calibrator	4231	Brüel & Kjær	2619374	20/01/2012**

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

***Hand-held analyser and ½ " microphone valid for two years from the date listed, calibrator 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 measurements, the environmental cases used for the continuous data logging were locked to avoid any potential tampering. The microphones were tripod-mounted approximately 1.3m above ground level. Windshields with bird spikes were fitted over the microphones at all times during the survey period to minimise the effects of any wind induced noise, and also to prevent birds from perching on the equipment.

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

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

Table G.2 Noise – weather conditions during baseline noise surveys

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation?	Description
Baseline Survey - 24th November, 2011 (daytime)				
Maximum: 1.5-5.4 Average: 0.4-1.2	S; SW	12-14	No	Bright, clear, dry, breezy, mild
Baseline Survey - 24th November, 2011 (evening)				
Maximum: 2.5-4.2 Average: 0.4-1.4	S	11	No	Cloudy, dry, breezy, mild
Additional baseline survey – 22nd March, 2012 (daytime, 10:00–12:00)				
Maximum: 2.1-5.0 Average: 0.5-2.7	NE, E	14-16	No	Sunny, dry, clear and breezy
Additional baseline survey – 22nd March, 2012 (daytime, 14:00–16:00)				
Maximum: 2.3-6.1 Average: 0.5-2.1	Easterly	15-19	No	Scattered cloud, sunny intervals, dry and breezy

Table G.3 Noise – contemporary weather data for Heathrow Airport

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation?	Description
Friday 22nd July, 2011 (22:00 - 05:00) [a] and [b]				
1-3	Variable (Predominantly NE and NW)	12-14	Yes (at 23:00 and 00:50)	Cloudy, light breeze, mild, light rain showers
Sunday 24th July, 2011 (22:00 - 05:00) [c] and [d]				
1-4.7	Variable (Predominantly NW and W)	10-18	No	Clear, dry, mild, breezy
Sunday 18th December, 2011 (00:00 - 00:00) [e]				
1-7.2	Variable (Predominantly W and WNW)	(-)1-6	Yes (between 14:00 and 15:00, 0.6mm total)	Clear and dry for majority of day. Light rain shower and strong gusts early PM.
Monday 19th December, 2011 (00:00 - 00:00) [f]				
1-6.7	Variable (Predominantly W and SSW)	(-)2-7	Yes (between midday and 18:30, 5.0mm total)	Generally overcast and wet for majority of day
Tuesday 20th December, 2011 (00:00 - 17:00) [g]				
1-6.7	Variable (Predominantly W and WNW)	5-8	No	Partly cloudy, dry, mild and breezy

[a] *http://www.wunderground.com/history/airport/EGLL/2011/7/22/DailyHistory.html*
[b] *http://www.wunderground.com/history/airport/EGLL/2011/7/23/DailyHistory.html*
[c] *http://www.wunderground.com/history/airport/EGLL/2011/7/24/DailyHistory.html*
[d] *http://www.wunderground.com/history/airport/EGLL/2011/7/25/DailyHistory.html*
[e] *http://www.wunderground.com/history/airport/EGLL/2011/12/18/DailyHistory.html*
[f] *http://www.wunderground.com/history/airport/EGLL/2011/12/19/DailyHistory.html*
[g] *http://www.wunderground.com/history/airport/EGLL/2011/12/19/DailyHistory.html*

Measurement locations

G.1.13 Table G.4 details the measurement locations which are also presented in Vol 21 Figure G.1 Noise – measurement locations (see separate volume of figures), and shown in Plates G.1 to G.4.

Table G.4 Noise – measurement locations

Measurement Location Number	Description	Co-ordinates	
		X	Y
KEM02	In back garden of residential dwelling along Shadwell Pierhead (private)	535413	180631
KEM01	Within King Edward Memorial Park (public)	535546	180702
KEM03	Within King Edward Memorial Park (public)	535632	180717
KEM04	Within King Edward Memorial Park (public)	535636	180756
KEM05	Footpath adjacent to The Highway, opposite King Edward Memorial Park (public)	535519	180799

Results

G.1.14 The range of values for each of the parameters collected during the baseline surveys are summarised in Table G.5 to Table G.9.

Table G.5 Noise – sampled noise survey results - KEM03

Location Detail: KEM03, on Thames Path within southeast corner of King Edward Memorial Park, opposite Free Trade Wharf						
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)	90	54	57-61	59	62*	60

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

Table G.6 Noise – sampled noise survey results - KEM04

Location Detail: KEM04, on public footpath within King Edward Memorial Park, near to eastern park boundary						
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)	75	56	60-61	61	64*	65

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

Table G.7 Noise – sampled noise survey results - KEM05

Location Detail: KEM05, on public footpath adjacent to The Highway						
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)	100	68 - 71	77 - 78	75*	78	80
Evening (8pm-10pm)	95	69	76 - 77	73*	76	75

** An approximation of the averaged ambient free field noise level has been obtained by subtracting 3dB from the measured averaged ambient facade level*

Table G.8 Noise – continuously logged noise survey results - KEM01

Location Detail: KEM01, within grassed area of King Edward Memorial Park							
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	22.00-07.00*	83	51	57	86	54	60
Sunday	21.00-07.00*	76	49	55	79	52	58

**The data presented in this row is deemed to be representative of the reference period. The continuous monitor only collected data until 05:00 AM, at which point the park opened at the equipment needed to be collected*

Table G.9 Noise – continuously logged noise survey results - KEM02

Location Detail: KEM02, adjacent to playground off Glamis Road, to the Southwest of King Edward Memorial Park							
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	72	49	54	75	52	57
	08.00-18.00	81	49	54	84	52	57
	18.00-19.00	75	47	53	78	50	56
	19.00-22.00	67	47	52	70	50	55
	22.00-07.00	72	44	50	75	47	53
Saturday	22.00-07.00*	72	45	49	75	48	52
Sunday	07.00-21.00	80	47	53	83	50	56
	21.00-07.00	74	41	49	77	44	52

**The data presented in this row is deemed to be representative of the reference period. The continuous monitor only collected data from 01:00 AM on the Sunday morning.*

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

Sensitive receptor locations	Measurement location	Measurement period	Noise level (dBL_{Aeq}, facade)
King Edward Memorial Park western bank	KEM02	Day/evening (07.00-23.00)	54
King Edward Memorial Park central bank	KEM01	Day/evening (07.00-23.00)	51
King Edward Memorial Park eastern bank	KEM01	Day/evening (07.00-23.00)	61

Plates of noise measurement locations

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

Plate G.1 Noise measurement location KEM01

Note: Continuous monitoring equipment within King Edward Memorial Park

Plate G.2 Noise measurement location KEM02

Note: Continuous monitoring equipment within back garden of private residential dwelling along Shadwell Pierhead, looking northeast

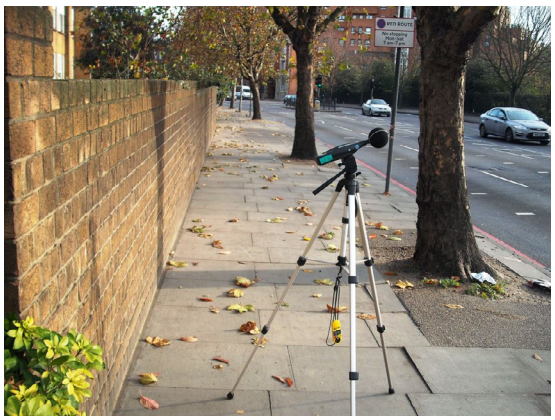
Plate G.3 Noise measurement location KEM03

Note: On Thames path in southeast corner of King Edward Memorial Park, looking northeast towards Free Trade Wharf

Plate G.4 Noise measurement location KEM04

Note: On public footpath within King Edward Memorial Park, looking south towards River Thames

Plate G.5 Noise measurement location KEM05



Footpath adjacent to The Highway (A1203) looking east (façade measurement)

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 are presented in Table G.11.

G.2.4 Time histories of the predicted daytime construction noise levels across the programme of construction works are shown in Plates G.5 to G.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	98	15	BS5228-1: Table C.2, Item 7	Tracked excavator,
	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
	Hand-held percussive breaker	1	111	15	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker,
	Compressor 250cfm	1	102	15	BS5228-1: Table C.1, Item 8	Hydraulic breaker power pack, 63 kg/ 138 bar
	Generator 35kVA	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Circular saw cutting timber	1	107	10	BS5228-1: Table D.7, Item 72	Hand-held electric circular saw,
	Cutting equipment (diamond saw)	1	108	10	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	Waste collection via skip or tipper lorry	1	106	5	BS5228-1: Table C.8, Item 21	Skip wagon,
	Oxyacetylene cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
Site set up and general site	Oxyacetylene cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
	Compressor 250cfm	1	93	50	BS5228-1: Table D.5,	Compressor for hand-

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
					Item 5	held pneumatic breaker,
	Generator - 200 kVA	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Cutting equipment (diamond saw)	2	108	10	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	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,
	JCB with hydraulic breaker	1	116	25	BS5228-1: Table C.5, Item 1	Backhoe mounted hydraulic breaker,
	Fuel delivery vehicle	1	104	5	BS5228-1: Table C.4, Item 15	Fuel tanker lorry,
	Well drilling Rig	1	107	50	Manufacturer	Bauer BBA well drilling rig,
Demolition General site	Service Crane 25T mobile Crane	1	98	30	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
equipment also applicable during this phase	22T Excavator c/w hydraulic hammer	1	118	30	BS5228-1: Table C.1, Item 9	Breaker mounted on excavator, 15 t, 1650 kg 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,
	Vibrating rollers	2	101	50	BS5228-1: Table C.2, Item 38	Roller, 18 t
Cofferdam construction General site equipment also applicable during this phase	150t 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,
	400 cfm compressor	1	93	500	BS5228-1: Table D.5, Item 5	Compressor for hand-held pneumatic breaker,
	Vibratory piling rig	1	116	60	BS5228-1: Table C.3, Item 8	Vibratory piling rig, 52 t
	Dewatering pumps - cofferdam	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
	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
note: piling and backfilling will be concurrent however the two operations will be separated by some distance.	Secant pile rig	1	107	60	BS5228-1: Table C.3, Item 16	Crane mounted auger
	Oxyaceteline cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
	Silent piler	1	91	60	BS5228-1: Table C.3, Item 9	Piling, 10 t
	25t excavator	1	105	80	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Vibrating rollers	2	101	50	BS5228-1: Table C.2, Item 38	Roller, 18 t
	Plate compactors	2	108	10	BS5228-1: Table C.2, Item 41	Vibratory plate (petrol) ,
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)	1	110	80	Manufacturer	Hydrofraise D wall rig,
	150t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	Dumper	1	104	50	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Concrete deliveries (discharging)	1	103	50	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging),
	Concrete pump	1	95	50	BS5228-1: Table C.4, Item 24	Concrete pump + cement mixer truck

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
						(discharging), 8 t / 350 bar
	Diaphragm wall slurry treatment plant	1	100	100	Measured	Slurry treatment plant,
	Waste water treatment plant	1	104	100	Measured	Dirty water plant
	Compressor 400cfm	1	98	100	BS5228-1: Table D.6, Item 41	Compressor, 7m^3/min
Shaft construction General site equipment also applicable during this phase	Long reach excavator	2	106	80	BS5228-1: Table C.7, Item 1	Long reach tracked excavator, 21 m arm / 39 t
	20t excavator with breaker	2	118	50	BS5228-1: Table C.1, Item 9	Breaker mounted on excavator,
	150t crawler crane	2	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
	Dewatering pump	4	96	100	BS5228-1: Table C.4, Item 88	Water pump (diesel), 100 kg
	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

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
	Ventilation fans	1	90	100	Measured	Ventilation plant,
Shaft secondary lining General site equipment also applicable during this phase	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
	Fixed and portable concrete vibrators	4	106	20	BS5228-1: Table C.4, Item 33	Poker vibrator,
	Hand tools (e.g. drills and wrenches)	4	95	80	Estimated	Impact wrench and compressor,
	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging),
	Concrete pump	2	95	20	BS5228-1: Table C.4, Item 24	Concrete pump + cement mixer truck (discharging), 8 t / 350 bar
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
Culvert and chamber	Service crane - 100T mobile 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
works General site equipment also applicable during this phase	25t excavator	1	105	50	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Fixed and portable concrete vibrators	4	106	20	BS5228-1: Table C.4, Item 33	Poker vibrator,
	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
	Dumper	1	104	50	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Hand tools (e.g. drills and wrenches)	4	95	80	Estimated	Impact wrench and compressor,
Landscaping General site equipment NOT applicable during this phase	25t excavator	1	97	50	BS5228-1: Table C.2, Item 25	Tracked excavator, 14 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	93	10	BS5228-1: Table C.5, Item 5	Compressor for hand-held pneumatic breaker, 1 t

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	20	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.

Plate G.5 Average monthly daytime noise level over duration of construction – Prospect Wharf (KE1)

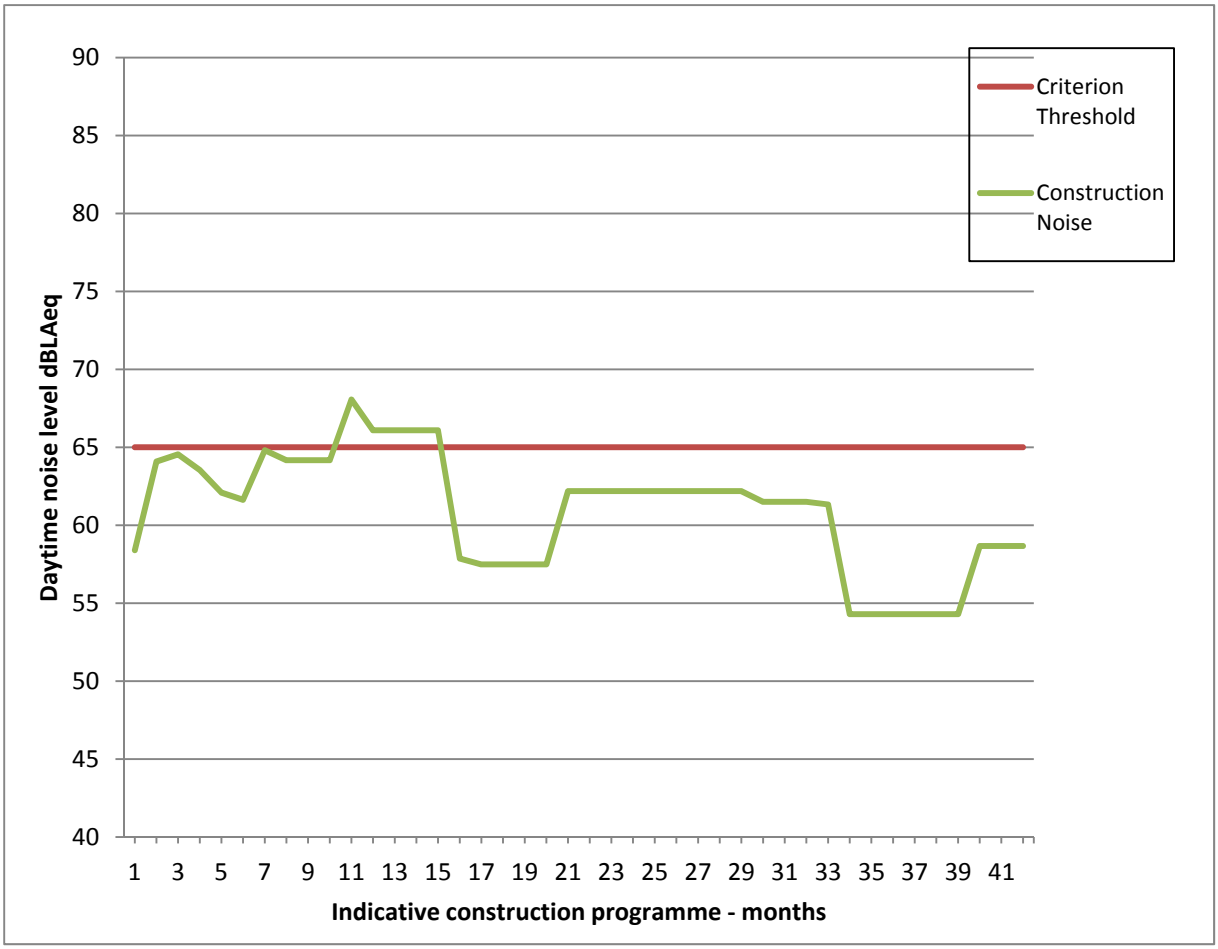


Plate G.6 Average monthly daytime noise level over duration of construction – Shadwell Basin Outdoor Centre (KE2)

