Thames Tideway Tunnel
Thames Water Utilities Limited

Development Consent Order

Application Reference Number: WWO10001

Documents for Certification
September 2014

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

Lindsay Speed

Sarah Fairbrother

September 2014

Thames Tideway Tunnel

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

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Environmental Statement

Doc Ref: **6.2.07**

Volume 7: Putney Embankment 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 7 Putney Embankment 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 six diffusion tube sites (PEFM1-PEFM3, PEFM5, W9 and WA7) as shown in Vol 7 Figure 4.4.1 (see separate volume of figures).

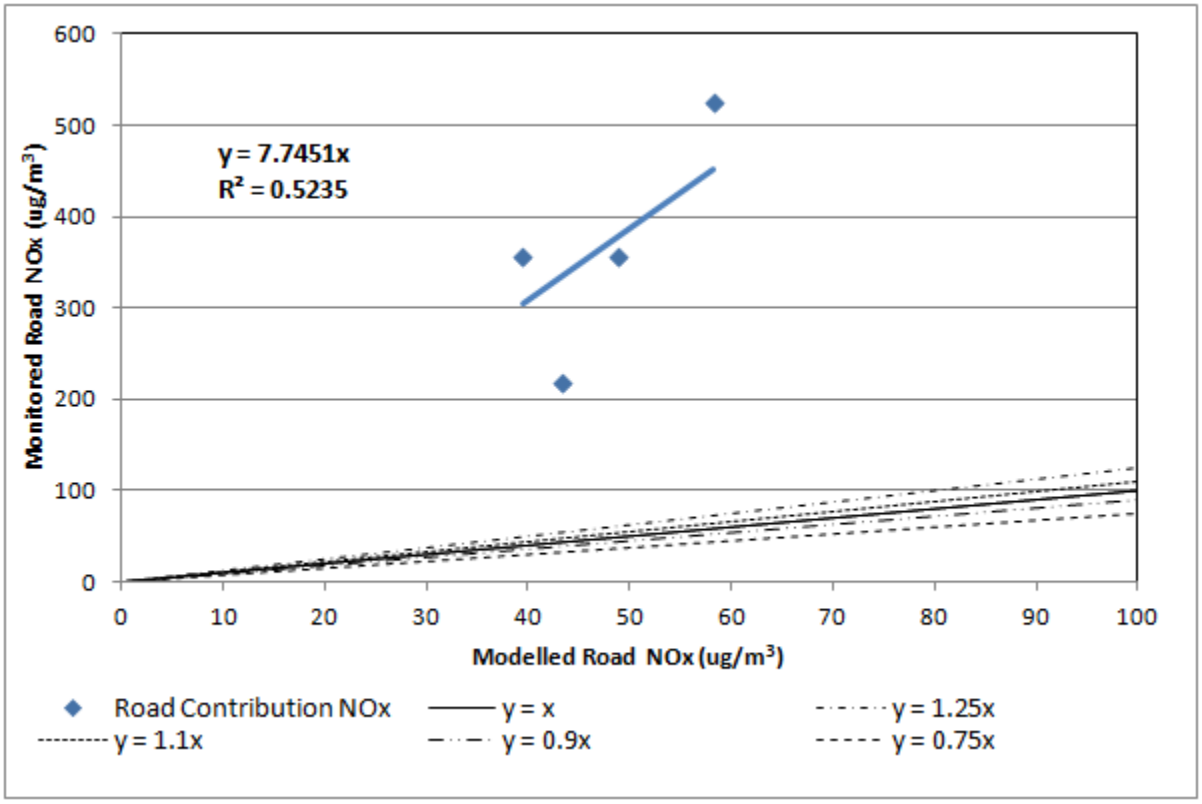
B.1.2 This showed that the modelled results underestimated NO_2 concentrations by between 7% and 54%. As the model has been optimised and no further improvement of the model was considered feasible (such as reducing vehicle speeds or using different pollutant backgrounds, etc), a model adjustment factor 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 7 Plate B.1 below). Putney Bridge High Street was treated as a street canyon. Therefore, sites along Putney High Street were adjusted by a different factor to those along side streets. An adjustment factor of 7.74 was calculated for adjusting modelled NO_X concentrations from Putney High Street, in accordance with LAQM.TG(09)[1] and subsequently applied. For all other streets, an adjustment factor of 2.33 was applied for adjusting modelled NO_X concentrations.

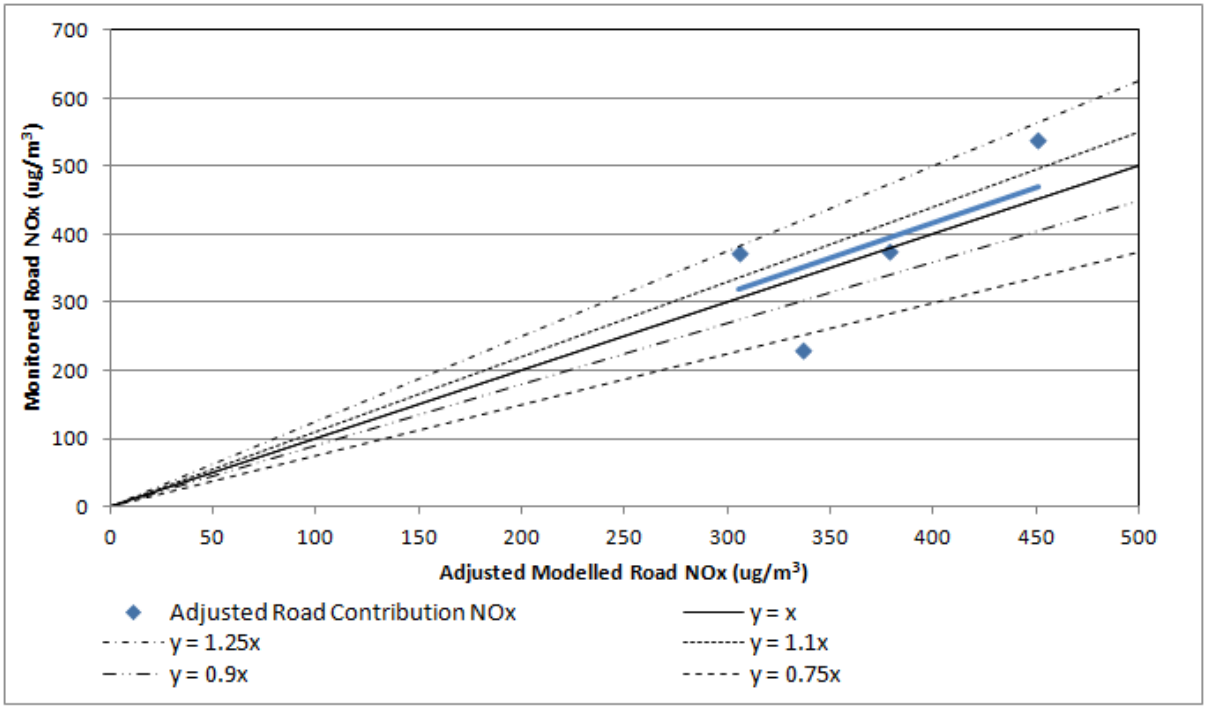
B.1.4 Local PM_{10} monitoring data were available, so a separate adjustment factor was calculated in accordance with LAQM.TG(09)1. An adjustment factor of 3.05 was calculated for adjusting modelled PM_{10} concentrations.

B.1.5 Applying the NO_X adjustment factor and then calculating NO_2 concentrations, as shown in Vol 7 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 7 Plate B.3, indicated that five of the six modelled concentrations were within 10% of the measured value and that all six were within 25% of the modelled value.

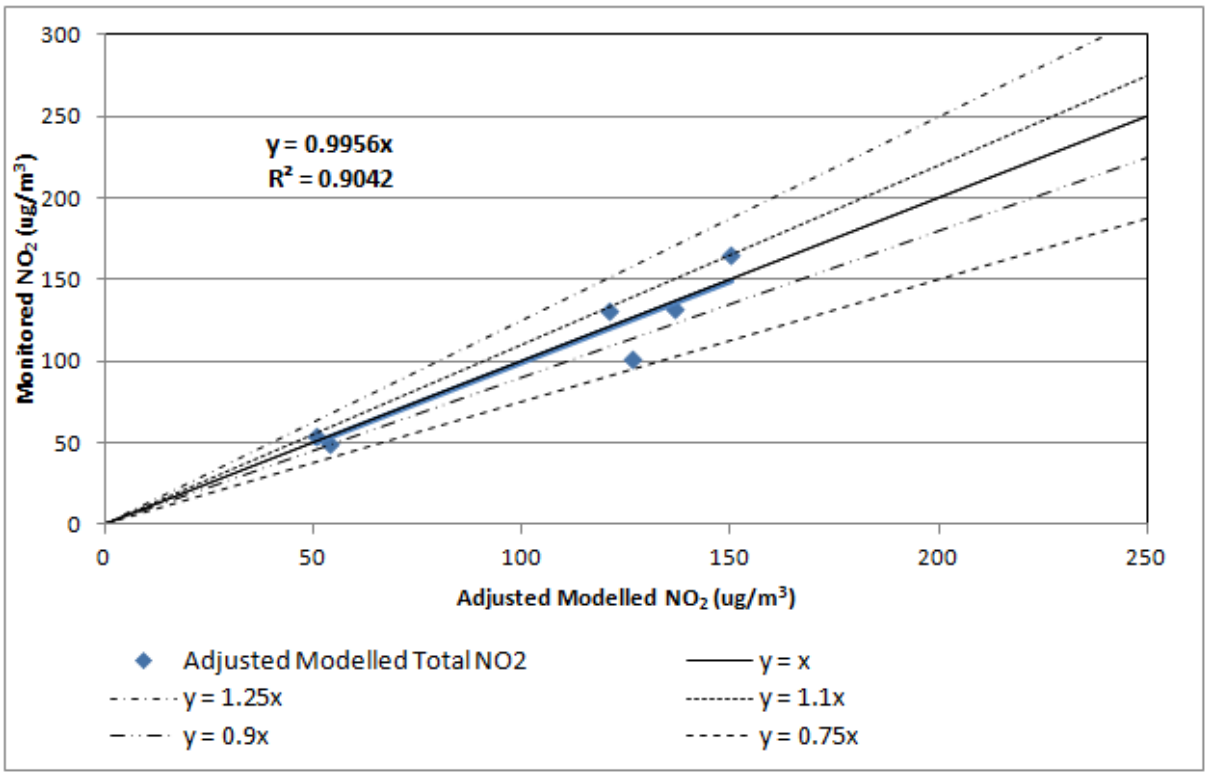
Vol 7 Plate B.1 Air quality - monitored road NO_X vs. modelled road NO_X



Vol 7 Plate B.2 Air quality – monitored road NO_X vs. adjusted modelled road NO_X



Vol 7 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 Putney Embankment Foreshore site are shown in Vol 7 Table B.1.

Vol 7 Table B.1 Air quality - traffic data model inputs

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak const-ruction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
ATC** 'direct'	A308 New Kings Road	20060	8.9%	30	20.5	6.9%	21444	0	21478	8.9%
ATC 'Indirect'	A219 Fulham High Street	29012	9.4%	30	20.5	6.9%	31015	0	31030	9.4%
ATC 'Indirect'	A219 Putney Bridge	47956	7.3%	30	20.5	6.9%	51266	0	51297	7.3%
TfL Model	B306 Lower Richmond Road east of Embankment	27835	4.3%	30	16.9	6.9%	29757	14	29796	4.4%
Speed Limit	Embankment north of Lower Richmond Road	815	0.6%	30	30.0	6.9%	871	14	885	2.2%
TfL	B306 Lower	26938	4.3%	30	16.9	6.9%	28797	0	28822	4.3%

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak const-ruction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
Model	Richmond Road west of Embankment									
Speed Limit	Embankment west of Thames Place	1096	2.8%	30	30.0	6.9%	1172	0	1172	2.8%
TfL Model	B306 Lower Richmond Road west of Thames Place	26422	5.1%	30	16.9	6.9%	28246	0	28271	5.1%
TfL Model	Putney High Street south of Putney Bridge	42409	9.8%	30	14.7	6.9%	45336	14	45356	9.9%
ATC 'Indirect'	Putney Bridge Road east of Putney High Street	19402	6.5%	30	25.4	6.9%	20742	4	20746	6.5%
ATC 'direct'	Putney Bridge Road east of Deodar Road	18753	9.9%	30	25.4	6.9%	20047	4	20080	9.9%
TfL	Putney High Street north of	20341	12.2%	30	29.4	6.9%	21745	8	21756	12.2%

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak const-ruction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
Model	South Circular									
ATC 'Indirect'	A205 South Circular west of Putney High Street	16190	7.7%	30	25.4	6.9%	17308	34	17345	7.9%
ATC 'Indirect'	A205 South Circular east of Putney High Street	14808	6.1%	30	25.4	6.9%	15830	26	15862	6.3%
TfL Model	Putney High Street south of South Circular	20829	11.9%	30	29.4	6.9%	22267	0	22270	11.9%

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

B.3 River tug emission factors

B.3.1 Emissions of NO_X and PM_{10} from tugs pulling the barges were calculated using the data shown in Vol 7 Table B.2 for the Putney Embankment Foreshore site.

Vol 7 Table B.2 Air quality - tug assessment model inputs

Parameter	Value	Units
Total tugs	145	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 barge area***	1724	m^2
NO_X emissions per tug	3.2×10^{-04}	$g/s/m^2$
PM_{10} emissions per tug	2.9×10^{-05}	$g/s/m^2$

* Time that tug is at the site.
** Hotelling refers to when the barge is securely moored or anchored and is not loading or unloading cargo.
*** Area modelled for the mooring and manoeuvring of barges.

B.4 Construction plant emission factors

B.4.1 For the purpose of the assessment, the following listed equipment in Vol 7 Table B.3 has been modelled for the peak construction year at the Putney Embankment Foreshore site.