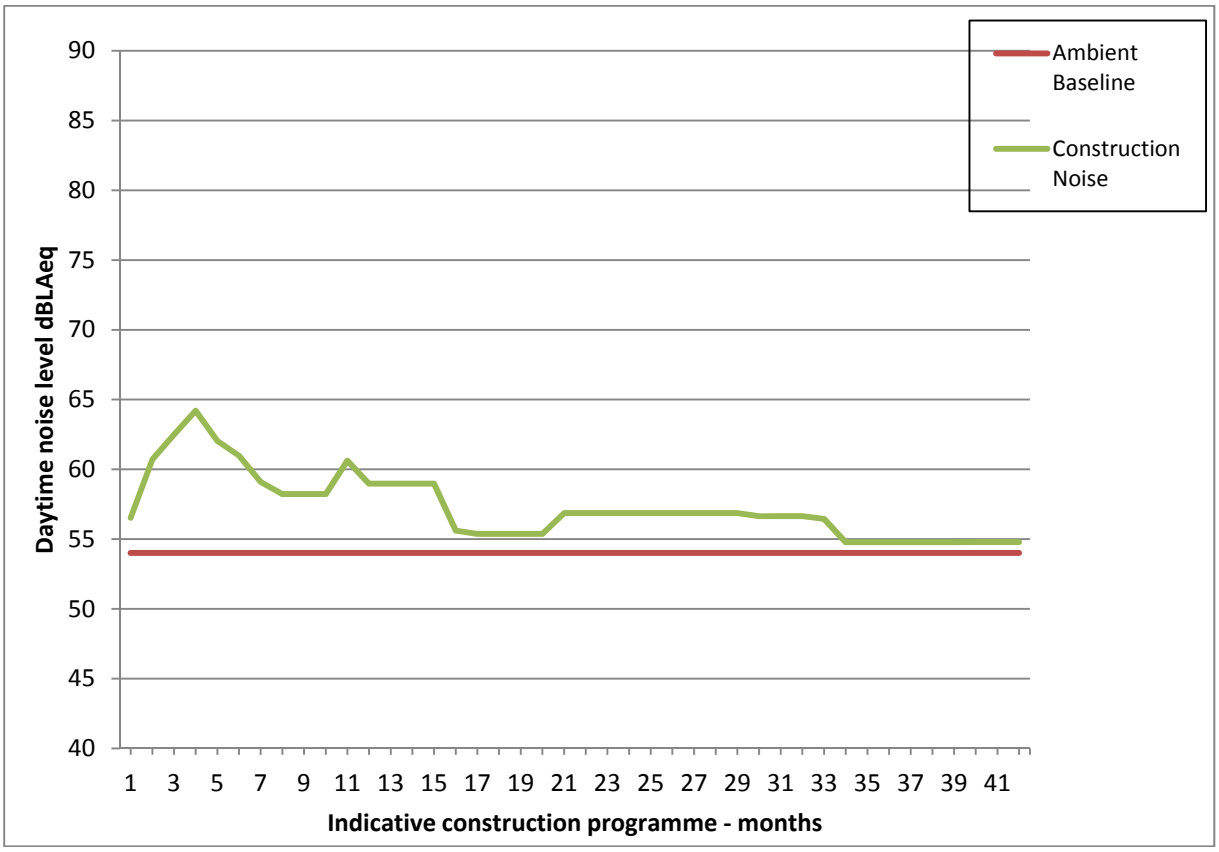


Plate G.7 Average monthly daytime noise level over duration of construction – Pier Hear Prep. School (KE3)

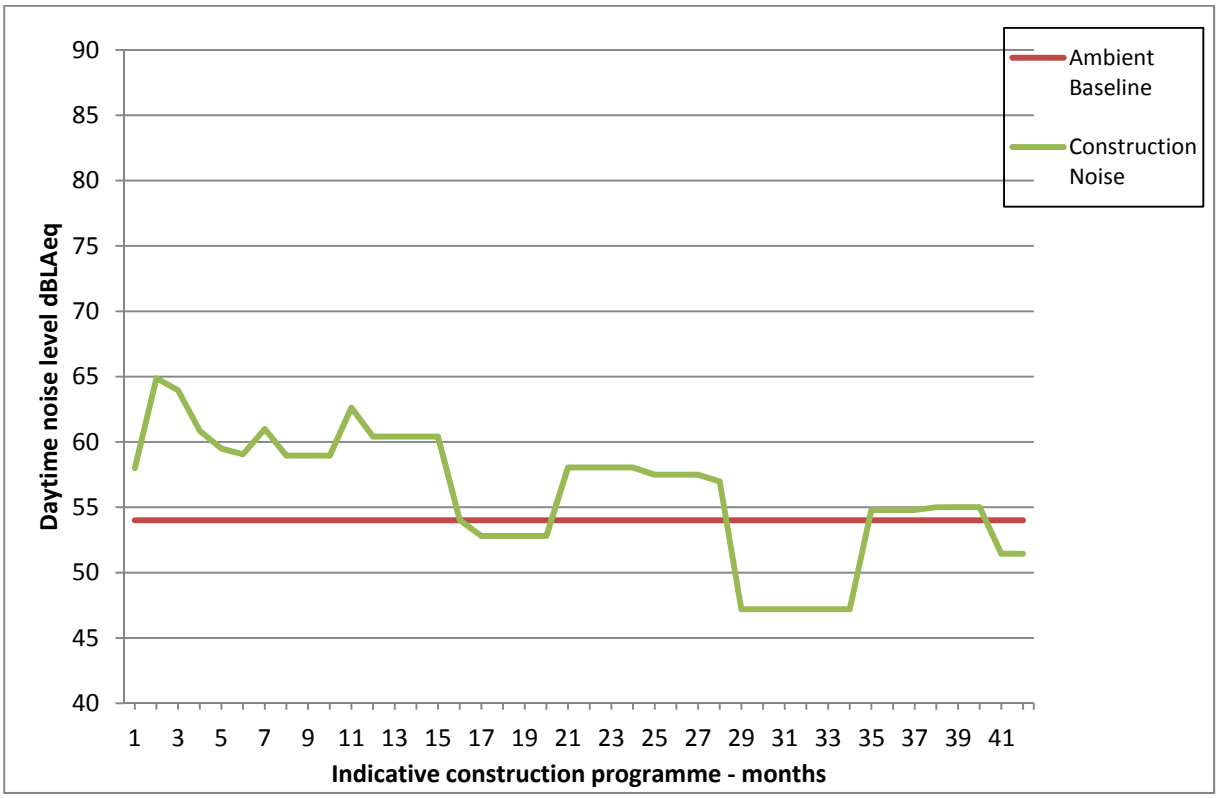


Plate G.8 Average monthly daytime noise level over duration of construction – 4 Shadwell Pierhead (KE4)

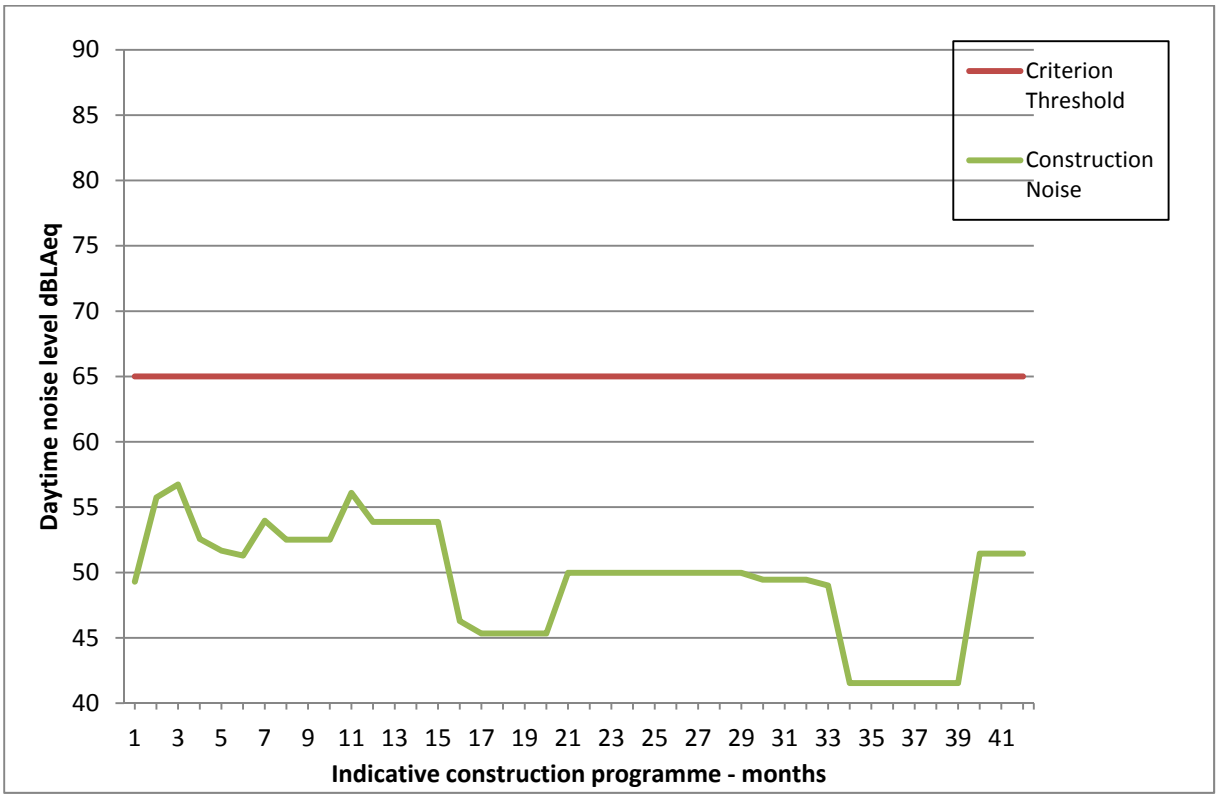


Plate G.9 Average monthly daytime noise level over duration of construction – 35 Peartree Lane (KE5)

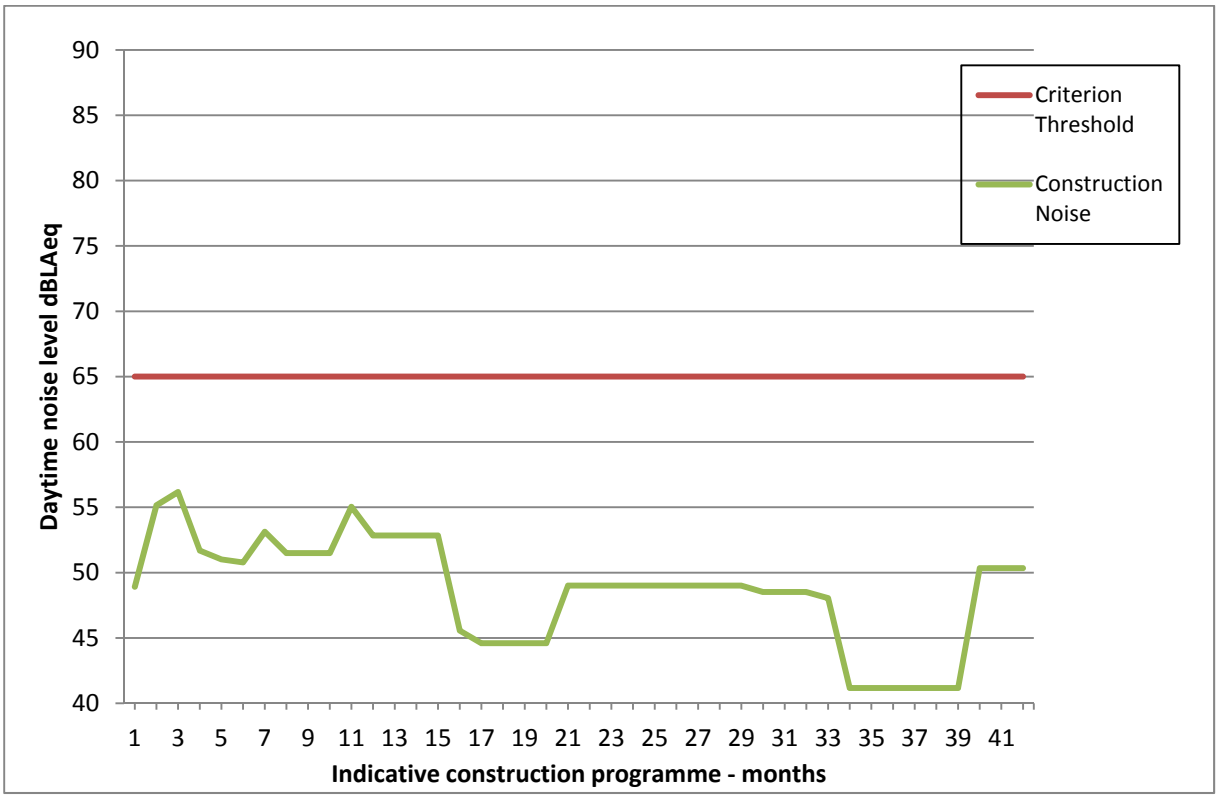


Plate G.10 Average monthly daytime noise level over duration of construction – The Highway (KE6)

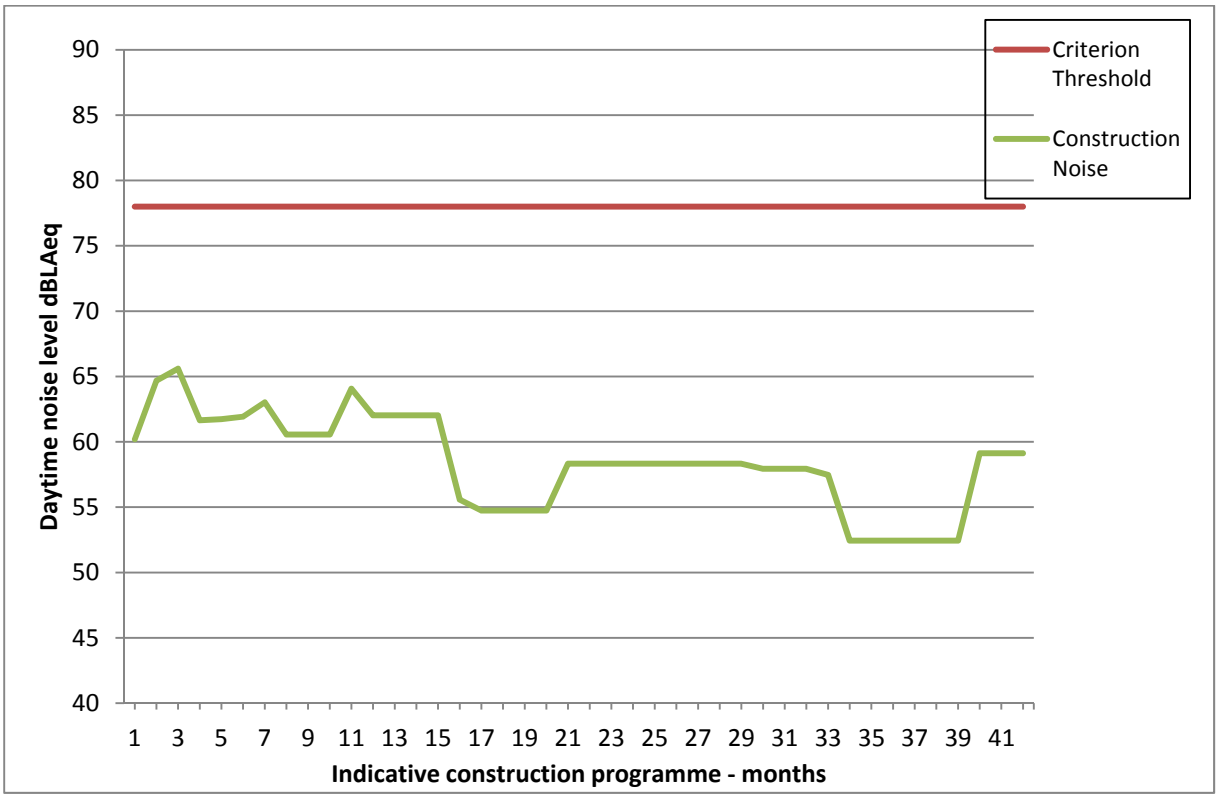


Plate G.11 Average monthly daytime noise level over duration of construction – Free Trade Wharf North (KE7)