Vol 7 Table B.3 Air quality - construction plant assessment model inputs

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NO_X emission rate ($g/s/m^2$)	PM_{10} emission rate ($g/s/m^2$)
Site set up and general site	Ground level behind hoarding	Compressor 250cfm*	1	50	104	6.3×10^{-07}	3.9×10^{-08}
	Ground level behind hoarding	Generator - 200kVA	1	100	160	1.9×10^{-06}	1.2×10^{-07}
	Ground level behind hoarding	JCB with hydraulic breaker	1	50	67	4.0×10^{-07}	2.5×10^{-08}
	Ground level behind hoarding	Cutting equipment (diamond saw)	2	10	2.3	1.4×10^{-08}	3.1×10^{-08}
	Ground level behind hoarding	Telescopic handler / FLT**	1	30	60	2.2×10^{-07}	1.4×10^{-08}
	Ground level behind hoarding	Hiab*** lorry/crane	1	5	56	3.4×10^{-08}	2.1×10^{-09}
	Ground level behind hoarding	Well drilling rig	1	50	403	2.4×10^{-06}	1.5×10^{-07}
Hoarding	Ground level behind hoarding	Excavator digging post holes for hoarding	1	30	301	1.1×10^{-06}	6.8×10^{-08}
	Ground level behind hoarding	Generator 35kVA	1	100	28	5.4×10^{-06}	5.1×10^{-07}

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	Cutting equipment (diamond saw)	1	10	2.3	4.4×10^{-08}	4.2×10^{-09}
	Ground level behind hoarding	Compressor 250cfm	1	30	104	3.8×10^{-07}	2.4×10^{-08}
Shaft and connection tunnel secondary lining	Ground level behind hoarding	100t crawler crane	1	50	14	1.4×10^{-06}	9.0×10^{-08}
	Ground level behind hoarding	Service crane 40t mobile crane	1	25	223	8.3×10^{-07}	5.2×10^{-08}
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	223	5.4×10^{-07}	3.4×10^{-08}
	Ground level behind hoarding	Concrete pump	1	20	30	1.1×10^{-06}	6.7×10^{-08}
Drive Connection Tunnel in sprayed concrete lining	Within excavation	Shotcrete robot	1	20	81	5.4×10^{-07}	5.1×10^{-08}
	Ground level behind hoarding	Concrete deliveries (agitating)	1	80	240	2.2×10^{-06}	1.3×10^{-07}
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	275	5.4×10^{-07}	3.4×10^{-08}
	Within excavation	Butor tunnel excavator	1	50	125	2.9×10^{-06}	2.7×10^{-07}
	Within excavation	Piccini dumpers	1	50	104	9.8×10^{-07}	6.1×10^{-08}
	Ground level	100t crawler crane	1	80	14	2.3×10^{-06}	1.4×10^{-07}

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 ($g/s/m^2$)
	behind hoarding						
	Ground level behind hoarding	25t mobile crane	1	20	223	6.6×10^{-07}	4.1×10^{-08}
	Ground level behind hoarding	25t excavator	1	50	223	7.5×10^{-07}	4.7×10^{-08}
	Ground level behind hoarding	400cfm compressor	1	50	30	6.3×10^{-07}	3.9×10^{-08}
Shaft and connection tunnel secondary lining	Ground level behind hoarding	100t crawler crane	1	50	240	1.4×10^{-06}	9.0×10^{-08}
	Ground level behind hoarding	Service crane 40t mobile crane	1	25	275	8.3×10^{-07}	5.2×10^{-08}
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	223	5.4×10^{-07}	3.4×10^{-08}
	Ground level behind hoarding	Concrete pump	2	20	223	1.1×10^{-06}	6.7×10^{-08}
Culvert works	Ground level behind hoarding	Service crane – 100t mobile crane	1	50	280	1.7×10^{-06}	1.1×10^{-07}
	Ground level behind hoarding	25t excavator	1	50	125	7.5×10^{-07}	4.7×10^{-08}
	Ground level behind hoarding	Dumper	1	50	81	4.9×10^{-07}	3.1×10^{-08}
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	223	5.4×10^{-07}	3.4×10^{-08}

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NO_X emission rate ($g/s/m^2$)	PM_{10} emission rate ($g/s/m^2$)
	Ground level behind hoarding	Concrete boom pump	1	20	223	5.4×10^{-07}	3.4×10^{-08}
Landscaping	Ground level behind hoarding	25t excavator	1	50	125	7.5×10^{-07}	4.7×10^{-08}
	Ground level behind hoarding	Dumper	1	70	81	6.8×10^{-07}	4.3×10^{-08}
	Ground level behind hoarding	Telescopic Handler / FLT	1	30	60	2.2×10^{-07}	1.4×10^{-08}
	Ground level behind hoarding	Hiab*** lorry / crane	1	5	56	3.4×10^{-08}	2.1×10^{-09}
	Ground level behind hoarding	Compressor for hand-held breaker	1	10	6	1.2×10^{-07}	1.1×10^{-08}
	Ground level behind hoarding	Plate compactors	2	10	3	1.8×10^{-08}	4.0×10^{-08}
	Ground level behind hoarding	Vibrating rollers	1	20	145	3.5×10^{-07}	2.2×10^{-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 24 November 2010 at the Putney Embankment Foreshore site (Vol 7 Figure 6.4.2 Phase 1 Habitat Map, see separate volume of figures). Based on this, surveys for the following species have been undertaken:

a. bats

b. wintering birds.

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.1.10). The results from the surveys are then presented (paras. D.1.11 to D.1.16). The final section provides an interpretation of the results (paras. to D.1.17 to D.1.23). Figures referred to in this report are contained within Vol 7 Putney Embankment Foreshore 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 single bat survey was carried out. This comprised a remote recording (bat triggering) survey using a remote Anabat™ recording device. Based on the habitat types identified during the Phase 1 habitat survey and their potential to support foraging, commuting or roosting bats, one location was chosen for the installation of the remote recording device (shown on Vol 7 Figure 6.4.3, see separate volume of figures).

D.1.7 The location was selected to record bat commuting and/or foraging activity associated with the River Thames corridor and trees on and adjacent to the site, and potential roosting activity associated with nearby buildings.

D.1.8 The bat activity recorded during the remote recording survey did not trigger the need for an additional dawn survey (see Vol 2 Methodology for

bat triggering criteria). Therefore, a second stage of bat surveying was not undertaken at the Putney Embankment Foreshore site.

Wintering birds

D.1.9 Wintering birds are mainly associated with aquatic habitats such as intertidal mudflats and marshes, marginal vegetation and wetlands, which they use for resting and foraging. Some wintering bird species are also associated with terrestrial habitats such as scrub and grassland, which they use for roosting at high tide or foraging. The survey area, as shown in Vol 7 Figure 6.4.4 (see separate volume of figures), includes the foreshore within the proposed development site and habitats in close proximity to the site that have potential for wintering birds.

D.1.10 The intertidal foreshore mainly consists of eroded building rubble, stones of various sizes and mud or silt.

Results

D.1.11 In this section, the results of the desk study and notable species surveys are presented. The results are then interpreted in paragraphs D.1.17 to D.1.23.

Desk study

D.1.12 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 4 Table D.1.

Vol 4 Table D.1 Terrestrial ecology – species recorded within 500m of the site between 2001 - 2011

Common name	Species name (Latin)	Record count
Mammals		
West European hedgehog	*Erinaceus europaeus*	11
Bats	*Vespertilionidae*	4
Noctule	*Nyctalus noctula*	9
Lesser noctule	*Nyctalus leisleri*	3
Pipistrelle	*Pipistrellus pipistrellus*	7
Soprano pipistrelle	*Pipistrellus pygmaeus*	8
Birds		
Greylag goose	*Anser anser*	4
Northern pintail	*Anas acuta*	14
Greater scaup	*Aythya marila*	4
European honey-buzzard	*Pernis apivorus*	6
Red kite	*Milvus milvus*	2

Common name	Species name (Latin)	Record count
Eurasian marsh harrier	*Circus aeruginosus*	2
Northern goshawk	*Accipiter gentilis*	2
Eurasian hobby	*Falco subbuteo*	4
Peregrine falcon	*Falco peregrinus*	4
Whimbrel	*Numenius phaeopus*	2
Herring gull	*Larus argentatus*	36
Eurasian eagle owl	*Bubo bubo*	2
Common kingfisher	*Alcedo atthis*	8
Lesser spotted woodpecker	*Dendrocopos minor*	8
Dunnock	*Prunella modularis*	20
Song thrush	*Turdus philomelos*	9
Redwing	*Turdus iliacus*	6
Common starling	*Sturnus vulgaris*	30
House sparrow	*Passer domesticus*	43
Eurasian tree sparrow	*Passer montanus*	2
Common redpoll	*Carduelis flammea*	6
Common crossbill	*Loxia curvirostra*	8
Brambling	*Fringilla montifringilla*	2
Amphibians		
Common frog	*Rana temporaria*	18
Common toad	*Bufo bufo*	2
Invertebrates		
Small heath	*Coenonympha pamphilus*	2
Stag beetle	*Lucanus cervus*	55

Bat surveys

Bat triggering (remote recording) surveys

D.1.13 The bat triggering (remote recording) surveys were undertaken between 17 and 19 May 2011 in suitable weather conditions (Vol 4 Table D.2).