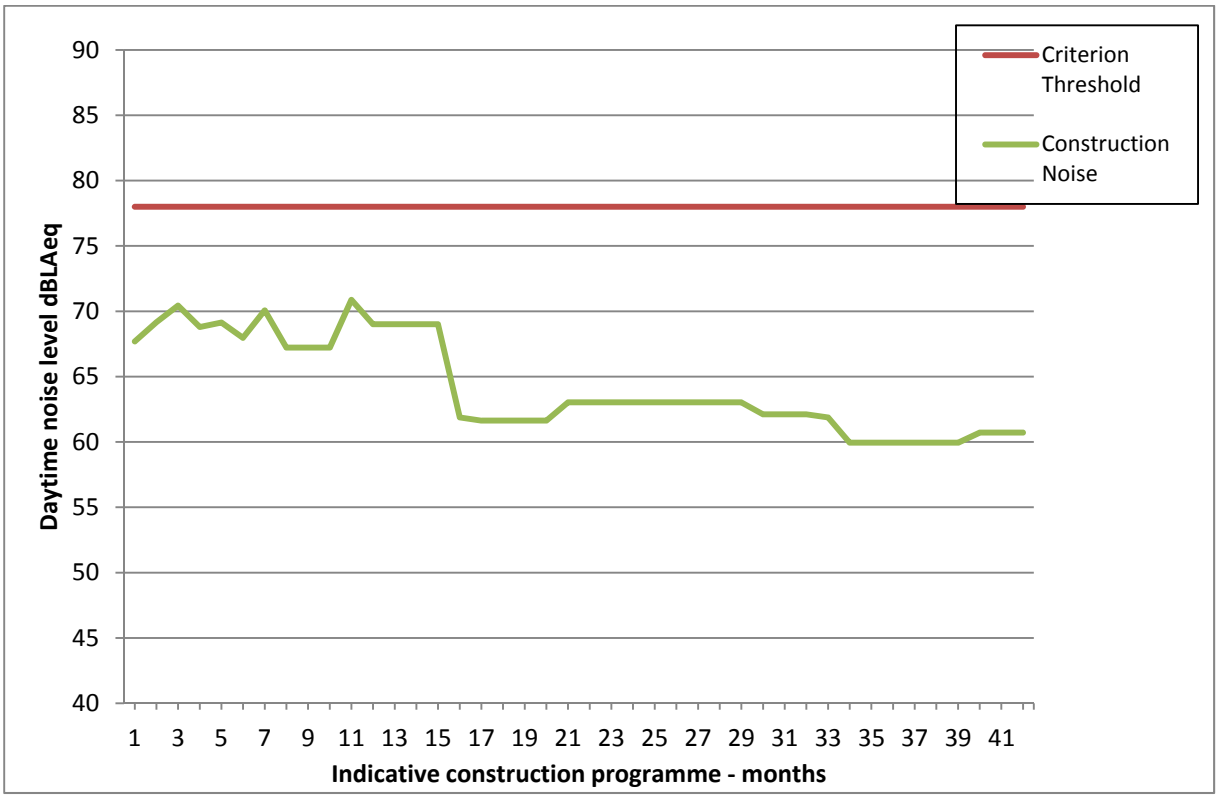


Plate G.12 Average monthly daytime noise level over duration of construction - Free Trade Wharf Middle (KE8)

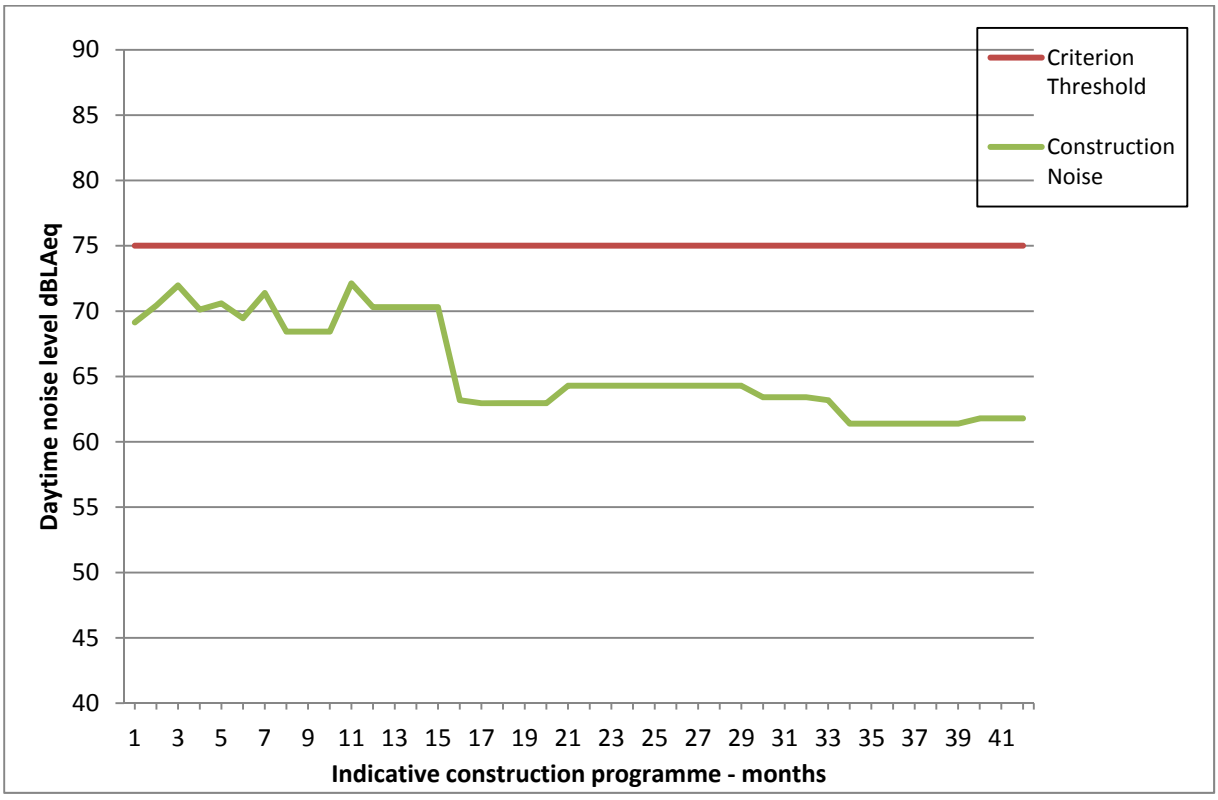


Plate G.13 Average monthly daytime noise level over duration of construction - Free Trade Wharf South (KE9)

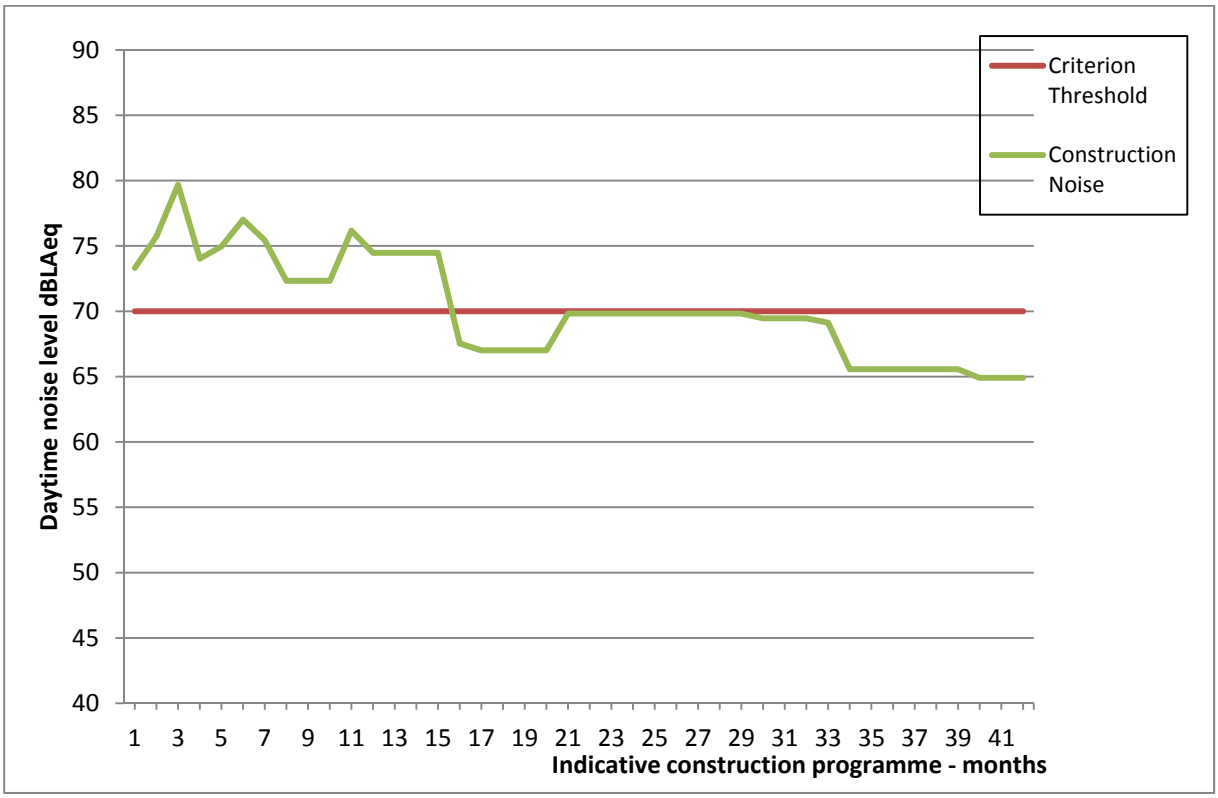
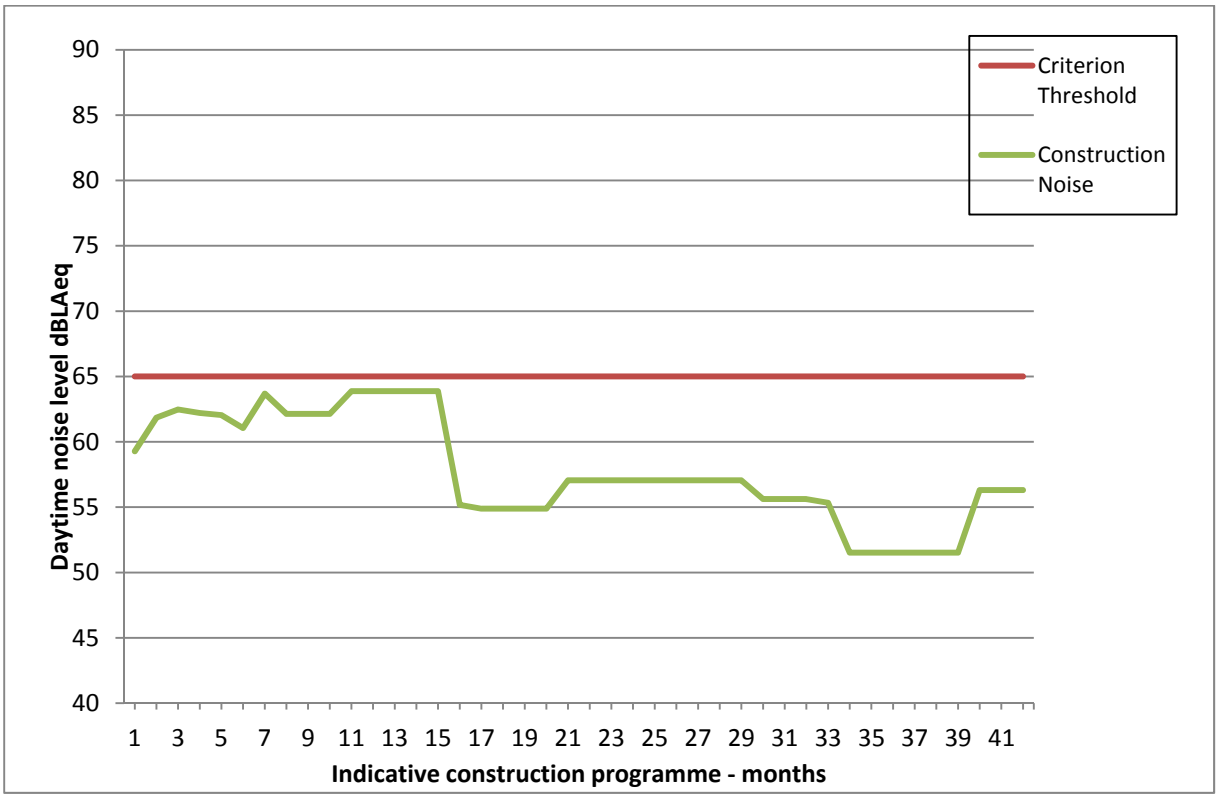


Plate G.14 Average monthly daytime noise level over duration of construction – Abbotshade Road (KE10)



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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.21**

Volume 21: King Edward Memorial Park Foreshore appendices

Appendix H: Socio-economics

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

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Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 21 King Edward Memorial Park appendices

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[iii]) and the overall borough level (which in this case is the London Borough [LB] of Tower Hamlets).

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

a. persons of 'Other' ethnicity.

b. persons suffering from overall deprivation.

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

a. persons of 'Mixed' ethnicity.

Resident population

H.1.5 The resident population was approximately 3,050 within 250m of the site and approximately 41,300 within 1km of the site at the time of the last census.

Gender and age

H.1.6 Of the total population within 250m of the site 52.8% of residents are male, broadly in line with the proportion of male residents within 1km of the site (51.1%) and slightly higher than at a borough wide level (50.1%). This contrasts with Greater London which has a slight predominance of female residents (51.6%).

[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] The statistics presented for the study area within 1km of the site include both sides of the River Thames.

[iv] 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.

H.1.7 Vol 21 Table H.1 outlines age breakdown by assessment area, it illustrates that the proportion of under 16 year olds within 250m (18.3%) is slightly lower than within 1km (21.4%), the LB of Tower Hamlets (22.8%) and the Greater London average (20.2%).

H.1.8 The proportion of over 65 year olds within 250m (8.4%) is broadly in line with the proportion within 1km (8.6%) and within the LB of Tower Hamlets (9.3%) and somewhat lower than the Greater London average (12.4%).

Vol 21 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 Tower Hamlets)	Greater London
Under 16 years old	18.3%	21.4%	22.8%	20.2%
Over 65 years old	8.4%	8.6%	9.3%	12.4%

Ethnicity

H.1.9 Vol 21 Table H.2 outlines ethnicity by assessment area, showing that within 250m of the site, White residents comprise almost two thirds of the population (62.4%), with Black and Minority Ethnic (BME) residents comprising the remaining 37.6%.

H.1.10 The proportion of White residents within 250m (62.4%) is somewhat higher than within 1km (55.1%) and the borough wide proportion (51.4%) but somewhat lower than the Greater London level (71.2%).

H.1.11 Within 250m, the proportion of Asian residents (26.7%) is somewhat lower than within 1km (34.5%) and the LB of Tower Hamlets (36.6%). Within the above assessment areas however, the proportion of Asian residents is considerably higher than the Greater London average (12.1%).

H.1.12 The proportion of Black residents within 250m (5.2%) and 1km (5.5%) is broadly in line and slightly lower than at a borough wide level (6.5%). Within the above assessment areas however, the proportion of Black residents is considerably lower than the Greater London average (10.9%).

Vol 21 Table H.2 Socio-economics – ethnicity by assessment area

Ethnicity	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Tower Hamlets)	Greater London
White	62.4%	55.1%	51.4%	71.2%
BME	37.6%	44.9%	48.6%	28.8%
Asian	26.7%	34.5%	36.6%	12.1%

Ethnicity	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Tower Hamlets)	Greater London
Black	5.2%	5.5%	6.5%	10.9%
Other	3.5%	2.2%	3.0%	2.7%
Mixed	2.2%	2.7%	2.5%	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 Christians are the predominant religious group within 250m of the site (46.1%) slightly higher than within 1km (41.4%) and at a borough wide level (38.6%) where Christians are also predominant. Muslims are the second most predominant religious group within all assessment areas. The proportion of Muslim residents within 250m (26.1%) is somewhat lower than within 1km (33.4%) and the LB of Tower Hamlets (36.4%) overall. Within the above assessment areas however, the proportion of Muslims is considerably higher than the Greater London average (8.5%).

H.1.14 Within 250m, approximately 24.6% of residents do not follow or state a religion, broadly in line the Greater London average (24.4%) and slightly higher than within 1km (21.8%) and at a borough wide level (21.6%).

Health indicators

H.1.15 Vol 21 Table H.3 outlines health indicators by assessment area, noting that within 250m of the site, the proportion of residents suffering from a long term or limiting illness (14.4%) is slightly lower than the level within 1km of the site (15.5%) and Greater London (15.5%). It is somewhat lower than the LB of Tower Hamlets average (17.2%).

H.1.16 The proportion of residents who claim disability living allowance within 250m (5.3%) is broadly in line with the LB of Tower Hamlets average (5.4%) and slightly higher than the rate within 1km of the site (4.9%) and Greater London overall (4.5%).

Vol 21 Table H.3 Socio-economics – health indicators by assessment area

Health indicator	Assessment area			
	Immediate area (250m)	Wider local are (1km)	Borough wide (LB of Tower Hamlets)	Greater London
Long term limiting sick	14.4%	15.5%	17.2%	15.5%
Disability living allowance	5.3%	4.9%	5.4%	4.5%

H.1.17 In the Middle Layer Super Output Area (MSOA)[v5] in which the site falls, adult obesity falls in the second lowest quintile (ie, the lowest being the best) relative to Greater London. By contrast, levels of child obesity fall within the highest quintile (ie, the highest being the worst) relative to Greater London.

H.1.18 In terms of the rates of adults and children undertaking physical activity, as measured borough wide, LB of Tower Hamlets ranks within the lowest quintile (ie, the lowest being the worst) relative to Greater London.

H.1.19 Death rates by circulatory disease, respiratory disease, cancer, strokes and heart disease within the MSOA are in the highest quintile (ie, the highest being the worst) relative to Greater London.

H.1.20 Male and female life expectancy within the MSOA are both in the lowest quintile (ie, the lowest being the worst) relative to Greater London. Average life expectancy for both male and female residents is 74.6 to 80.3 years old.

Lifestyle and deprivation indicators

H.1.21 Vol 21 Table H.4 outlines lifestyle and income deprivation indicators by assessment area, showing that within 250m and 1km of the site, almost half of all households do not own cars (45.5% and 49.8% respectively); somewhat higher than the Greater London average (37.5%).

H.1.22 The incidence of income deprivation[vi] within 250m (72.6%) is broadly in line with the LB of Tower Hamlets (76.6%) and somewhat higher than the incidence within 1km (59.9%).

H.1.23 Similarly, overall deprivation within 250m (72.6%) is broadly in line with the LB of Tower Hamlets proportion of overall deprivation (69.6%) however it is somewhat higher than within 1km (55.6%).

H.1.24 While the incidence of deprivation within 1km of the site compares favourably with the immediate areas within 250m and with the LB of Tower Hamlets overall, the incidence of deprivation within the above assessment areas is considerably higher than income deprivation (21.5%) and overall deprivation (18.3%) across Greater London overall.

Vol 21 Table H.4 Socio-economics – lifestyle, income deprivation, by assessment area

Indicator	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Tower Hamlets)	Greater London
No car	45.5%	49.8%	56.8%	37.5%

[v] 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.

[vi] 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.

Indicator	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Tower Hamlets)	Greater London
households				
Income	72.6%	59.9%	76.6%	21.5%
Overall	72.6%	55.6%	69.6%	18.3%

H.2 Baseline economic profile

H.2.1 This section presents a profile of the economy local to the proposed construction site within the King Edward Memorial Park.

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 Tower Hamlets) and for Greater London.

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

Employment and businesses

H.2.4 Within 250m of the site there are approximately 800 jobs.[viii] Vol 21 Table H.5[ix] illustrates the breakdown of employment by sector based on the UK Standard Industrial Classification (SIC) 2007[6]. It shows data for those sectors which account for more than 7% of total employment within approximately 250m. It can be seen that:

b. Professional, Scientific and Technical Activities account for 15% of employment within 250m of the site, somewhat more than within both the LB of Tower Hamlets (12%) and Greater London (11%).

c. Accommodation and Food Service Activities account for 13% of employment within 250m, more than double that within the LB of Tower Hamlets (6%) and considerably more than within Greater London (8%).

d. Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles accounts for 12% of employment within 250m which is considerably less than within the LB of Tower Hamlets (20%) and somewhat less than within Greater London (16%).

e. Administrative and Support Service Activities account for 12% of employment within 250m of the site which is considerably more than within the LB of Tower Hamlets (7%) and Greater London (8%).

f. Information and Communication accounts for between 7% to 9% of employment at all three geographical levels.

g. Other Service Activities account for 7% of employment within 250m, more than three times that within the LB of Tower Hamlets (2%) and almost double that within Greater London (4%).

[vii] 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.

[viii] 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.

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

Vol 21 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 Tower Hamlets)**	**Greater London**
Professional, Scientific and Technical Activities	15%	12%	11%
Accommodation and Food Service Activities	13%	6%	8%
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	12%	20%	16%
Administrative and Support Service Activities	12%	7%	8%
Information and Communication	9%	9%	7%
Other Service Activities	7%	2%	4%
Other (including unclassified)	32%	44%	46%

H.2.5 Within 250m of the site there are approximately 170 businesses (defined here as business locations[x]). The split of businesses by sector within approximately 250m generally reflects the breakdown of employment by sector as set out in Vol 21 Table H.5, with a large proportion engaged in Information and Communication (12%), Professional, Scientific and Technical Activities (12%), and Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles (11%). However, Accommodation and Food Service Activities and Administrative and Support Service Activities account for 6% and 5% of businesses respectively compared to 13% and 12% of employment.

H.2.6 Vol 21 Table H.6 illustrates the size of businesses in terms of the number of employees on site. At all geographical levels the split of businesses by size band is similar, with businesses within the smallest size band (1 to 9 employees) accounting for the greatest proportion. Within approximately 250m, 88% of business units have one to nine employees which is slightly greater than within the LB of Tower Hamlets (86%) and similar to within Greater London (88%).

H.2.7 For the sectors accounting for the greatest proportion of jobs and businesses within approximately 250m the size banding of businesses varies. Within the Professional, Technical and Scientific Activities sector 77% of businesses have one to nine employees compared to an average across all sectors of 88%; whereas 80% of businesses within the Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles sector are of this size. However, within the Information and

[x] 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.

Communication sector all of the businesses employ one to nine employees.

H.2.8 Of the leading sectors, the Accommodation and Food Service Activities sector has the greatest spread of business sizes, with 60% of businesses employing one to nine employees and 20% of businesses employing ten to 24 and 25 to 49 employees respectively.

Vol 21 Table H.6 Socio-economics – businesses by size band (number of employees)

Assessment area / sector		Size band (number of employees)					
		1-9	10-24	25-49	50-99	100-249	250 +
Immediate area (250m)		88%	10%	1%	1%	0%	0%
	Information and Communication	100%	0%	0%	0%	0%	0%
	Professional, Scientific and Technical Activities	77%	23%	0%	0%	0%	0%
	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	80%	20%	0%	0%	0%	0%
-	*Accommodation and Food Service Activities*	60%	20%	20%	0%	0%	0%
Borough wide (LB of Tower Hamlets)		86%	9%	2%	1%	1%	1%
Greater London		88%	8%	2%	1%	1%	0%

H.3 Baseline - open space usage surveys

H.3.1 Please refer to Volume 2 Appendix H for details on the methodology used for the open space usage surveys and subsequent analysis.

Survey dates and times

H.3.2 Surveys were undertaken as follows.

Summer

a. Thursday 28th July 10am to 4pm (sunny, 20°C to 24°C)

b. Sunday 31st July 2011, 10am to 4pm (sunny, 24°C to 28°C)

c. Monday 5th September 2011, 8am to 4pm (largely overcast, 19°C)

d. Wednesday 14th September, 4pm to 7pm[xi] (sunny, 16 °C to 17°C)

Autumn

a. Friday 14th October 2011, 8am to 11am and 1pm to 4pm (partly sunny, 15°C)

b. Saturday 15th October 2011, 10am to 3pm (sunny, 16°C)

Survey zones

H.3.3 Vol 21 Figure H.1 (separate volume of figures) shows the location of the survey areas listed in Vol 21 Table H.7 below.

Vol 21 Table H.7 Socio-economics – survey zones and duration of survey period

Name	Location	Survey duration	Frequency
Survey zone 1	Riverside walkway (including Thames Path)	15 minutes	Hourly
Survey zone 2	All weather football pitch (multi-use games area)	Regular point in time observations	Hourly
Survey zone 3	Playground	Regular point in time observations	Hourly
Survey zone 4	Wildflower garden	10 minutes	Hourly
Survey zone 5	Main lawn area	15 minutes	Hourly
Survey zone 6	Upper terrace	10 minutes	Hourly
Survey zone 7	Tennis courts	Regular point in time observations	Hourly
Survey zone 8	Bowling green	Regular point in time observations	Hourly

[xi] A supplementary survey undertaken in lieu of poor weather conditions after 4pm on Monday 5th September

Site specific considerations

H.3.4 Summer surveys were not carried out during Ramadan (between 1st August to 29th August) due to its potential effect on usage levels.

Key findings and observations

Survey zone 1 – Riverside walkway (including Thames Path)

H.3.5 The Thames Path was moderately well used, particularly by commuters and joggers in the early mornings, lunchtimes and late afternoons. A peak of 260 users per hour was recorded during a summer weekday lunchtime survey, with a similar peak of 264 recorded on a weekend (during the autumn survey). At other times, the area appeared to be used as a recreational walking and cycling route.

H.3.6 Cyclists and joggers were predominantly White (over 80%) young adults (18 to 39 years old) with a smaller proportion of older adults (40 to 59 years old).

H.3.7 Seating along the Thames Path overlooking the River Thames was often well used.

H.3.8 See Vol 21 Table H.8 for more details on the use of the Thames Path area.

Vol 21 Table H.8 Socio-economics – usage level by type at survey zone 1

Date	Time of survey	Number of users traversing through				Estimated number of users p/hr*	Passive recreation (sitting on benches)
		Walkers	Joggers	Dog walkers	Cyclists		
Summer							
Thursday 28th July	10.45 - 11.00	14	-	1	2	68	-
	11.45 - 12.00	20	15	-	2	148	2
	13.00 - 13.15	25	35	-	5	260	12
	14.00 - 14.15	40	5	-	2	188	8
	15:00 - 15:15	33	6	2	6	188	18
	15:45 - 16:00	42	3	-	8	212	20
Sunday 31st July	10:30 - 10:45	22	19	-	10	204	4
	11:30 - 11:45	27	9		9	180	2
	12:30 - 12:45	42	14	-	5	244	8
	13:30 - 13:45	28	5	3	20	224	9
	14:30 - 14:45	33	9	2	8	208	12
	15:30 - 15:45	42	3	2	12	236	15
Monday 5th September	09:00 - 09:15	8	5	2	8	92	1
	10:00 - 10:15	2	1	-	5	32	-
	11:00 - 11:15	14	6	3	4	108	-
	12:00 - 12:15	6	11	-	1	72	2
	13:00 - 13:15	7	50	-	4	244	2
	14:00 - 14;15	12	12	-	2	104	7
	15:00 - 15:15	16	11	-	5	128	-
	16.00 - 16:15	14	6	-	10	120	4

Date	Time of survey	Number of users traversing through				Estimated number of users p/hr*	Passive recreation (sitting on benches)
		Walkers	Joggers	Dog walkers	Cyclists		
	17:00 - 17:15	8	6	-	5	76	-
	18:00 - 18;15	7	6	1	9	92	-
Wednesday 14th September	16:00 - 16:15	14 (and a group of 41)	-	1	2	29	8
	17:00 - 17:15	8	2	-	3	52	2
	18:00 - 18:15	18	2	1	5	104	1
Autumn							
Friday 14th October AM	08:35 - 08:50	22	7	2	11	168	1
	09:30 - 09:45	20	4	2	4	120	1
	10:30 - 10:45	25	3	-	6	136	2
Friday 14th October PM	16:00 - 16:15	15	7	-	1	92	4
	17:00 - 17:15	19	9	2	3	132	4
	18:00 - 18:15	30	20	-	9	236	6
Saturday 15th October	10:30 - 10:45	7	13	-	6	104	2
	11:30 - 11:45	22	28	-	3	212	4
	12:30 - 12:45	17	10	-	2	116	15
	13:30 - 13:45	39	5	-	10	216	12
	14:30 - 14:45	53	6	2	5	264	15

**Estimated proportionate level of usage*

Survey zone 2 – All weather football pitch (multi-use games area)

H.3.9 This facility was very lightly used during the survey periods, predominantly in the afternoons for semi-organised games/matches. Over 60% of the total users observed over the course of the survey were from BME backgrounds.

H.3.10 See Vol 21 Table H.9 for more details on the use of the pitch.

Vol 21 Table H.9 Socio-economics – usage level and demographic characteristics at survey zone 2

Date	Time of Survey	Number of users	Age (%)		Gender (%)		Ethnicity (%)			
			0-17	18-39	M	F	Black	E. Asian	S. Asian	White
Summer										
Thursday 28th July	10:15	-	-	-	-	-	-	-	-	-
	11:15	-	-	-	-	-	-	-	-	-
	12:15	-	-	-	-	-	-	-	-	-
	13:15	-	-	-	-	-	-	-	-	-
	14:15	10	-	100	100	-	-	-	100	0
	15:15	11	-	100	100	-	-	-	100	0
	16:00	2	50	50	100	-	-	-	0	100
Sunday 31st July	10:15	-	-	-	-	-	-	-	-	-
	11:15	1	-	100	100	-	-	-	0	100
	12:15	-	-	-	-	-	-	-	-	-

Date	Time of Survey	Number of users	Age (%)		Gender (%)		Ethnicity (%)			
			0-17	18-39	M	F	Black	E. Asian	S. Asian	White
	13:15	-	-	-	-	-	-	-	-	-
	14:15	-	-	-	-	-	-	-	-	-
	15:15		-		-	-	-	-	-	-
	16:00	16	-	-	100	-	-	-	100	-
Monday 5th September	08:45	-	-	-	-	-	-	-	-	
	09:45	1	-	100	100	-	-	-	-	100
	10:45	-	-	-	-	-	-	-	-	
	11:45	-	-	-	-	-	-	-	-	
	12:45	1	-	100	100	-	100	-	-	-
	13:45	-	-	-	-	-	-	-	-	-
	14:45	1	-	100	100	-	-	-	-	100
	15:45	-	-	-	-	-	-	-	-	-
	16:45	4	100	0	100	-	-	-	-	100
	17:45	4	-	100	100	-	-	-	-	100
	18:45	-	-	-	-	-	-	-	-	-
Wednesday 14th September	16:15	1	100	-	100	-	-	-	-	100
	17:15	-	-	-	-	-	-	-	-	-
	18:15	2	50	50	100		-	-	-	100
	18:55	4	50	50	100		-	-	-	100
Autumn										
Friday 14th October AM	08:15	-	-	-	-	-	-	-	-	-
	09:15	-	-	-	-	-	-	-	-	-
	10:15	-	-	-	-	-	-	-	-	-
Friday 14th October PM	13:45	-	-	-	-	-	-	-	-	-
	14:45	1	-	100	100	-	-	-	-	100
	15:45	4	-	100	75	25	25	-	-	75
Saturday 15th October PM	10:15	-	-	-	-	-	-	-	-	-
	11:15	-	-	-	-	-	-	-	-	-
	12:15	-	-	-	-	-	-	-	-	-
	13:15	4	-	100	100	-	-	-	-	100
	14:15	2	-	100	100	-	-	-	-	100

Survey zone 3 – Playground

H.3.11 The playground was well used throughout the survey days in the summer school holidays, with lower user numbers being recorded during the summer term time and autumn surveys. It was used by a diverse ethnic mix of young families.

H.3.12 A peak of 38 users was recorded during a weekday lunchtime survey in the school summer holidays.

H.3.13 See Vol 21 Table H.10 for more details on users of the playground.

Vol 21 Table H.10 Socio-economics – usage level and demographic characteristics at survey zone 3

Date	Time of survey	Age (%)		Gender (approximate %)		Ethnicity (approximate %)			
		Children	Adults	M	F	Black	E. Asian	S. Asian	White
Summer									
Thursday 28th July	10:15	3	1	75	25	-	-	-	100
	11:15	9	5	50	50	-	-	50	50
	12:15	26	12	50	50	25	-	25	50
	13:15	14	8	50	50	25	-	25	50
	14:15	21	15	50	50	0	-	33	67
	15:15	20	15	50	50	26	-	26	48
Sunday 31st July	10:15	6	4	40	60	-	-	-	100
	11:15	6	3	50	50	-	-	50	50
	12:15	7	9	50	50	33	-	33	33
	13:15	3	3	67	33	33	-	-	66
	14:15	3	4	50	50	-	-	50	50
	15:15	12	6	50	50	-	-	50	50
	16:00	18	8	50	50	-	-	50	50
Monday 5th September	09:00	-	-	-	-	-	-	-	-
	10:00	1	1	50	50	-	-	100	-
	11:00	4	3	14	86	-	-	-	100
	12:00	5	2	20	80	-	-	-	100
	13:00	1	1	50	50	-	-	-	100
	13:50	5	2	57	43	-	-	-	100
	14:50	6	3	44	56	-	-	22	78
	15:50	2	1	-	100	-	-	-	100
	16:50	3	2	40	60	-	-	-	100
	17:50	1	1	100	-	-	-	-	100
	18:50	-	-	-	-	-	-	-	-
Wednesday 14th September	16:15	4	4	25	75	-	25	-	75
	17:15	4	5	33	67	-	23	-	77
	18:15	6	4	40	60	-	-	-	100
	18:55	-	-	-	-	-	-	-	-
Autumn								-	
Friday 14th October AM	08:15	-	-	-	-	-	-	-	-
	09:15	-	-	-	-	-	-	-	-
	10:15	-	-	-	-	-	-	-	-
Friday 14th October PM	13:45	1	3	25	75	-	-	50	50
	14:45	4	4	25	75	-	-	70	30
	15:45	6	4	50	50	-	-	-	100
Saturday 15th October PM	10:15	1	1	-	100	-	-		100
	11:15	4	4	75	25	-	25	-	75
	12:15	4	3	57	43	-	-	-	100

Date	Time of survey	Age (%)		Gender (approximate %)		Ethnicity (approximate %)			
		Children	Adults	M	F	Black	E. Asian	S. Asian	White
	13:15	4	3	29	71	29	-	-	71
	14:15	4	4	50	50	-	-	-	100

Survey zone 4 – Wildflower garden

H.3.14 The area was lightly used during the surveys and used significantly less than the main lawn area to the west (see below). User numbers were highest during the summer surveys although no more than nine users were recorded during any survey period over the course of the programme.