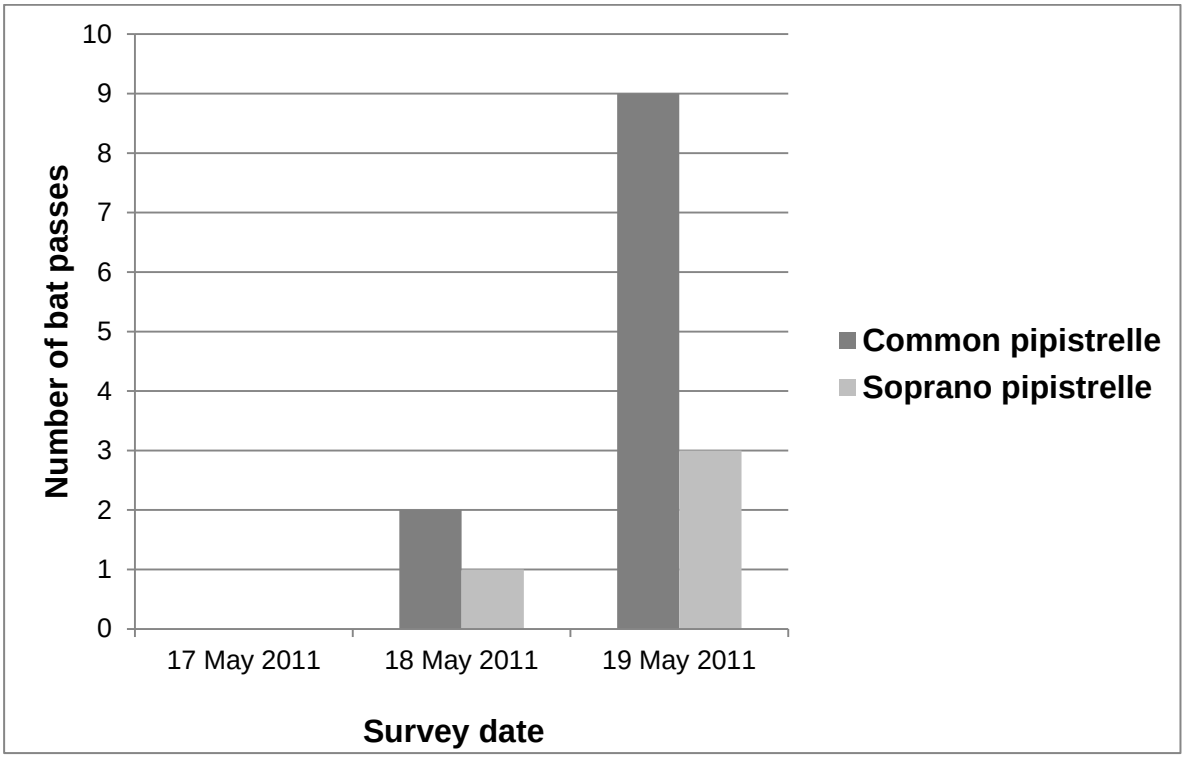
D.1.14 Two species of bats were recorded using the site: common pipistrelle (*Pipistrellus pipistrellus*) and soprano pipistrelle (*Pipistrellus pygmaeus*). No bats were recorded on the first night (17 May 2011). Two common pipistrelle bat passes and one soprano pipistrelle bat pass were recorded on the second night (18 May 2011). Nine common pipistrelle and three

soprano pipistrelle bat passes were recorded on the final night (19 May 2011). There were no records of bat passes close to sunset or sunrise.

Vol 4 Table D.2 Terrestrial ecology – bat survey weather conditions

Survey visit	Weather conditions
17 May 2011	12°C, light westerly wind, 100% cloud cover, dry
18 May 2011	13°C, light breeze, 100% cloud cover, dry
19 May 2011	9°C, light breeze, 100% cloud cover, dry

Vol 4 Plate D.1 Terrestrial ecology – bat passes recorded during remote recording surveys at Putney Embankment Foreshore



Wintering birds

D.1.15 A total of six surveys were undertaken at monthly intervals between October 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 4 Table D.3). The main foraging and resting areas for wintering birds are indicated on Vol 7 Figure 6.4.4 (see separate volume of figures).

Vol 4 Table D.3 Terrestrial ecology – wintering bird survey weather conditions

Survey visit	Weather conditions
13 December 2010	2°C, calm, 100% cloud cover, dry
20 January 2011	5°C, light westerly wind, 100% cloud cover, dry

Survey visit	Weather conditions
18 February 2011	6°C, light north-easterly wind, 100% cloud cover, dry
19 March 2011	-1°C, calm, 100% cloud cover, dry
10 October 2011	20°C, light westerly wind, 100% cloud cover, dry
9 November 2011	12°C, light south-easterly wind, 100% cloud cover, dry

D.1.16 The numbers of individuals of each species recorded in each month are provided in Vol 4 Table D.4. A total of 15 waterbird[i] species were recorded within foreshore on and adjacent to the site:

a. On two occasions, small numbers of teal *(Anas crecca)* were observed foraging on the foreshore following the receding tide.

b. Mallard *(Anas platyrhynchos),* tufted duck *(Aythya fuligula),* black-headed gull *(Larus ridibundus*), common gull *(Larus canus),* lesser black-backed gull *(Larus fuscus)* and herring gull *(Larus argentatus).*

c. High numbers of gulls, particularly black-headed gulls, were recorded during each survey visit. This is likely to be due to bird feeding by the public at this location.

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

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

Species name	Latin name	Conservation designation[ii]	Monthly wintering waterbird counts					
			December 2010	January 2011	February 2011	March 2011	October 2011	November 2011
Great crested grebe	*Podiceps cristatus*	Green List	1	-	-	-	-	-
Cormorant	*Phalacrocorax carbo*	Green List	3	1	1	5	4	2
Grey heron	*Ardea cinerea*	Green List	-	1	-	-	1	2
Mute swan	*Cygnus olor*	Green List		2	2		3	2
Greylag goose (feral)	*Anser anser*	Green List	-	-	-	1	1	-
Canada goose	*Branta canadensis*	Green List	-	2	3	-	26	2
Mandarin	*Aix galericulata*	No status	-	1	-	-	-	-
Teal	*Anas crecca*	Amber List	10	3	-	-	-	-
Mallard	*Anas platyrhynchos*	Amber List	7	13	11	6	12	26
Tufted duck	*Aythya fuligula*	Amber List	-	-	-	2	-	-

[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					
			December 2010	January 2011	February 2011	March 2011	October 2011	November 2011
Coot	*Fulica atra*	Green List	-	-	-	2	-	-
Black-headed gull	*Chroicocephalus ridibundus*	Amber List	152	302	152	33	118	52
Common gull	*Larus canus*	Amber List	9	3	1	-	-	-
Lesser black-backed gull	*Larus fuscus*	Amber List	3	3	5	10	4	2
Herring gull	*Larus argentatus*	Red List UK BAP Priority List	19	20	14	20	19	6

Interpretation

Bats

D.1.17 There is the potential for bats to commute along the River Thames and forage around trees on and adjacent to the site.