H.3.15 See Vol 21 Table H.11 for more details on users of the garden.

Vol 21 Table H.11 Socio-economics – usage level by type at survey zone 4

Date	Time of survey	Number of users traversing through				
		Walkers	Joggers	Dog walkers	Cyclists	Passive recreation
Summer						
Thursday 28th July	11:00 - 11:15	-	-	-	-	3
	12:00 - 12:15	1	-	-	-	1
	13:15 - 13:30	7	-	-	-	1
	14:15 - 14:30	2	-	1	-	2
	15:15 - 15:30	-	-	-	-	-
Sunday 31st July	10:45 - 11:00	-	-	-	-	5
	11:45 - 12:00	-	-	-	-	1
	12:45 - 13:00	-	-		-	3
	13:45 - 14:00	2	-	-	-	3
	14:45 - 15:00	-	-	3	-	3
	15:45 - 16:00	1	-	-	-	8
Monday 5th September	09:15 - 09.25	1	-	1	-	-
	10:15 - 10:25	2	-	4	-	-
	11:15 - 11:25	-	-	1	-	-
	12:15 - 12:25	1	-	-	-	-
	13:15 - 13:25	-	-	1	-	3
	14:15 - 14:25	3	-	-	-	2
	15:15 - 15:25	3	-	-	-	-
	16:15 - 16:25	2	1	-	-	-
	17:15 - 17:25	1	-	-	-	-
	18:15 - 18:25	-	-	-	-	-
Wednesday 14th September	16:45 - 17:00	2	-	-	-	2
	17:45 - 18:00	5	-	2	-	-
	18:45 - 19:00	5	-	-	-	-
Autumn						
Friday 14th	08:55 - 09:10	-	-	-	-	-

Date	Time of survey	Number of users traversing through				
		Walkers	Joggers	Dog walkers	Cyclists	Passive recreation
October AM	09:45 - 10:00	-	-	-	-	-
	10:45 - 11:00	-	-	-	-	-
Friday 14th October PM	14:15 - 14:30	1	-	3	-	-
	15:15 - 15:30	2	-	-	-	-
	16:15 - 16:30	-	-	-	-	-
Saturday 15th October	10:45 - 10:55	-	2	2	-	-
	11:45 - 11:55	-	-	1	-	-
	12:45 - 12:55	3	-	-	-	-
	13:45 - 13:55	4	-	-	1	-
	14:45 - 14:55	1	-	-	-	-

Survey zone 5 – Main lawn area

H.3.16 The lawn was particularly heavily used during summer with a peak of 100 passive recreational users recorded on the warmest survey day (Sunday 31st July). People of various ethnic backgrounds and ages were observed using the area during all survey periods.

H.3.17 See Vol 21 Table H.12 for more detail on users of the main lawn.

Vol 21 Table H.12 Socio-economics – usage level by type at survey zone 5

Date	Time of survey	Number of users traversing through					
		Walkers	Joggers	Dog walkers	Cyclists	Passive recreation	Active recreation (informal)
Summer							
Thursday 28th July	10:15 - 10:30	3	-	1	-	-	1
	11:15 - 11:30	-	-	-	-	10	11
	12:15 - 12:30	-	-	2	-	17	30
	13:30 - 13:45	5	-	-	-	29	40
	14:30 - 14:45	2	-	-	-	33	16
	15:30 - 15:45	5	-	-	2	32	7
Sunday 31st July	10:00 - 10:15	1	-	-	-	7	-
	11:00 - 11:15	6	1	1	4	6	5
	12:00 - 12:15	5	1	-	1	21	3
	13:00 - 13:15	15	1	2	-	16	3
	14:00 - 14:15	-	-	-	-	36	-
	15:00 - 15:15	4	-	-	1	63	-
	16:00	-	-	-	-	100	-
Monday 5th September	08:30 - 08:45	2	4	6	3	-	4
	09:30 - 09:45	5	1	1	-	-	3
	10:30 - 10:45	7	-	2	4	-	-
	11:30 - 11:45	1	2	2	-	-	-
	12:30 - 12:45	6	7	-	-	-	1
	13:30 – 13:45	7	1	-	-	-	-
	14:30 – 14:45	10	2	-	3	-	-

Date	Time of survey	Number of users traversing through					
		Walkers	Joggers	Dog walkers	Cyclists	Passive recreation	Active recreation (informal)
	15:30 – 15:45	16	-	-	-	2	1
	16:30 – 16:45	11	-	3	5		3
	17:30 – 17:45	8	2	3	4	-	-
	18:30 – 18:45	2	-	3	3	-	-
Wednesday 14th September	16:45 - 17:00	14 and a group of 41	-	1	2	8	2
	17:45 - 18:00	8	2	-	3	2	-
	18:45 - 19:00	18	2	1	5	1	-
Autumn							
Friday 14th October AM	08:00 - 08:15	2	1	2	3	-	-
	09:00 - 09:15	5	2	3	-	-	-
	10:00 - 10:15	2	-	1	-	7	-
Friday 14th October PM	13:30 - 13;45	9	8	2	-	6	2
	14:30 - 14:45	2	-	3	-	4	-
	15:30 - 15:45	12	-	-	-	5	1
Saturday 15th October	10:00 - 10:15	4	3	1	-	2	3
	11:00 - 11:15	10	2	3	1	2	1
	12:00 - 12:15	6	2	-	1		-
	13:00 - 13:15	18	-	-	-	3	1
	14:00 - 14:15	7	-	-	1	8	-

Survey zone 6 – Upper terrace

H.3.18 During surveys, this area was rarely used (averaging less than 10 people per each entire survey day) and was significantly less used than the main lawn area to the south of it.

H.3.19 It was mostly used for recreational walking or for passive recreation, with no clear trend in the ethnicity of users being observed.

Survey zone 7 – Tennis courts

H.3.20 The two sets of two tennis courts were observed to be well utilised, with at least one court recorded to be in use during approximately 80% of the total survey observations made.

H.3.21 Over 90% of recorded users were young adults (18 to 39 years old), with several instances of use by older children (12 to 17 years old) also observed. The majority of users (over 70%) were White, though users from ethnic minority backgrounds were observed on every survey day.

H.3.22 See Vol 21 Table H.13 for more details on users of the tennis courts.

Vol 21 Table H.13 Socio-economics – usage level and demographic characteristics at survey zone 7

Date	Time of survey	Number of users	Age (%)		Gender (approximate %)		Ethnicity (approximate %)			
			Children	Adults	M	F	Black	E. Asian	S. Asian	White
Summer										
Thursday 28th July	10:00	-	-	-	-	-	-	-	-	-
	11:00	2	-	100	100	-	-	-	-	100
	12:00	2	-	100	100	-	-	-	-	100
	13:00	8	-	100	100	-	100	-	-	-
	14:00	6	50	50	100		50	-	-	50
	15:00	-	-	-	-	-	-	-	-	-
Sunday 31st July	10:15	8	-	100	100	-	-	-	-	100
	11:15	6	-	100	100	-	-	-	17	83
	12:15	4	25	75	75	25	-	-	50	50
	13:15	4	25	75	75	25	-	-	50	50
	14:15	4	-	100	100	-	-	-	-	100
	15:15	7	-	100	60	40	-	-	-	100
	16:00	8	-	100	50	50	-	-	-	100
Monday 5th September	08:45	2	-	100	100	-	-	-	-	100
	09:45	-	-	-	-	-	-	-	-	-
	10:45	2	-	100	100	-	-	-	-	100
	11:45	2	-	100	100	-	-	-	-	100
	12:45	-	-	-	-	-	-	-	-	-
	13:45	2	-	100	100	-	-	-	-	100
	14:45	2	-	100	100	-	-	-	-	100
	15:45	7	-	100	100	-	-	-	100	-
	16:45	4	-	100	75	25	-	-	-	100
	17:45	8	-	100	87	13	-	-	25	75
	18:45	-	-	-	-	-	-	-	-	-
Wednesday 14th September	16:15	2	100	-	100	-	-	-	100	-
	17:15	2	-	100	50	50		50	50	
	18:15	4	-	100	100	-	-	-	-	100
	18:55	8	-	100	100	-	-	-	-	100
Autumn										
Friday 14th October AM	08:15	-	-	-	-	-	-	-	-	-
	09:15	-	-	-	-	-	-	-	-	-
	10:15	-	-	-	-	-	-	-	-	-
Friday 14th October PM	13:45	-	-	-	-	-	-	-	-	-
	14:45	2	-	100	100	-	-	-	-	100
	15:45	4	-	100	75	25	25	-	-	75
Saturday 15th October PM	10:15	4	-	100	100	-	-	-	50	50
	11:15	4	25	75	100	-	-	-	50	50
	12:15	10	-	100	80	20	-	-	20	80
	13:15	8	-	100	75	25	-	-	-	100

Date	Time of survey	Number of users	Age (%)		Gender (approximate %)		Ethnicity (approximate %)			
			Children	Adults	M	F	Black	E. Asian	S. Asian	White
	14:15	8	-	100	100	-	-	25	-	75

Survey Point 8 – Bowling green

H.3.23 The bowling green was only used once (for light exercise and not for its intended use), during the entire survey period. It was well-kept and maintained throughout the surveys.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.21**

Volume 21: King Edward Memorial Park Foreshore appendices

Appendix I: Townscape and visual

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Appendix I: Townscape and visual

I.1 Introduction

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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Thames Tideway Tunnel
Thames Water Utilities Limited

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Appendix J: Transport

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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

K.1 Geology

K.1.1 A summary of the anticipated geological succession at the King Edward Memorial Park Foreshore (KEMP) site is shown in Vol 21 Table K.1.

Vol 21 Table K.1 Groundwater - anticipated geological succession

Period	Series	Group	Formation
Quaternary	Holocene	Superficial deposits	Made ground
			Alluvium
			Langley Silt
	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**
			Lewes Nodular Chalk
			New Pit Chalk
			Holywell Nodular 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 (BGS, 2009)[1], is shown in Vol 21 Figure 13.4.1 and Vol 21 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 the geological layers have been based on ground investigation boreholes located up to 260m from the KEMP site and on one foreshore borehole immediately adjacent to the site; these are SR1031, SR1033A. SR1033H, PR1034A, SR1034A and SR2029. The locations of boreholes around the site are shown in Vol 21 Figure 13.4.1 (see separate volume of figures). The depths and thicknesses of geological layers encountered is summarised in Vol 21 Table K.2.

Vol 21 Table K.2 Groundwater - anticipated ground conditions

Formation	Top elevation* (mATD)**	Depth below river bed (m)	Thickness (m)
River Terrace Deposits	98.0	0.0	2.5
London Clay			
A2	95.5	2.5	0.3
Lambeth Group			
UMB	95.2	2.8	3.2
LtB	92.0	6.0	1.4
Sand Unit	90.6	7.4	1.0
LtB/LSB	89.6	8.4	3.0
LMB	86.5	11.4	2.2
Upn (Gv)	84.3	13.7	1.6
UPN	82.6	15.3	5.8
Thanet Sand	76.8	21.2	11.6
Seaford Chalk	65.1	32.8	Not proven

* *Based on an assumed ground level of 105.5mATD.*

** *mATD = metres above tunnel datum.USB–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 CSO drop shaft at KEMP would extend down to approximately 45.21mATD and would pass through the River Terrace Deposits, London Clay Formation, Lambeth Group, Thanet Sand Formation and into the Seaford Chalk. The base slab would extend to approximately 40.21mATD and be founded in the Chalk.

K.1.5 The River Terrace Deposits are formed by extensive alluvial sand and gravel deposits laid down in river terraces by a braided river system of approximately 5km width, in river terraces since the Anglian glaciation. The River Terrace Deposits are expected to be 2.5m thick at the KEMP site.

K.1.6 The London Clay is described by the BGS as “fine, sandy, silty clay/silty clay, glauconitic at base”[2] and is comprised of firm to stiff sandy, silty clay at the KEMP 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. However the London Clay Formation is expected to be very thin (approximately 0.3m thick) at the KEMP site and to comprise of unit 2 only. In the eastern part of London the formation is absent, and at the site it is very near the feather edge of this stratum.

K.1.7 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 and are expected to be 3.2m thick at the KEMP site.

K.1.8 The Laminated Beds (LtB) of the Lambeth Group comprise thinly interbedded fine to medium grained sand, silt and clay with shells, with sand lenses found locally. The Lower Shelly Beds (LSB) of the Lambeth Group comprises of dark grey to black clay with abundant shells. These units in combination are expected to be 5.4m thick, including a sand horizon of 1m thickness identified in the middle of these units.

K.1.9 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 and are expected to be 2.2m thick at the KEMP site.

K.1.10 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 at the base and top. The Upnor Formation is expected to be 7.4m thick at the KEMP site.

K.1.11 The Thanet Sand Formation is described by the BGS as “marine glauconitic clayey silts and fine sands, varying in thickness” (BGS, 2012)[2] and only occurs in the London Basin (British Geological Survey, 2000)[3]. The Thanet Sand is expected to be 11.6m thick at the KEMP site.

K.1.12 The Seaford Chalk is the upper unit of the White Chalk, comprising of 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 the Seaford Chalk was not proven through the available ground investigation.

K.1.13 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 KEMP 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 also enhance or impede groundwater movement.

K.2 Hydrogeology

K.2.1 A summary of the anticipated hydrogeological conditions at the KEMP site is shown in Vol 21 Table K.3.

Vol 21 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	Sand Unit 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**	
	Lewes Nodular Chalk	
	New Pit Chalk	
	Holywell Nodular 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[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].*

**** Not a Formation but an important depositional feature*

K.2.2 The Alluvium, overlying the River Terrace Deposits or upper aquifer, was drilled dry in the ground investigation boreholes, with groundwater encountered within the River Terrace Deposits. This suggests that the Alluvium acts to confine these deposits.

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).

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 CSO drop shaft would pass through the upper aquifer and then the London Clay Formation (A2 sub division). The London Clay Formation is generally acknowledged as an aquiclude between the upper and lower aquifers. However the London Clay Formation is very thin at the KEMP site and may not act to separate these aquifers. Any groundwater present in this layer likely to consist of localised seepages and/or minor inflows.

K.2.6 The hydrograph of water levels recorded in the River Terrace Deposits (upper aquifer) and in the Thanet Sands and Seaford Chalk (lower aquifer) confirm these aquifers are not in hydraulic continuity and that the Upper Mottled Beds of the Lambeth Group acts as an aquiclude between these two aquifers.

K.2.7 The CSO drop shaft would then 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. There is no recorded groundwater strike within the sand unit associated with the Laminated Beds. The Lower Mottled Beds are anticipated to act as an aquiclude, separating the confined groundwater body in the Laminated Beds and the lower aquifer beneath.

K.2.8 The CSO drop shaft would pass through the Upnor Formation, the Thanet Sands and into the underlying Chalk. These units have been considered to be in hydraulic continuity with each other and with the underlying Seaford Chalk.

K.2.9 The ground investigation borehole logs indicate the presence of fracture zones and nodules within the Chalk at depth (for example nodules are identified at approximately 38mATD and a fracture zone fractures at approximately 37 and 38mATD in SR1033A). These features remain at approximately 2m below from the base slab.

K.2.10 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 the KEMP site is expected to have a medium transmissivity value of between $30m^2/d$ and $200m^2/d$ (average of $90m^2/d$). The storativity value is expected to be approximately 1×10^{-4} (EA and ESI, 2010)[7].