D.1.18 Small numbers of common pipistrelle and soprano pipistrelle bats were recorded during the remote recording survey, indicating that these species occasionally commute through the site and forage around trees on and adjacent to the site.

D.1.19 As no bats were recorded close to sunset or sunrise when bats leave and return to their roost sites, it is considered unlikely that there is a roost on or in close proximity to the site.

Wintering birds

D.1.20 The embankments on either side of the River Thames include pavements, which are well-used by pedestrians, and busy roads used mainly by motor vehicles. Therefore, birds on the foreshore are subject to some disturbance.

D.1.21 Of the 15 waterbird species that were recorded within the survey area, seven are of nature conservation importance and are included in the Birds of Conservation Concern Red or Amber List[iii] and/or UK BAP Priority Species. These species comprise; teal, mallard, tufted duck, black-headed gull, common gull, lesser black-backed gull and herring gull.

D.1.22 The majority of species were recorded foraging on the foreshore, with gulls also taking advantage of food supplied to them by the public from the embankment. This resulted in high numbers of gulls being recorded on site.

D.1.23 Greylag goose was recorded on site, which is an Icelandic species of international importance listed on the Amber List of conservation importance. The Icelandic greylag goose mainly winters in Scotland (particularly around the Moray Firth) and northern England. The UK also has a resident (breeding in the UK) feral population, mainly in southern England. The resident feral greylag goose population has established from birds that have escaped or been released from captivity. For this reason the resident greylag goose population at Putney Embankment Foreshore do not qualify for Amber List status and are therefore considered to be a Green List species.

[iii] The UK's birds can be split into three categories of conservation importance – red, amber and green. Red is the highest conservation priority, with species needing urgent action. Amber is the next most critical group, followed by green. (http://www.rspb.org.uk. Page last updated on Monday 7 March 2011).

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.07**

Volume 7: Putney Embankment Foreshore appendices

Appendix E: Historic environment

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

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Thames Tideway Tunnel

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Thames Tideway Tunnel

Environmental Statement

Volume 7 Putney Embankment 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 7 Table E.1, with their location shown on the historic environment features map (Vol 7 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 7 Table E.1 Historic environment – gazetteer of known heritage assets within the site and assessment area

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
1A	Putney Bridge. Grade II listed. 1884 by Sir Joseph Bazalgette, modelled on Rennie's London Bridge. Rusticated granite-faced bridge of four cutwaters with buttresses, five spans with false voussoirs with stepped extrados. Bold cornice and plain parapet. On the parapets iron lamp standards with foliate base and three foliate branches: lamps replaced.	1357672
1B	Thames Foreshore, adjacent to Lower Richmond Road A flint flake (MLO26796) dating to the upper Palaeolithic period and an undated ring (MLO26921) were discovered here by the Thames Archaeological Survey (TAS) in the 1990s.	106039 MLO26796 MLO26921 FWW02 TAS 1999 A103
1C	Thames Riverfront, immediately behind the slipway to the west of Putney Bridge. Timber piles which formed a post-medieval flood defence/river wall. Located immediately behind the present embankment and slipway. Identified by the TAS foreshore shore survey in the 1990s.	FWW02 TAS 1999 A308
1D	Subterranean toilets, adjacent to Putney Embankment The location of subterranean toilets dating to the	---

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	late 19th century, contemporary with Putney Bridge. Now disused, they were observed through pavement lights during the site visit.	
1E	Wall of public garden, located between Putney Embankment and slipway. A low stone wall, dating to the 19th century, located between the Putney Embankment river wall and 19th century slipway.	---
1F	Cobbled slipway, adjacent to Putney Embankment A cobbled stone and granite slipway leading down to the foreshore, dated to the later 19th century and still in use. One of the only remaining examples along the Thames of its kind.	FWW02 A301
1G	Subterranean brick-built vaults with arched ceilings, part of the Putney Bridge approach, beneath Lower Richmond Road. The remains of brick vaults with arched brick ceilings were observed during the MOLA Thames Tideway Tunnel project site visit in 2011 through a hole bored through the granite facing of the listed bridge approach (carried out illegally by a developer in 2008).	---
1H	Junction of Lower Richmond Road and Putney High Street. The remains of 19th century steps with a commemorative stone dating to 1884, leading to the Thames foreshore west of Putney Bridge.	FWW03 TAS 1999 A113 022688 MLO70080
1I	Thames foreshore Chalk barge bed, which was probably used in the construction of Putney Bridge (see also HEA 1O). Identified by the TAS foreshore shore survey in the 1990s. The MOLA site visit as part of the Thames Tideway Tunnel project in 2011 noted that the remains were still present.	FWW02 A303
1J	Thames foreshore, beneath Putney Bridge Foundation piles, composed of grouped square wooden timbers, probably part of a cofferdam, used in the construction of Putney Bridge. Identified by the TAS foreshore shore survey in the 1990s. The MOLA site visit as part of the	FWW03 TAS 1999 A101

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	Thames Tideway Tunnel project in 2011 noted that the remains were still present.	
1K	Putney Bridge The remains of a Bazalgette late 19th-century outfall drain set within the Putney Bridge abutment beneath the bridge. The outfall consists of a culvert with two metal, grilled outlets (A120) and a timber and stone drain apron (A121).	FWW03 TAS 1999 A120 A121
1L	Beneath Putney Bridge foreshore The remains of three post-medieval metal, circular piles driven into the foreshore; possibly the remains of the 19th century Chelsea Waterworks viaduct. Identified by the TAS foreshore shore survey in the 1990s.	FWW03 A302
1M	Putney Bridge foreshore Dump of stone rubble to consolidate the foreshore around the Bazalgette outfalls beneath the bridge (HEA 1K), and possibly contemporary. Note by the Thames Foreshore Survey (TAS) in 1996. The MOLA site visit as part of the Thames Tideway Tunnel project in 2011 noted that the remains were still present.	022108 022678 MLO70089 FWW03 A120 & A122
1N	Line of the Bazalgette Southern Lower Level Sewer. Constructed in the 1880s.	---
1O	Thames Foreshore, to the east of Putney Bridge Hard chalk consolidation layer perhaps the remains of a barge bed related to the construction of Putney Bridge (see also HEA 1I). Dated to the 19th century. Identified by the TAS foreshore shore survey in the 1990s.	MLO10053 TAS 1999 A102
1P	Thames Foreshore, to the east of Putney Bridge Medieval pot sherd found by chance and noted on the Greater London Historic environment Record (GLHER).	106049 MLO26922
1Q	Port of London Authority (PLA) marker set into the brick riverside wall recording the high water level of the 1928 flood.	FWW02 A306
1R	A swamped mooring (No. 115) on foreshore, described by a PLA survey as consisting of a	6370000011 34015