K.3 Groundwater level monitoring

K.3.2 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.3.3 Information on groundwater levels for this assessment was collected from three off site ground investigation boreholes located within 100m from the KEMP site (SR1034A, SR1033A and PR1034A). These boreholes have response zones[i] and monitor groundwater levels in the River Terrace Deposits, Thanet Sands and Seaford Chalk. The response zone depths, the monitored strata and the frequency of monitoring are detailed in Vol 21 Table K.4. The manual dip and logger data collected from these monitoring boreholes is shown in Vol 21 Table K.5.

Vol 21 Table K.4 Groundwater - monitoring boreholes

Borehole	Response zone depths mATD	Strata	Monitoring
SR1034A	101.99 - 97.99	River Terrace Deposits	Fortnightly dips
SR1033A*	76.04 - 64.04	Thanet Sand Formation	Fortnightly dips and logger data
PR1034A**	45.4 - 41.5	Seaford Chalk	Fortnightly dips and logger data
TQ37/376	-	Seaford Chalk	Sporadic dips

** SR1034A (L) records similar piezometric levels in the Thanet Sands*
*** SR1031 and SR1034H record similar piezometric levels in the Seaford Chalk*

Vol 21 Table K.5 Groundwater – summary level data

Borehole	Period of record	Maximum		Minimum		Average over the period of record	
		mbgl	mATD	mbgl	mATD	mbgl	mATD
SR1034A	28/05/2009 - 01/08/2012	3.60 (Aug. 2012)	102.89 (Aug. 2012)	4.45 (Oct. 2009)	102.04 (Oct. 2009)	4.08	102.41
SR1033A	19/10/2009 – 01/08/2012	29.91 (Nov. 2009)	76.13 (Nov. 2009)	31.04 (Jan. 2011)	75.00 (Jan. 2011)	30.67	75.37
PR1034A	19/10/2009 – 11/04/2012	29.79 (April 2011)	76.61 (April 2011)	30.88 (July 2010)	75.52 (July 2010)	30.46	75.94
TQ37/276	07/01/1994 – 15/02/2012	13.17 (May 1994)	90.17 (May 1994)	22.60 (Sept. 1996)	80.74 (Sept. 1996)	19.40	83.96

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

K.3.4 The water levels recorded in the River Terrace Deposits (SR1034A) range from 102.04mATD to 102.89mATD. These levels remain consistently above the top of the River Terrace Deposits at 98mATD, suggesting that this unit is confined by the overlying Made Ground.

K.3.5 The water levels (piezometric head[ii]) recorded in the Thanet Sands (SR1033A) (lower aquifer) range from 75.00mATD to 76.13mATD. These levels remain below the top of the Thanet Sands at 76.8mATD and show a downward trend, suggesting that water levels are being drawn down by nearby pumping.

K.3.6 The piezometric levels recorded in the Seaford Chalk (PR1034A) range from 75.52mATD to 76.61mATD. These levels remain above the top of the Chalk confirming confined conditions here. These are very similar to those measured in the Thanet Sands indicating that these units are in hydraulic continuity.

K.3.7 The nearest EA groundwater level monitoring borehole is called Rotherhithe (London Underground), station number TQ37/276) located at approximately 1km to the southwest of the KEMP site (see Vol 21 Figure 13.4.3 in separate volume of figures). The fluctuations in Chalk piezometric levels here vary annually by less than 1m (based on recent years). Some slightly larger fluctuations have occurred of up to 5m (in 1994-95), that was coincident with a major drought period which affected surface water flows in particular. The monitoring details and the average, minimum and maximum recorded levels are shown in Vol 21 Table K.4 and Vol 21 Table K.5 respectively.

K.3.8 A plot of groundwater levels within the Chalk in the vicinity of the site is shown in Vol 21 Figure 13.4.3 (see separate volume of figures). The EA have produced regional groundwater contour plots which display the groundwater flowing in to the northwest across site (EA, 2011)[8].

K.3.9 In the absence of monitoring boreholes within the upper aquifer, it is difficult to determine the direction of groundwater flow within this waterbody. However it is likely that the direction of groundwater movement is from northwest to southeast, towards the River Thames, in these shallow deposits.

K.4 Groundwater abstractions and protected rights

Groundwater licensing policy

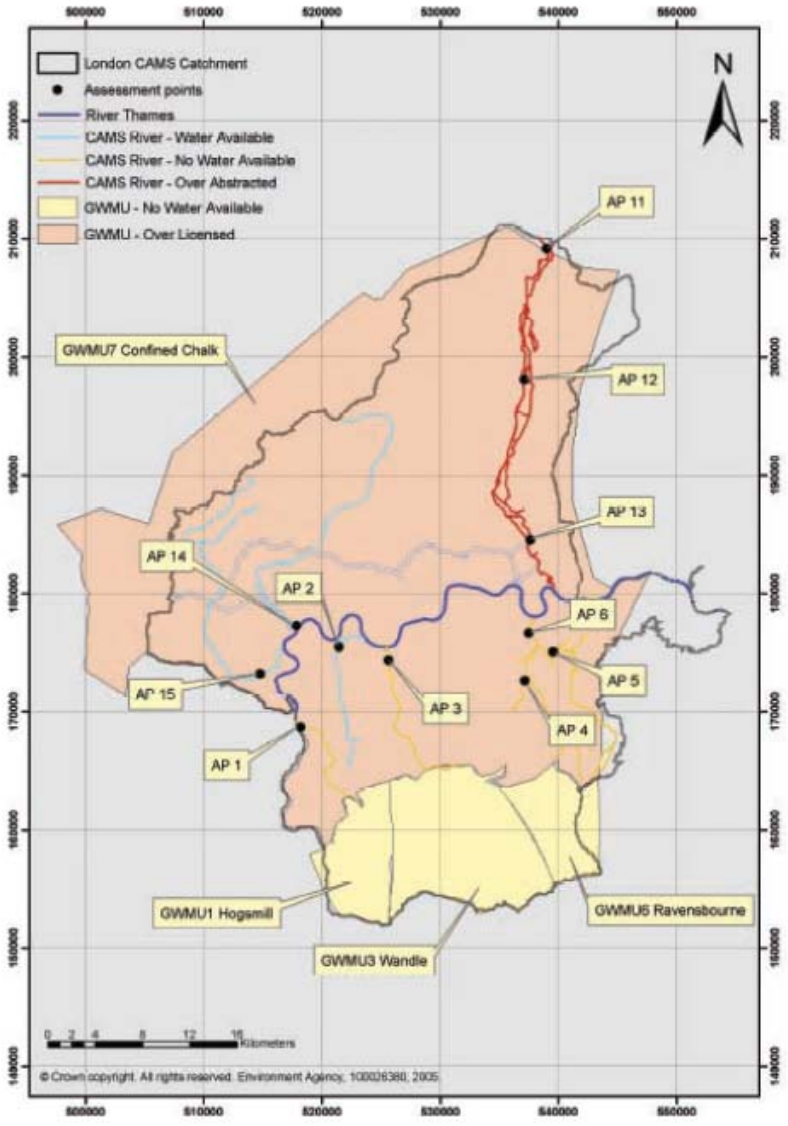
K.4.2 The London Catchment Abstraction Management Strategy (CAMS), (EA, 2006)[9] does not identify a condition status for the upper aquifer.

K.4.3 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)[10]. The KEMP site is located within the confined Chalk groundwater management unit GWM7, which is

[ii] Piezometric head – the level or pressure head to which confined groundwater would rise to in a piezometer if it is open to the atmosphere.

classified as being over-licensed (see Vol 20 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)[10].

Vol 21 Plate K.1 Groundwater - confined chalk licensing



K.4.4 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 21 Table K.6.

Vol 21 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 21 Figure 13.4.4 (see separate volume of figures) for EA observation boreholes in the vicinity of the site show the groundwater level to have been broadly stable with no downward trend since 2000.
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 water level in the lower aquifer is expected to be at about 76mATD and around 1m below the top of the Thanet Sand Formation. The dewatering activity associated with the CSO drop shaft construction could locally lower the water level further below the top of the Thanet Sand.
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. There are no licensed or known unlicensed groundwater abstractions from the Chalk located within 1km of the KEMP site.
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.4.5 The estimated dewatering volume required at Chambers Wharf from the lower aquifer of less than 200m^3/d and this is within 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 unlikely to be required by the EA.

Licensed abstractions

K.4.6 The EA licenses abstraction from groundwater within London for all sources in excess of 20m^3/d. Groundwater abstractions within 1km of the site have been identified.

K.4.7 There are no licensed abstraction sources from the upper or lower aquifers located within a radius of 1km around the King Edward Memorial Park Foreshore site. The nearest abstraction source is 28/39/42/48, located at approximately 1.1km to the south, which abstracts from the Chalk for amenity purposes.

K.4.8 There are no known unlicensed groundwater abstractions within 1km of the KEMP site.

K.5 Groundwater Source Protection Zones

K.5.2 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.5.3 The KEMP site is not located within a modelled SPZ. The nearest modelled SPZ for a Chalk source lies at approximately 3.2km to the northeast.

K.6 Environmental designations

K.6.2 There are no environmental designations relevant to groundwater such as SSSI, SAC or SNCIs, within 1km of the KEMP site.

K.7 Groundwater quality and land quality assessment

K.7.2 Historical land use mapping at the KEMP site, reviewed as part of the land quality assessment, has identified six sites located within the 250m radius with historical potentially contaminating industrial uses (Vol 21 Section 8). These are all located along the edge of the foreshore. In addition, there also two historic landfill sites approximately 250m to the west of the King Edward Memorial Park Foreshore site. These are located in Shadwell New Basin and Shadwell Old Basin. 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.7.3 The groundwater quality data presented in Vol 21 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 between 75m and 260m of the KEMP site (SR1033H, SR1033A, PR1034A and SR1031) (for locations see Vol 21 Figure 13.4.1 in separate volume of figures) and within the Made Ground, River Terrace Deposits, Upnor Formation, Thanet Sands and Chalk. Any exceedances of the UK drinking water standards (The Water Supply Regulations, 2000)[11] or relevant Environmental Quality Standards (EQS) (River Basin Districts Typology, 2010)[12] are shaded in blue in this table.

K.7.4 The data shows exceedances of the relevant standards within the Made Ground with respect to aromatic hydrocarbons and electrical conductivity at SR1033A (located 74m from the site), within the River Terrace Deposits with respect to ammonia, heavy metals, pesticides, and turbidity at SR1033A and with respect to nitrate and sulphate at SR1034A (located 105m from the site), within the Upnor Formation with respect to aromatic hydrocarbons and magnesium at PR1034A (located 94m from the site), within the Thanet Sands with respect to aromatic hydrocarbons, electrical conductivity and magnesium at SR1033A and aromatic hydrocarbons at SR1034A, and within the Chalk with respect to ammonia, electrical conductivity and magnesium at SR1033A and aromatic hydrocarbons and sulphate at SR1031 (located 260m from the site).

K.7.5 The EA monitors groundwater quality at number of points across London. The nearest EA monitoring is located at Tower Hamlets (PGWU1827). The distance of this location from the site (approximately 1.6km to the northeast) makes it difficult to extrapolate the quality observed at the EA monitoring location.

K.7.6 The land quality data from the ground investigation boreholes used in the groundwater quality assessment show exceedances of the human health screening values[13] (soil guideline values designed to be protective of human health) within the Made Ground, Alluvium and London Clay Formation with respect to heavy metals. Further detail is provided in the land quality assessment (see Vol 21 Appendix F).

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Vol 21 Table K.7 Groundwater – groundwater quality results

Source of data*				SI	TT	TT	TT	TT	TT	SI	SI	TT	TT	TT	TT	TT	SI	SI	SI	SI	SI	SI	SI	SI
Name				SR1033H	SR1033H	SR1033H	SR1033H	SR1033H	SR1033H	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	PR1034A	PR1034A	SR1034A	SR1034A	SR1031	SR1029	SA1038	SA1029A
Hydrogeological unit**				SCK	CK	CK	CK	CK	CK	MG	TSF	RTD	RTD	RTD	RTD	RTD	SCK	UF	RTD	TSF	SCK	CK	TSF	RTD
Distance from site	EQS Criteria			74m	74m	74m	74m	74m	74m	93m	93m	93m	93m	93m	93m	93m	94m	94m	105m	105m	258m	641m	645m	650m
Chemical	Value	Units	Source	2009	15/8/11	1/11/11	10/1/12	17/4/12	15/5/12	2009	2009	15/8/11	1/11/11	10/1/12	17/4/12	15/5/12	2009	2009	2009	2009	2009	2009	2009	2009
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	-	-	-	-	-	-	-	-
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	-	-	-	-	-	-	-	-
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	-	-	-	-	-	-	-	-
1,2,4 - Trimethylbenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1.7	-	-
1,3,5 - Trimethylbenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1.8	-	-
2,3 - Dimethylphenol {2,3-Xylenol}	-	ug/l	None	-	-	-	-	<0.0500	-	-	-	-	-	-	<0.0500	-	-	-	-	-	-	-	-	-
2,3,5,6 - Tetrachloroaminobenzene {2,...Aniline}	-	ug/l	None	-	-	-	-	0.00700	-	-	-	-	-	-	<0.00500	-	-	-	-	-	-	-	-	-
2,4 - Dichlorophenol	20	ug/l	WFD 2010	<0.1	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.4	-
2,4 - Dimethylphenol {2,4-Xylenol}	-	ug/l	None	<0.1	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.4	-
2,4,6 - Trichlorophenol	-	ug/l	None	<0.1	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.4	-
2,6 - Dichlorophenol	-	ug/l	None	<0.1	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.4	-
2,6 - Dimethylphenol {2,6 Xylenol}	-	ug/l	None	-	-	-	-	<0.0500	-	-	-	-	-	-	<0.0500	-	-	-	-	-	-	-	-	-
3,4 - Dimethylphenol {3,4 Xylenol}	-	ug/l	None	-	-	-	-	<0.0500	-	-	-	-	-	-	<0.0500	-	-	-	-	-	-	-	-	-
4 - Chloro - 3- Methylphenol {P-Chloro-M-Cresol}	40	ug/l	WFD 2010	<0.1	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.4	-
4-Methylphenol {para-Cresol}	-	ug/l	None	-	-	-	-	<0.0500	-	-	-	-	-	-	<0.0500	-	-	-	-	-	-	-	-	-
Acenaphthene	-	ug/l	None	<0.01	-	-	-	-	-	1000	67	-	-	-	-	-	<0.01	10000	<0.01	55	39	<0.015	<0.01	-
Acenaphthylene	-	ug/l	None	<0.01	-	-	-	-	-	<0.01	<0.01	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.011	<0.01	-
Acenapthene	-	ug/l	None	-	-	-	-	<0.01	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-
Acenapthylene	-	ug/l	None	-	-	-	-	<0.01	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-
Aliphatics >C10-C12	-	ug/l	None	2	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	2	<0.1	1	<0.1	<0.1	<10	1	<10
Aliphatics >C12-C16 (Aqueous)	-	ug/l	None	31	-	-	-	-	-	56	3	-	-	-	-	-	3	2	4	1	<1	<10	2	<10
Aliphatics >C16-C21 (Aqueous)	-	ug/l	None	12	-	-	-	-	-	860	7	-	-	-	-	-	4	25	5	7	2	<10	5	<10
Aliphatics >C21-C35 (Aqueous)	-	ug/l	None	31	-	-	-	-	-	13	6	-	-	-	-	-	6	280	12	6	4	<10	3	<10
Aliphatics >C6-C8	-	ug/l	None	<0.1	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<10	<0.1	<10
Aliphatics >C8-C10	-	ug/l	None	<0.1	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<10	<0.1	<10
Aliphatics C5-C6	-	ug/l	None	<0.1	-	-	-	-	-	7.2	6.9	-	-	-	-	-	<0.1	<0.1	<0.1	7.5	7.3	<10	<0.1	<10
Alkalinity (Carbonate)	-	mg/l as CaCO3	None	-	<4	<4	-	-	-	-	-	-	<4	-	-	-	-	-	-	-	-	-	-	-
Alkalinity Ph 4.5 - As CaCO3	-	mg/l as CaCO3	None	280	290	292	291	-	288	610	370	731	714	733	-	-	260	350	340	250	210	-	210	-
Aluminium Dissolved	200	ug/l as Al	DWS 2010	-	-	-	-	0.21	-	-	-	-	-	-	0.028	-	-	-	-	-	-	-	-	-
Aluminium Total	200	ug/l as Al	DWS 2010	-	26	36	0.033	-	0.11	-	-	14000	59	0.034	-	0.066	-	-	-	-	-	-	-	-
Ammonia - As N	0.39	mg/l as N	WS Regs 20	-	1.15	1.06	1.04	-	1.13	-	-	1.18	1.12	1.7	-	0.67	-	-	-	-	-	-	-	-
Ammoniacal nitrogen	-	mg/l	None	1.5	-	-	-	-	-	3.1	1.3	-	-	-	-	-	0.8	0.99	0.03	2.5	0.15	0.224	0.81	7.58
Anthracene	0.1	ug/l	SW WFD	<0.01	-	-	-	<0.01	-	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	0.0248	<0.01	-
Antimony Total	5	ug/l	DWS 2010	-	-	-	-	0.6	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-
Aromatics >C7-C8	50	ug/l	WFD 2010	<0.1	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<10	<0.1	<10
Aromatics >EC10-EC12	-	ug/l	None	5	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	2	<0.1	4	<0.1	<0.1	<10	6	<10
Aromatics >EC12-EC16 (Aqueous)	-	ug/l	None	8	-	-	-	-	-	8	3	-	-	-	-	-	3	3	5	2	2	<10	6	<10
Aromatics >EC16-EC21 (Aqueous)	-	ug/l	None	10	-	-	-	-	-	71	8	-	-	-	-	-	6	14	8	4	3	<10	9	<10