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	mooring screw and chain.	
1S	A swamped mooring (No. 116) on foreshore, described by a PLA survey as consisting of a mooring screw and chain.	6370000011 34012
1T	Thames foreshore, beneath Putney Bridge Three circular metal piles set into the foreshore. Identified by the Thames Discovery Programme (TDP) foreshore shore survey in 2009.	FWW03 TDP2009 A302
1U	Stone stairway, adjacent to Putney Bridge. Identified by the TAS foreshore shore survey in the 1990s.	FWW03 TAS 1999 A113
1V	Thames foreshore, to the east of Putney Bridge Brick footings of the south bridgehead of Putney Old Bridge (c. 1729). Exposed and recorded by the TAS foreshore shore survey in the 1990s.	FWW03 TAS 1999 A103
1W	Thames Foreshore, immediately to the east of Putney Bridge 18th century remains described in the Greater London Historic environment Record (GLHER) entry as comprising “random scattered timbers, angled into foreshore”.	022681 MLO70073 TAS 1999 A106
1X	Thames foreshore, adjacent to the Putney Constitutional Club A post-medieval timber structure; possibly an access causeway.	FWW02 TAS 1999 A102
1Y	Thames foreshore The approximate location of finds recorded by the Portable Antiquities Scheme (PAS), including a Roman mount, a post-medieval token and a post-medieval handle.	LON-672808 LON-8303C5 LON-91DFE1
1Z	Putney Embankment, to the west of Putney Bridge The University Boat Race stone that marks the starting line of the Oxford and Cambridge Boat Race that was first held in 1829. It is situated on the south bank adjacent and to the west of the site. Observed during MOLA Thames Tideway	---

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	Tunnel project site visit in 2012.	
2A	Thames Foreshore, at the junction of Putney Embankment and Lower Richmond Road The foundation of the river wall, with the remains of round wooden timbers surrounding. Observed during MOLA Thames Tideway Tunnel project site visit in 2012.	FWW02 A104
2B	Thames Foreshore, to the west of Putney Bridge. Putney Pier. Post-medieval pier consisting of four earthfast timber structures connected by modern walkways. First appears in this location on the Ordnance Survey 1st edition map of 1862 (but possibly earlier). Possibly rebuilt in the 20th century.	FWW02 TAS 1999 A105
3	2–4 Lower Richmond Road An archaeological watching brief and excavation was carried out by Sutton Archaeological Services (SAS) in 1996. At least three timber waterfronts were revealed, dating to the late 16th century and late 17th or early 18th century. Traces of other, incomplete, timbers were also recovered, but it is not known to what structures or dates they belonged. The site was stripped down to the natural river gravels and alluvial clay. Coins, pottery and other finds from the Roman, medieval and post-medieval periods were recovered, including 11 Roman coins, mostly dated to the 4th century AD, and a 14th century pot.	LWR96
4	ICL House, Putney High Street An evaluation and watching brief was carried out by Pre-Construct Archaeology (PCA) in 1998. Natural sand was discovered to have been cut by two medieval ditches (HER 025336; MLO072853) and HER025337; MLO072852), possibly boundaries, the larger of which was backfilled in the 16th century. In the west of the site the remains of structures (HER 025338; MLO072854) were found; these are identified as cottages, documented from 1636 to 1888, when they were demolished. A boundary wall (HER	PTY98 025336 025337 025338 025339 025340 025341 025342 025343 MLO72856

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	025341; MLO72857) defined an area of intense pitting (HER 025339; MLO072855) that probably represents domestic refuse disposal. To the east of the wall were features of a horticultural nature, perhaps bedding trenches (HER 025343; MLO72859) with some very fragmentary remains of a large house (HER 025342; MLO72858), probably that represented on 17th–19th century maps. One residual struck flint tool was recovered. The remains of a post-medieval road (MLO72856) were also discovered.	
5	Friends Provident, Brewhouse Street An evaluation of the site was carried out by Foundations Archaeology in 1997. No features or artefacts of archaeological significance were noted, probably due to terracing, carried out when the brewery was built in the 19th century.	BWS97
6	Thames foreshore, to the east of Putney Bridge The approximate location of finds recorded by the PAS, including a Roman coin and an early medieval pin beater.	LON-A3E53 LON-1A16F3
7	Approximate line of the Platt The approximate line of a Roman road, tracked as far north as Thames Place, adjacent to Putney Embankment.	---
8	Thames Foreshore, immediately to the south-east of Putney Bridge The remains of 19th century brick and stone flood defences. At the bottom of the steps down to the foreshore, immediately to the east of the bridge, was a deposit of stone rubble, perhaps associated with a drain outlet. Probably part of the same structure as HEA 1M.	022689 MLO70081 FWW03 TAS 1999 A114
9	The findspot of a piece of Roman tile (HER 031304) discovered by chance at this location. Noted on the GLHER.	031366 212227 031304
10	Thames foreshore, to the east of Putney Bridge The approximate location of a Neolithic axe, recorded by the PAS.	LON-27B591
11	Thames Foreshore, immediately to the east of	106066

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	Putney Bridge Flint artefacts (MLO19296; 25011) and two axes (MLO26120; 19970), dating to the Lower Palaeolithic period, were discovered here.	
12	Thames foreshore, Fulham A possible wattle revetment/structure, noted by the TDP in 2011.	FHM07 TDP 2011 A307
13	Thames Foreshore, to the east of Putney Bridge Rectangular vertical wooden post. Possibly relating to Putney Old Bridge and dating to c. 1729. Noted by TAS in the 1990s.	022685 MLO70077 FWW03 A301
14	Thames Foreshore, to the east of Putney Bridge The remains of a 19th riverfront defence of brick with timber fenders and mooring chain. Noted by the TAS in the 1990s.	022690 MLO70082 FWWW03 A115
15	River Thames, to the east of Putney Bridge Medieval ferry crossing point. The ferry continued until the wooden bridge was erected in 1729.	031581 MLO17111
16	Thames Foreshore, to the east of Putney Bridge Medieval mullion window fittings, dating to the 15th century; possibly associated with St. Mary's Church. Noted by the TAS in the 1990s.	022697 MLO70091 FWW03 TAS 1999 A123
17	Thames Foreshore, to the east of Putney Bridge Medieval pot sherd, dated to the 13th century.	106050 MLO26779
18	Thames Foreshore, to the east of Putney Bridge Post-medieval timber drain. Noted by TAS in the 1990s.	022682 MLO70074 FWWW03 A107
19	Riverside Walk, opposite Brewhouse Lane The remains of a 19th century cobbled slipway. Noted by TAS in the 1990s.	022687 MLO70079 FWW03 A112
20	Riverside Walk, east of Putney Bridge Timber structure, possibly a causeway, dated to	022683 MLO70075

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	the late 18th or early 19th century (constructed prior to the building of the riverwall in the 19th century). Noted by TAS in the 1990s.	FWW03 A108
21	Thames foreshore, west of the northern end of Putney Bridge Around 40 objects, mainly dating from the late Neolithic to the late Bronze Age, consisting of a Bronze Age sword, a Bronze Age axe, palstaves, spearheads, pot sherd, flint implements, a Bronze Age pin, a ring, a razor and a bowl were all discovered within this area. They may have been uncovered as a result of dredging. Also the location of an unclassified structure, consisting of two small posts, located about 1m apart, and a peat/organic clay layer, exposed at lowest tides. Noted by the TAS in the 1990s.	100165 – 100191; 100033; 10043 – 5 TAS 1999 A109 A110 FHM07
22	Hippodrome Theatre car park, west of Weimar Street A gravel surface (road) (HER 020736; MLO19068) with an adjacent ditch (HER 020823; MLO27480); both dated to the 1st century AD, interpreted as a roadway. It is suggested that the gravel was originally flanked by ditches on both sides, which were subsequently removed. Excavated by the Wandsworth Historical Society (WHS) in 1981.	FEL VIII 020736 020823 MLO19068 MLO27480
23	16 Mount Court, Weimar Street Roman settlement evidence excavated by the WHS in 1976.	FEL V 020754 MLO16731
24	2 Waterman Street, near University Mansions A Roman pottery assemblage (HER 031331), a medieval pot sherd (HER 031376), and a post medieval pottery assemblage (HER 031488).	031331 031376 031488
25	6 Waterman Street A shallow Roman ditch, post holes and spread of pottery. Excavated by the WHS in 1966.	GAY IX 020748 MLO1480
26	7 Waterman Street 512 Roman pot sherds and two Roman coins dating to the mid 3rd and mid 4th century AD, were discovered to the southwest of a nearby Roman ditch and post hole, discovered at 6	GAY I 020751 MLO16725

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	Waterman Street.	
27	22–25 Waterman Street Unclassified Roman and medieval finds, including pot sherds, and an Elizabeth I coin, recovered from a modern drainage ditch. The area was much disturbed by modern walls and foundations. Excavated by the WHS in 1962.	GAY II 020741 020742 MLO1487
28	24–38 The Platt Roman road and ditch and Roman and medieval pot sherds.	031336 031379 MLO1476 MLO23419
29	Junction of Waterman Street (nos. 13–14) Roman potsherd from a borehole. Excavated by the WHS in 1962.	GAY VI 020757 MLO23105
30	38–42 Gay Street Seven sherds of unstratified Roman pottery from a spoil heap as part of a WHS investigation in 1968.	GAY V 020756 MLO16747
31	38 Felsham Road A Roman settlement (HER 031318): a hut with timber beam foundations and stakeholes (HER 03131802; MLO38308; MLO38310), apparently contemporary with a ditch (HER 03131803; MLO38309), a road (HER 03131801; MLO52641) and rubbish pits (MLO46692). Iron Age pottery (HER 031277; MLO9562) and a medieval lynchet (HER 020743; MLO3232).	031277; 0313101–03; 031318; 020743
32	Felsham Street, adjacent to Weimar Street A Roman pit and ditch. Noted on the GLHER.	020866
33	South-west of Putney High Street The GHLER approximate centre point of the medieval settlement of Putney, which is believed to have clustered around the parish Church of St. Mary.	MLO73313
34	Brewhouse Street Foundations Archaeology investigation in 1997. No archaeological finds or features were recorded.	MLO71644 PRO97

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
35	3–29 Putney High Street An unspecified find/monument. No further information available.	MLO3646
36	Thames Foreshore, to the east of Putney Bridge Unspecified find/monument. The GLHER records "observations made by the WHS in 1973". No further information listed.	HIG IV MLO10040
37	Thames Foreshore, to the east of Putney Bridge Four unspecified finds. No further information listed in the GLHER.	MLO10044-47
38	Thames Foreshore, to the east of Putney Bridge Post-medieval timber-lined drain noted by the TAS in the 1990s.	MLO10048 FWW03 TAS 1999 A107
39	River Thames, to the north-west of Putney Bridge The antiquarian find spot of a Bronze Age ring; accessioned in 1915.	MLO10065
40	Putney Wharf, Brewhouse Street, Putney Bridge Road An evaluation by Compass Archaeology (CA) in 2001. A medieval ditch (MLO75978) and cut feature were found beneath plough soil which contained finds dating to the mid-18th century. Above the plough soil was a brick wall which separated the more domestic activity on the west side of the site – including a series of 18th century pits – from agricultural activity on the east side. A prehistoric struck flint flake (MLO77224), a Roman coin and Roman structural remains (MLO77625) were also uncovered on the site.	PHT01 MLO77627 MLO75978 MLO77624 MLO77625
41	Church of St. Mary the Virgin. Grade II* listed. Earliest remaining fabric dates from the 15th century with early 16th century and early 17th century additions. Restored by Edward Lapidge 1836-37 and again in the 1980s by Ronald Sims following a fire in 1973. 2005 additions by Alan Pates.	1065519
42	The White Lion Hotel Public House. Grade II listed. Dated 1887; symmetrical three-bays, four-storeys	1184658

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	and dormers. Red brick, stone dressings, French pavilion slate roof with elaborate iron cresting. Ground floor altered. Upper floors form succession of pilaster orders. First and second floors, two-storey canted bow with stone balconies and iron balustrades, third floor pedimented centre bay, fourth floor tripartite centre window surmounted by dated blocking and stone figure of lion passant.	
43	Group of five bollards at junction with Lower Richmond Road. Grade II listed. Group of five cast iron bollards: one group of three aligned north-west to south-east across the pavement, the other pair aligned approximately west to east along the pavement edge. Each bollard has a flared base, a slim band of chevron patterning and a knob finial.	1300019
44	Thames Foreshore, to the west of Putney Bridge The remains of a post-medieval timber causeway or slipway. Noted by the TAS in the 1990s.	FWW02 TAS 1999 A101
45	Thames channel/foreshore, to the east of Putney Bridge Two pieces of human cranial (skull) bone, belonging to a mature male, dated to the mid-Iron Age, were recovered in 2003 at very low tide from within a grey-black silty sand deposit; possibly an in situ prehistoric deposit within the foreshore now subject to erosion. Analysis of the skull revealed some trauma/injury to the head.	524300; 175620
46	Thames foreshore, Fulham Two horizontal timbers. Noted by the TDP in 2011.	FHM07 TDP 2011 A306
47	Thames foreshore, to the east of Putney Bridge Post-medieval, rectangular timber post. Noted by the TAS in the 1990s.	FWW03 TAS 1999 A110
48	Thames foreshore, Fulham The find spot of an artefact scatter, including Roman building material. Noted by the TAS in the 1990s.	FHM07 TAS 1999 A102/A105
49	Thames foreshore, Fulham	FHM07

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	Vertical, squared post-medieval timber stake. Noted by the TAS in the 1990s.	TAS 1999 A106
50	Thames foreshore, Fulham Prehistoric tree root. Noted by the TAS in the 1990s.	FHM07
51	Thames foreshore, Fulham Post-medieval mooring feature/chain. Noted by the TAS in the 1990s.	FHM07
52	Star and Garter Hotel, Putney Embankment A locally listed building dating to the later 19th century. It now functions as a public house. Four storey and attics, red brick with slate roofs. Triangular pedimented windows to the first floor, circular windows with festoons to the second floor. Corner turret with decorative stone cupolas.	Locally Listed
53	Star and Garter Mansions, Putney Embankment A locally listed building dating to the later 19th century and currently functioning as residential mansion flats. Four storey and attics, red brick with slate roofs. Stone arcading to ground floor, stone pilasters and window dressings to upper storeys.	Locally Listed
54	Thames foreshore, Fulham Three Iron Age timber piles.	FHM07 TDP 2009 A301
55	Thames foreshore, to the east of Putney Bridge The find spot of a worked stone block, observed during the MOLA site visit in 2011.	---
56	Thames foreshore, to the east of Putney Bridge Four square timber piles, to the west of A108. Noted by the TDP in 2011.	FWW03 TDP 2011 A308
57	Central Thames channel, to the west of Putney Bridge. The site of a swamped mooring (No. 114).	6370000011 34001
58	Winchester House, Putney Constitutional Club. Grade II listed. 19th century; mid three storeys, five windows wide with three window splayed projection (west).	1300160