Source of data*				SI	TT	TT	TT	TT	TT	SI	SI	TT	TT	TT	TT	TT	SI	SI	SI	SI	SI	SI	SI	SI
Name				SR1033H	SR1033H	SR1033H	SR1033H	SR1033H	SR1033H	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	PR1034A	PR1034A	SR1034A	SR1034A	SR1031	SR1029	SA1038	SA1029A
Hydrogeological unit**				SCK	CK	CK	CK	CK	CK	MG	TSF	RTD	RTD	RTD	RTD	RTD	SCK	UF	RTD	TSF	SCK	CK	TSF	RTD
Distance from site	EQS Criteria			74m	74m	74m	74m	74m	74m	93m	93m	93m	93m	93m	93m	93m	94m	94m	105m	105m	258m	641m	645m	650m
Chemical	Value	Units	Source	2009	15/8/11	1/11/11	10/1/12	17/4/12	15/5/12	2009	2009	15/8/11	1/11/11	10/1/12	17/4/12	15/5/12	2009	2009	2009	2009	2009	2009	2009	2009
Aromatics >EC21-EC35 (Aqueous)	-	ug/l	None	20	-	-	-	-	-	11	13	-	-	-	-	-	15	140	20	8	6	<10	16	<10
Aromatics >EC8-EC10	-	ug/l	None	<0.1	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<10	<0.1	<10
Aromatics C6-C7	1	ug/l	DWS 2010	<0.1	-	-	-	-	-	6	11	-	-	-	-	-	<0.1	7700	<0.1	10	8	<10	<0.1	<10
Arsenic Total	10	ug/l as As	DWS 2010	<1	2.3	1.1	1.7	-	1.2	4	<1	29.8	15.6	17.2	-	6.4	<1	<1	3	<1	<1	1.57	<1	0.907
Atrazine { }	0.1	ug/l	DWS 2010	-	<0.00300	<0.04000	<0.00300	-	<0.00800	-	-	<0.00300	<0.04000	<0.04000	-	<0.00800	-	-	-	-	-	-	-	-
Barium Dissolved	100	ug/l as Ba	SW Regs 96	-	-	-	-	110	-	-	-	-	-	-	120	-	-	-	-	-	-	-	-	-
Barium Total	100	ug/l as Ba	SW Regs 96	-	-	-	-	110	-	-	-	-	-	-	120	-	-	-	-	-	-	-	-	-
Bentazone	0.1	ug/l	DWS 2010	-	<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	-	-	-	-	-	-	-	-	-
Benzene	1	ug/l	DWS 2010	<1	<0.07	<0.07	<0.07	<0.07	< 0.07	<0.2	<0.2	<0.07	0.15	<0.07	<0.07	< 0.07	<1	<0.2	<1	<0.2	<0.2	<10	<1	<10
Benzene (Ethylbenzene)	20	ug/l	FW List II	-	-	-	-	0.19	-	-	-	-	-	-	0.11	-	-	-	-	-	-	-	-	-
Benzo (a) anthracene	-	ug/l	None	<0.01	-	-	-	-	-	<0.01	<0.01	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.009	<0.01	-
Benzo[a]Pyrene	0.01	ug/l	DWS 2010	<0.01	<0.00500	<0.00500	0.00530	<0.01	<0.00500	<0.01	<0.01	<0.00500	<0.00500	<0.00500	<0.01	<0.00500	<0.01	<0.01	<0.01	<0.01	<0.01	0.0112	<0.01	0.178
Benzo[b]Fluoranthene	0.03	ug/l	WFD D 10	<0.01	-	-	-	<0.01	-	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.023	<0.01	-
Benzo[g,h,i]Perylene	0.002	ug/l	WFD D 10	<0.01	-	-	-	<0.01	-	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.016	<0.01	0.12
Benzo[k]Fluoranthene	0.03	ug/l	WFD D 10	<0.01	-	-	-	<0.01	-	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.027	<0.01	-
Bifenthrin	-	ug/l	None	-	-	-	-	<0.00500	-	-	-	-	-	-	<0.00500	-	-	-	-	-	-	-	-	-
Boron Dissolved	1000	ug/l as B	DWS 2010	-	-	-	-	280	-	-	-	-	-	-	390	-	-	-	-	-	-	-	-	-
Boron Total	1000	ug/l as B	DWS 2010	320	290	270	300	-	0.28	420	350	470	450	430	-	0.42	280	370	330	540	310	70.3	430	377
Bromate	10	ug/l as BrO3	DWS 2010	-	<0.5	<0.5	<0.5	-	< 1.0	-	-	<0.5	<0.5	<0.5	-	< 1.0	-	-	-	-	-	-	-	-
Cadmium Total	5	ug/l as Cd	DWS 2010	<2	<1.5	<1.5	<1.5	<1.5	< 1.5	<2	<2	2.2	<1.5	<1.5	<1.5	< 1.5	<2	<2	<2	<2	<2	<0.22	<2	<0.22
Calcium Total	250	mg/l as Ca	DWS 2010	-	110	150	150	-	140	-	-	570	430	470	-	440	-	-	-	-	-	-	-	-
Carbendazim / Benomyl	0.1	ug/l	FW List II	-	<0.00300	<0.00300	<0.00300	-	<0.00500	-	-	<0.00300	<0.00300	-	-	<0.00500	-	-	-	-	-	-	-	-
Carbetamide	-	ug/l	None	-	<0.00600	<0.00600	<0.00600	-	<0.01000	-	-	<0.00600	<0.00600	-	-	<0.01000	-	-	-	-	-	-	-	-
Carbon Dioxide	-	ug/l	None	-	-	-	-	41000	-	-	-	-	-	-	63800	-	-	-	-	-	-	-	-	-
Carbon Organic Dissolved	-	mg/l as C	None	-	-	-	-	0.3	-	-	-	-	-	-	1.3	-	-	-	-	-	-	-	-	-
Carbon tetrachloride	3	ug/l	DWS 2010	-	<0.07	<0.07	<0.07	-	< 0.070	-	-	<0.07	<0.07	<0.07	-	< 0.070	-	-	-	-	-	-	-	-
Chlorfenvinphos	0.1	ug/l	DWS 2010	-	<0.00900	<0.00900	<0.00900	-	<0.00900	-	-	<0.00900	<0.00900	<0.00900	-	<0.00900	-	-	-	-	-	-	-	-
Chloride	250	mg/l as Cl	DWS 2010	650	725	746	702	-	734	830	1200	1110	1200	1310	-	1250	400	290	110	280	100	-	790	-
Chloroform	100	ug/l	WS Regs 20	-	<0.6	<0.6	<0.6	-	< 0.600	-	-	<0.6	<0.6	<0.6	-	< 0.600	-	-	-	-	-	-	-	-
Chlortoluron	2	ug/l	FW List II	-	<0.00400	<0.00400	<0.00400	-	<0.01000	-	-	<0.00400	<0.00400	<0.20000	-	<0.01000	-	-	-	-	-	-	-	-
Chromium Dissolved	50	ug/l as Cr	DWS 2010	-	-	-	-	19	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-
Chromium Total	50	ug/l as Cr	DWS 2010	<5	16	15	12	-	15	<5	<5	62	20	18	-	19	<5	<5	<5	<5	<5	6.8	<5	24.6
Chrysene	-	ug/l	None	<0.01	-	-	-	<0.01	-	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.013	<0.01	-
Clopyralid	-	ug/l	None	-	<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	2400	-	-	-	-	-	3690	4350	-	-	-	-	-	1640	1770	1560	1390	1410	866	2590	-
Copper Total	2000	ug/l as Cu	DWS 2010	<2	<5.5	<5.5	<5.5	-	< 5.5	<2	<2	52	<5.5	<5.5	-	< 5.5	<2	6	2	<2	<2	12.7	2	7.2
Coumaphos	0.1	ug/l	DWS 2010	-	-	-	-	<0.00500	-	-	-	-	-	-	<0.00500	-	-	-	-	-	-	-	-	-

Source of data*				SI	TT	TT	TT	TT	TT	SI	SI	TT	TT	TT	TT	TT	SI	SI	SI	SI	SI	SI	SI	SI
Name				SR1033H	SR1033H	SR1033H	SR1033H	SR1033H	SR1033H	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	PR1034A	PR1034A	SR1034A	SR1034A	SR1031	SR1029	SA1038	SA1029A
Hydrogeological unit**				SCK	CK	CK	CK	CK	CK	MG	TSF	RTD	RTD	RTD	RTD	RTD	SCK	UF	RTD	TSF	SCK	CK	TSF	RTD
Distance from site	EQS Criteria			74m	74m	74m	74m	74m	74m	93m	93m	93m	93m	93m	93m	93m	94m	94m	105m	105m	258m	641m	645m	650m
Chemical	Value	Units	Source	2009	15/8/11	1/11/11	10/1/12	17/4/12	15/5/12	2009	2009	15/8/11	1/11/11	10/1/12	17/4/12	15/5/12	2009	2009	2009	2009	2009	2009	2009	2009
Cresols	-	ug/l	None	<0.1	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.4	-
Cyanazine	0.1	ug/l	DWS 2010	-	<0.00700	<0.00700	<0.00700	-	<0.00800	-	-	<0.00700	<0.00700	<0.06000	-	<0.00800	-	-	-	-	-	-	-	-
Cyanide (Free)	50	ug/l as CN	DWS 2010	<20	-	-	-	-	-	<20	<20	-	-	-	-	-	<20	<20	<20	<20	<20	<50	<20	<50
Cyanide (Total)	50	ug/l as CN	DWS 2010	<40	-	-	-	-	-	<40	<40	-	-	-	-	-	<40	<40	<40	<40	<40	-	<40	-
Cypermethrin	0.0001	ug/l	WFD 2010	-	<0.1	<0.1	<0.1	-	< 0.100	-	-	<0.1	0.2	<0.1	-	< 0.100	-	-	-	-	-	-	-	-
Cypermethrin ID	-	Code	None	-	-	-	-	5.3	-	-	-	-	-	-	<5	-	-	-	-	-	-	-	-	-
Dalapon	-	ug/l	None	-	<0.05000	<0.05000	<0.05000	-	<0.05000	-	-	<0.05000	<0.05000	<0.05000	-	<0.05000	-	-	-	-	-	-	-	-
Diazinon	0.1	ug/l	DWS 2010	-	<0.00900	<0.00900	<0.00900	-	<0.00900	-	-	<0.00900	<0.00900	<0.00900	-	<0.00900	-	-	-	-	-	-	-	-
Dibenz-[A,H]-Anthracene	-	ug/l	None	<0.01	-	-	-	<0.01	-	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.016	<0.01	-
Dichloromethane	20	ug/l	WFD 2010	-	<3	<3	<3	-	< 3.0	-	-	<3	<3	<3	-	< 3.0	-	-	-	-	-	-	-	-
Dichlorprop	0.1	ug/l	DWS 2010	-	<0.01100	<0.01100	<0.01100	-	<0.01100	-	-	<0.01100	<0.01100	<0.01100	-	<0.01100	-	-	-	-	-	-	-	-
Diuron	0.1	ug/l	DWS 2010	-	<0.00500	<0.05000	<0.00500	-	<0.01000	-	-	<0.00500	<0.05000	<0.05000	-	<0.01000	-	-	-	-	-	-	-	-
Enterococci (Species)	-	Nr/100 ml	None	-	-	-	-	5	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-
Escherichia coli (Confirmed)	0	Nr/100 ml	WS Regs 20	-	-	-	-	1	-	-	-	-	-	-	43	-	-	-	-	-	-	-	-	-
Ethofumesate	-	ug/l	None	-	-	-	-	<0.01	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	ug/l	None	<1	-	-	-	-	-	<1	<1	-	-	-	-	-	<1	<1	<1	<1	<1	<10	<1	<10
Fenuron	-	ug/l	None	-	-	-	-	<0.01	-	-	-	-	-	-	<0.01	-	-	-	-	-	-	-	-	-
Fluoranthene	0.2	ug/l	EEC MAC	<0.01	-	-	-	<0.01	-	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	0.0145	<0.01	-
Fluorene	-	ug/l	None	<0.01	-	-	-	<0.01	-	<0.01	<0.01	-	-	-	<0.01	-	<0.01	0.02	0.02	<0.01	<0.01	<0.014	<0.01	-
Fluoride	1.5	mg/l as F	DWS 2010	-	0.78	0.69	0.66	-	0.759	-	-	0.15	0.15	0.16	-	0.111	-	-	-	-	-	-	-	-
Glyphosate	-	ug/l	None	-	<0.01400	<0.01400	<0.01400	-	<0.01400	-	-	<0.01400	<0.01400	<0.01400	-	<0.01400	-	-	-	-	-	-	-	-
GRO C4-C12	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	-	<10
Hardness Total - As CaCO3	-	mg/l as CaCO3	None	-	-	-	-	700	-	-	-	-	-	-	1400	-	-	-	-	-	-	-	-	-
Indeno-[1,2,3-Cd]-Pyrene	0.002	ug/l	WFD D 10	<0.01	-	-	-	<0.01	-	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.014	<0.01	-
Iodide Ion	-	ug/l as I	None	-	-	-	-	61	-	-	-	-	-	-	26	-	-	-	-	-	-	-	-	-
Irgarol 1051	-	ug/l	None	-	-	-	-	<0.00500	-	-	-	-	-	-	<0.00500	-	-	-	-	-	-	-	-	-
Iron Dissolved	200	ug/l as Fe	DWS 2010	-	-	-	-	3.9	-	-	-	-	-	-	4.4	-	-	-	-	-	-	-	-	-
Iron Total	200	ug/l as Fe	DWS 2010	-	-	-	-	4	-	-	-	-	-	-	4.2	-	-	-	-	-	-	-	-	-
Isoproturon (Diip1,3Dithiolan-2-Ylidenemalonate)	0.1	ug/l	DWS 2010	-	<0.00300	<0.05000	<0.00300	-	<0.00800	-	-	<0.00300	<0.05000	<0.05000	-	<0.00800	-	-	-	-	-	-	-	-
Lambda Cyhalothrin	-	ug/l	None	-	-	-	-	<5.00	-	-	-	-	-	-	<5.00	-	-	-	-	-	-	-	-	-
Lead Total	10	ug/l	WS Regs 20	<4	<5	<5	<5	-	< 5	<4	<4	42	<5	<5	-	< 5	<4	<4	<4	<4	<4	4.01	<4	0.77
Lithium Dissolved	-	ug/l as Li	None	-	-	-	-	0.014	-	-	-	-	-	-	0.042	-	-	-	-	-	-	-	-	-
Lithium Total	-	ug/l as Li	None	-	-	-	-	0.014	-	-	-	-	-	-	0.044	-	-	-	-	-	-	-	-	-
Magnesium Dissolved	50	mg/l as Mg	EEC MAC	-	-	-	-	77	-	-	-	-	-	-	51	-	-	-	-	-	-	-	-	-
Magnesium Total	50	mg/l as Mg	EEC MAC	19	61	81	77	-	76	50	130	55	46	52	-	48	18	65	46	32	48	-	84	-
Manganese Dissolved	50	ug/l as Mn	DWS 2010	-	-	-	-	0.29	-	-	-	-	-	-	2.3	-	-	-	-	-	-	-	-	-
Manganese Total	50	ug/l as Mn	DWS 2010	-	-	-	-	0.29	-	-	-	-	-	-	2.3	-	-	-	-	-	-	-	-	-
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	-	-	-	-	-	-	-	-

Source of data*				SI	TT	TT	TT	TT	TT	SI	SI	TT	TT	TT	TT	TT	SI	SI	SI	SI	SI	SI	SI	SI
Name				SR1033H	SR1033H	SR1033H	SR1033H	SR1033H	SR1033H	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	PR1034A	PR1034A	SR1034A	SR1034A	SR1031	SR1029	SA1038	SA1029A
Hydrogeological unit**				SCK	CK	CK	CK	CK	CK	MG	TSF	RTD	RTD	RTD	RTD	RTD	SCK	UF	RTD	TSF	SCK	CK	TSF	RTD
Distance from site	EQS Criteria			74m	74m	74m	74m	74m	74m	93m	93m	93m	93m	93m	93m	93m	94m	94m	105m	105m	258m	641m	645m	650m
Chemical	Value	Units	Source	2009	15/8/11	1/11/11	10/1/12	17/4/12	15/5/12	2009	2009	15/8/11	1/11/11	10/1/12	17/4/12	15/5/12	2009	2009	2009	2009	2009	2009	2009	2009
Mecoprop {}	0.1	ug/l	DWS 2010	-	<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	<0.05	0.008	0.004	0.01	-	0.009	<0.05	<0.05	0.017	0.006	0.017	-	0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.01	<0.05	<0.01
Metazachlor	-	ug/l	None	-	-	<0	<0	-	< 0	-	-	<0	<0	<0	-	< 0	-	-	-	-	-	-	-	-
Methane	-	ug/l	None	-	-	-	-	<10.0	-	-	-	-	-	-	<10.0	-	-	-	-	-	-	-	-	-
Molybdenum Total	0	ug/l	GW Regs 98	-	-	-	-	<5	-	-	-	-	-	-	<5	-	-	-	-	-	-	-	-	-
MTBE {Methyl Tert-Butyl Ether}	-	ug/l	None	<1	-	-	-	-	-	<1	<1	-	-	-	-	-	<1	<1	<1	<1	<1	<10	<1	<10
Multi Residual Scan	-	ug/l	None	-	-	-	-	-	<0.10000	-	-	-	-	-	-	<0.10000	-	-	-	-	-	-	-	-
Naphthalene	1.2	ug/l	WFD D 10	<0.01	-	-	-	0.11	-	<0.01	<0.01	-	-	-	0.12	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.01	-
Nickel Total	20	ug/l as Ni	DWS 2010	<10	<4	<4	<4	-	< 4	18	<10	53	<4	<4	-	9	<10	<10	<10	<10	<10	3.77	12	15.4
Nitrate - N	11.3	mg/l as N	WS Regs 20	<0.1	<0.043	<0.043	<0.043	-	< 0.068	<0.1	<0.1	<0.043	<0.043	<0.043	-	0.904	<0.1	2.4	31	<0.1	<0.1	6.63	<0.1	3.77
Nitrogen Total Oxidised	11.3	mg/l as N	WS Regs 20	-	-	-	-	<0.081	-	-	-	-	-	-	<0.081	-	-	-	-	-	-	-	-	-
Orthophosphate	-	mg/l as P	None	-	-	-	-	<0.18	-	-	-	-	-	-	1.32	-	-	-	-	-	-	-	-	-
Oxamyl	-	ug/l	None	-	-	-	-	<0.00500	-	-	-	-	-	-	0.00520	-	-	-	-	-	-	-	-	-
o-Xylene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	-	<10
PAH 16 Total	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	1.53
PAHs Total	0.1	ug/l	DWS 2010	-	-	-	-	0.11	-	-	-	-	-	-	0.12	-	-	-	-	-	-	-	-	-
Permethrin (Cis + Trans)	0.01	ug/l	WFD D 10	-	-	<0.10000	<0.10000	-	-	-	-	-	<0.10000	<0.10000	-	-	-	-	-	-	-	-	-	-
pH	10	pH units	DWS 2010	7.1	-	-	-	-	-	7.2	6.9	-	-	-	-	-	7.3	7.1	6.8	7.5	7.3	8.41	7.6	7.92
Phenanthrene	-	ug/l	None	<0.01	-	-	-	<0.01	-	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.022	0.02	-
Phenol	0.5	ug/l	EEC MAC	<0.1	-	-	-	-	-	<1	<1	-	-	-	-	-	<0.1	<1	<0.1	<1	<1	<2.0	<0.4	<2.0
Phenol (Pentachlorophenol (PCP))	-	ug/l	None	-	<0.00900	0.01600	<0.00900	-	<0.00900	-	-	<0.00900	<0.00900	<0.00900	-	<0.00900	-	-	-	-	-	-	-	-
Phenols Total For SWAD (7 Compounds)	-	ug/l	None	-	<80.0	<8.0	26.0	-	<8.0	-	-	<80.0	21.0	19.0	-	<8.0	-	-	-	-	-	-	-	-
Polynuclear Aromatic Hydrocarbons (Total)	0.1	ug/l	DWS 2010	<0.2	-	-	-	-	-	0.09	0.03	-	-	-	-	-	<0.2	<0.01	<0.2	<0.01	<0.01	-	<0.2	-
Potassium Dissolved	-	mg/l as K	None	-	-	-	-	20	-	-	-	-	-	-	100	-	-	-	-	-	-	-	-	-
Potassium Total	-	mg/l as K	None	-	21	20	18	-	19	-	-	89	92	100	-	100	-	-	-	-	-	-	-	-
Propazine	0.1	ug/l	DWS 2010	-	<0.00400	<0.00400	<0.00400	-	<0.00500	-	-	<0.00400	<0.00400	<0.04000	-	<0.00500	-	-	-	-	-	-	-	-
Propetamphos	0.1	ug/l	DWS 2010	-	<0.00500	<0.00500	<0.00500	-	<0.00500	-	-	<0.00500	<0.00500	<0.00500	-	<0.00500	-	-	-	-	-	-	-	-
Pyrene	-	ug/l	None	<0.01	-	-	-	<0.01	-	0.04	<0.01	-	-	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	0.01	<0.015	<0.01	-
Selenium	10	ug/l as Se	DWS 2010	<3	-	-	-	<0.4	-	<3	<3	-	-	-	<0.4	-	<3	<3	<3	<3	<3	<1	<3	6.42
Silicate Reactive Dissolved - As SiO2	-	mg/l	None	-	-	-	-	15	-	-	-	-	-	-	31	-	-	-	-	-	-	-	-	-
Simazine	0.1	ug/l	DWS 2010	-	<0.00900	<0.04000	<0.00900	-	<0.00400	-	-	<0.00900	<0.04000	<0.04000	-	<0.00400	-	-	-	-	-	-	-	-
Sisumxylene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	-	<10
Sodium Total	200	mg/l as Na	DWS 2010	240	300	320	310	-	310	360	390	430	460	520	-	490	180	140	51	180	87	-	250	-
Strontium Dissolved	-	ug/l as Sr	None	-	-	-	-	7.3	-	-	-	-	-	-	1.4	-	-	-	-	-	-	-	-	-
Strontium Total	-	ug/l as Sr	None	-	-	-	-	7.4	-	-	-	-	-	-	1.5	-	-	-	-	-	-	-	-	-
Sulphate	250	mg/l as SO4	DWS 2010	84	95.5	93.6	96.3	-	93.6	170	87	119	137	141	-	164	74	200	420	85	450	108	160	525
Sulphide	-	ug/l	None	<10	-	-	-	<29.0	-	<10	<10	-	-	-	<29.0	-	<10	<10	<10	<10	<10	-	<10	-
Sum of BTEX	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	-	<10

Source of data*				SI	TT	TT	TT	TT	TT	SI	SI	TT	TT	TT	TT	TT	SI	SI	SI	SI	SI	SI	SI	SI
Name				SR1033H	SR1033H	SR1033H	SR1033H	SR1033H	SR1033H	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	SR1033A	PR1034A	PR1034A	SR1034A	SR1034A	SR1031	SR1029	SA1038	SA1029A
Hydrogeological unit**				SCK	CK	CK	CK	CK	CK	MG	TSF	RTD	RTD	RTD	RTD	RTD	SCK	UF	RTD	TSF	SCK	CK	TSF	RTD
Distance from site	EQS Criteria			74m	74m	74m	74m	74m	74m	93m	93m	93m	93m	93m	93m	93m	94m	94m	105m	105m	258m	641m	645m	650m
Chemical	Value	Units	Source	2009	15/8/11	1/11/11	10/1/12	17/4/12	15/5/12	2009	2009	15/8/11	1/11/11	10/1/12	17/4/12	15/5/12	2009	2009	2009	2009	2009	2009	2009	2009
Terbutryn	0.1	ug/l	DWS 2010	-	<0.00300	<0.00300	<0.00300	-	<0.00500	-	-	<0.00300	<0.00300	<0.04000	-	<0.00500	-	-	-	-	-	-	-	-
Tetrachloroethylene	-	ug/l	None	-	<0.09	<0.09	<0.09	-	< 0.09	-	-	<0.09	<0.09	<0.09	-	< 0.09	-	-	-	-	-	-	-	-
Tetrachlorothioanisole	-	ug/l	None	-	-	-	-	<0.00500	-	-	-	-	-	-	<0.00500	-	-	-	-	-	-	-	-	-
Tin Total	0	ug/l as Sn	GW Regs 98	-	-	-	-	6	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-
Titanium	0	ug/l as Ti	GW Regs 98	-	-	-	-	0.055	-	-	-	-	-	-	0.16	-	-	-	-	-	-	-	-	-
Toluene (Methylbenzene)	50	ug/l	WFD 2010	<1	-	-	-	<0.55	-	<1	<1	-	-	-	<0.55	-	<1	<1	<1	<1	<1	<10	<1	<10
Total Aliphatic TPH	-	ug/l	None	75	-	-	-	-	-	13	16	-	-	-	-	-	14	2200	22	16	14	-	11	-
Total Aliphatics & Aromatics >C12-C44 (Aqueous)	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	-	<10
Total Aliphatics >C12-C35 (Aqueous)	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	-	<10
Total Aliphatics C5-C12	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	-	<10
Total Aromatic TPH	-	ug/l	None	43	-	-	-	-	-	940	27	-	-	-	-	-	27	8000	37	24	15	-	36	-
Total Aromatics >EC12-EC35 (Aqueous)	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	-	<10
Total Aromatics C6-C12	1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	-	<10
Total Chemical Oxygen Demand	-	mg/l	None	<10	-	-	-	-	-	110	14	-	-	-	-	-	<10	12	<10	14	<10	-	38	-
Total Monohydric Phenols (W)	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<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	-	-	-	-	-	-	-	-
Trietazine	-	ug/l	None	-	<0.00600	<0.00600	<0.00600	-	<0.00800	-	-	<0.00600	<0.00600	<0.02000	-	<0.00800	-	-	-	-	-	-	-	-
Trifluralin	0.1	ug/l	DWS 2010	-	<0.01000	<0.01000	<0.01000	-	<0.01000	-	-	<0.01000	<0.01000	<0.01000	-	<0.01000	-	-	-	-	-	-	-	-
Turbidity	1	FTU	WS Regs 20	-	36.6	16.6	16.4	-	15.4	-	-	344	41	41.8	-	15.3	-	-	-	-	-	-	-	-
Uranium	0	ug/l as U	GW Regs 98	-	-	-	-	0.3	-	-	-	-	-	-	0.9	-	-	-	-	-	-	-	-	-
Xylene (Meta & Para){1,3+1,4-Dimethylbenzene}	30	ug/l	WFD 2010	<1	0.1	<0.09	0.17	0.67	< 0.09	<1	<1	<0.09	1.82	<0.09	0.19	< 0.09	<1	<1	<1	<1	<1	<10	<1	<10
Xylene (ortho)	30	ug/l	SW Regs 98	-	-	-	-	0.21	-	-	-	-	-	-	<0.09	-	-	-	-	-	-	-	-	-
Zinc Total	50	ug/l as Zn	DWS 2010	<1	<5	<5	<5	-	7	4	2	67	<5	<5	-	< 5	<1	2	<1	1	<1	20.6	16	130

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, MG – Made Ground, UF – Upnor Formation, TSF – Thanet Sands Formation*

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K.8 Groundwater status

K.8.2 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.8.3 The Thames River Basin Management Plan (RBMP)[14] shows that the Lambeth Group, Thanet Sands and Chalk Formation in the area of the KEMP site are designated as the Greenwich Chalk and Tertiaries groundwater body.

K.8.4 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.8.5 The predicted quantitative and chemical quality was poor for 2015 due to treatment or improvement being disproportionately expensive or technically infeasible.

K.8.6 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.8.7 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)[14].

K.8.8 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)[14]:

- 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.

- Prevent direct discharges of pollutants to groundwater.

K.9 Data sources

K.9.1 A list of data used for the KEMP assessment is given in Vol 21 Table K.8.

Vol 21 Table K.8 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 to 2012	Last updated September 2012	Final ES
Thames Tideway Tunnel project	Groundwater monitoring strategy	Draft strategy Feb 2012	
Thames	Land quality data	February 2011	

Source	Data	Date received	Notes
Tideway Tunnel project			
Individual licence holders	Letters sent out to 30 licence holders	December 2011	

** LBs – London Borough*

References

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

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

[3] British Geological Survey. *The Physical Properties of Minor Aquifers in England and Wales*. Hydrogeology Group, Technical Report WD/00/04, Environment Agency R&D Publication 68 (2000).

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.21**

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Appendix L: Water resources - surface water

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

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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

M.1 Policy considerations

M.1.1 The relevant planning document that would be used to assess the proposals is the National Policy Statement 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 King Edward Memorial Park Foreshore is provided below.

Local policy

Strategic Flood Risk Assessment

M.1.4 The site lies within the London borough (LB) of Tower Hamlets. LB of Tower Hamlets has produced a Strategic Flood Risk Assessment (SFRA) (Capita Symonds Ltd, 2008)[2]. This SFRA is a combination of a Level 1 and a Level 2 assessment and outlines the main flood sources to the borough.

M.1.5 The SFRA confirms that the Thames Tidal Defence network reduces the annual probability of flooding from the Thames to less than 0.1%. The risk of flooding is a residual risk associated with a breach in the defences.

M.1.6 According to the SFRA:

a. The LB of Tower Hamlets predominantly overlies London Clay with areas overlain by drift deposits from river terraces.

b. The site is within the Environment Agency (EA) Flood Zone 3.

c. The site is in the Tidal Thames flood warning area between Limehouse Basin and King Edward Memorial Park.

d. There is a high risk of surface water and sewer flooding.

e. There is a medium risk of groundwater flooding due to the geology, soils and presence of shallow aquifers.

f. The site is in close proximity to artificial flood sources, Shadwell Basin and Limehouse Basin, however the flood risk from artificial sources is considered to be extremely low.

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 LB of Tower Hamlets, in partnership with the Greater London Authority (GLA), Thames Water and the EA has produced a Surface Water Management Plan (SWMP) (Capita Symonds and Scott Wilson ,

2011)[3] as part of the Drain London project. The SWMP sets out the preferred surface water management strategy for the borough.

M.1.9 According to the SWMP:

a. The site does not lie within a Critical Drainage Area.

b. A section of the site lies within an area of moderate (danger for some) surface water flood hazard for the 1% annual probability rainfall even, including an allowance for the impact of climate change (ie, 30% increase).

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

Regional policy

Thames Estuary 2100

M.1.10 King Edward Memorial Park lies within the London City Policy Unit which has been assigned the 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 at this location as including:

a. tidal flooding from the River Thames

b. heavy rainfall and urban drainage sources

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

M.1.12 Flood mitigation from these sources include:

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

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 are 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, environmentally acceptable and cost effective way.

M.1.15 There is particular concern surrounding confluences of tributary rivers with the Tidal Thames and the interactions between tidal and fluvial flows in the future due to climate change.

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] Capita Symonds Ltd. *LB of Tower Hamlets Strategic Flood Risk Assessment.* (Aug 2008).

[3] Capita Symonds and Scott Wilson. *LB Tower Hamlets Surface Water Management Plan Final Report.* (Aug 2011).

[4] Environment Agency. *Thames Estuary 2100 Plan*. (November 2012).

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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 21 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.

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Vol 21 Table N.1 Development schedule for King Edward Memorial Park Foreshore

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)	2017 (peak construction traffic year)	2023 (Year 1 of operation)		
John Bell House, King David Lane	150m northwest	PA/06/ 01759	Unite Group	Redevelopment to provide a 6-11 storey building comprising 132 bedroom student accommodation and landscaping.	A	100% complete & operational	100% complete & operational	100% complete & operational	Application documents	Base case (all years)
Former land bounded by Schoolhouse Lane, Cable Street and Glasshouse Fields	Approx 300m northeast	PA/06/ 01809	Kier London	Erection of a part four / part 7 storey building to provide 198 residential units; 1865 sq.m of B1 floorspace; 220 sq.m of A1 floorspace; 31 car parking spaces; 118 cycle parking spaces and associated landscaping.	A	100% complete & operational	100% complete & operational	100% complete & operational	Application documents	Base case (all years)

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

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