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	Brown brick slightly projecting centre with open pediment with circular panel and keystone. Band at first floor. Gauged flat arches to recessed windows, lunette window second floor. Palladian window first floor with brick pilasters with stone moulded caps and bases and triple keystone. Wood doorcase with Doric columns, pulvinated frieze and architrave with scroll and sculptured head. Panelled hall and two staircases with turned balusters with enrichment and carved ends. Other good interior features. Two storey, three window annex with cove cornice to tiled roof.	
59	37, 39 and 41 Lower Richmond Road SW15. Grade II listed. Early 19th century, yellow stock brick two-storey terrace with pantile roof. Simple bracketed hoods to doors. Cambered arches to windows. No 37 one window wide with addition containing the entrance. No 39 three windows wide with blind window over central entrance. No 41 one window wide with entrance offset to left.	1065543
60	Three bollards at junction with Putney Embankment. Grade II listed. 19th century, cast iron.	1065492
61	Bollard at junction with Lower Richmond Road. Grade II listed.	1065493
62	4 Bemish Road WHS excavation in 1962 uncovered a 1st or 2nd century Roman cremation cemetery, containing cremation urns, along with fragments of calcinated bone, grey ware pottery and a brooch.	BEM1/62 MLO23210 MLO617
63	10 Bemish Road WHS excavation in 1972 uncovered sherds of Neolithic pottery (Fengate and other), flints, a few Iron Age pottery sherds and a great deal of Roman pottery and building material. Other Roman features discovered included two ditches and two hearths.	BEM3/72
64	Spring Passage WHS investigation as part of flood defence works	PAS II & III MLO13097

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	in 1978: four Roman pot sherds; later medieval pottery dating to the 14th and 15th centuries; 17th century pottery; late 17th– early 18th century brick foundations and late 19th century fill material. (Roman and medieval finds were uncovered as part of the PAS II investigation; 17th–19th century remains as part of PAS III).	MLO13116 MLO9594 MLO12171
65	22 Bendemeer Road WHS investigation in 1977 revealed prehistoric flint flakes; and Roman settlement remains, including tile and pottery sherds, dating from the 1st to the 5th centuries AD; late medieval pottery; post-medieval pottery and the remains of a WWII air raid shelter.	PAS I MLO12035 MLO10494 MLO10513 MLO23279 MLO12016
66	51 Lower Richmond Road The find spot of a Roman coin, minted in the 1st century AD, brought to the attention of WHS by a local resident; date of discovery unrecorded by the GLHER.	MLO10493
67	6–12 The Platt Roman settlement evidence, including a ditch system, postholes and associated floor, and a cremation burial, discovered by WHS; date of investigation unrecorded by the GLHER.	GAY X MLO22041 MLO10483 MLO10484
68	37 Lower Richmond Road An unclassified Roman find from an investigation by the WHS in 1967. No further information listed in the GLHER.	GAY XI MLO1479
69	Thames Channel, opposite the Putney slipway A number of finds dating to the Mesolithic period, including two unclassified finds, two axes and a blade were uncovered here, probably recovered in channel dredging.	MLO105 MLO14586–90
70	Thames foreshore, Fulham Five unclassified finds, recorded by the PAS as having been discovered in 2008. No further information listed in the GLHER.	MLO100370 MLO100371 MLO100372 MLO100373 MLO100374
71	Thames foreshore, Fulham Antiquarian find of a 1st century Roman legionary	MLO8665

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	sword with a highly decorated scabbard, dredged from the Thames in 1846.	
72	Thames foreshore, Fulham Unclassified find, recorded by the PAS as having been discovered in 2009. No further information listed in the GLHER.	MLO100429
73	Thames foreshore, Fulham A possible mooring block/feature. Noted by the TDP in 2011.	FHM07 TDP 2011 A305
74	Thames foreshore, Fulham Timber cofferdam. Noted by the TAS in the 1990s.	FHM07 TAS 1999 A108
75	Thames foreshore, to the east of Putney Bridge Square, timber pile; possibly related to the construction of Putney Old Bridge (c. 1729). Noted by the TDP in 2011.	FWW03 TDP 2011 A309
76	Thames foreshore, Fulham An anchor chain; probably modern. Noted by the TAS in the 1990s.	FHM07 TAS 1999 A113
77	Thames foreshore, Fulham A possible causeway structure; consisting of four roundwood stakes. Possibly associated with Bishop's Palace Stair. Noted by the TAS in the 1990s.	FHM07 TAS 1999 A107
78	Thames foreshore, to the east of Putney Bridge A copper-alloy mid 2nd–3rd century Roman mount-looped vessel documented by the WHS.	524230; 175650
79	Thames foreshore, to the east of Putney Bridge The approximate location of numerous finds, including a mid-Bronze Age spearhead with a narrow, leaf-shaped blade; a lead bird, thought to be Roman, found in 1987; an iron sword with a double-edged blade dated to c. 1300 discovered in 1922; a 17th century iron dagger with a leaf-shaped blade, curved quillons and a wooden grip, discovered in 1922; an 18th century iron hammer with an original oak handle discovered in c. 1922; and a post-medieval gold ring with a herringbone decoration, inscribed "Je ne croisse tout seul",	524250; 175620

HEA ref no.	Description	Site code/ GLHER ref/ List entry number
	with an angel in enamel and loop for suspension. Chance finds were also made of one or more medieval coins (pennies); pilgrim badges (some dedicated to Mary and possibly reflecting a medieval ferry point by St Mary's church), and a medieval sword dated to the 13th century.	
80	Thames foreshore, to the east of Putney Bridge Iron Age spearhead and four worked flints including a Mesolithic/Neolithic flint blade, found pre-1981.	524300; 175600
81	Thames foreshore, to the east of Putney Bridge The findspot of a 2nd century Samian (glossy, red-brown fine pottery; mass-produced and used as tableware) bowl, discovered by chance in 1998.	524305; 175613
82	Thames foreshore, to the east of Putney Bridge The findspot of a late Iron Age-early Roman copper-alloy rosette/thistle brooch, discovered by chance in 1995.	524307; 175610
83	Thames channel, to the west of Putney Bridge Antiquarian findspot of an early Palaeolithic handaxe, dredged from the site as part of the construction of the present Putney Bridge in the 1880s.	524200; 175750
84	Felsham Road An investigation was carried out here by the WHS in 1976, which uncovered numerous early Neolithic remains indicating a settlement, including pottery, evidence of flint-knapping and a fire-pit.	FEL VI
85	Felsham Road/Kingsmere Close WHS investigation in 1986 revealed Roman pottery and a possibly Roman ditch. Large quantities of 19th century (Victorian) finds were also recovered, consisting mainly of bottles, jars, and glass and paint pots.	FEL X

E.2 Site location, topography and geology

Site location

E.2.1 The site consists of two separate areas; the main site and the temporary slipway site (the secondary site). It is located on the south bank of the Thames foreshore to the west of Putney Bridge (the main site lies partially beneath the bridge). It is bounded by the Thames embankment and Lower Richmond Road to the south, the River Thames and Thames foreshore to the north and west, and the foreshore and grounds of the Church of St. Mary the Virgin to the east. The site lay in what was the ancient parish of Putney, within the former boundary of the county of Surrey.

E.2.2 The southern-central part of the main site is occupied by a cobbled 19th century slipway leading down from the eastern end of the Thames embankment. The eastern part of the main site contains the southern approach to Putney Bridge, under which Bazalgette's Low Level Sewer to Deptford runs. Sewer outfalls, protected by metal gates, form part of the structure of the southern stone abutment of Bazalgette's 1884 Putney Bridge (Grade II listed), within the main site. The western part of the main site includes Putney Pier, originally constructed in the 19th century, although the present structure appears to be a 20th century re-build. The remainder of the site is undeveloped and comprises part of the southern bank of the Thames foreshore beneath and to the east and west of Putney Bridge.

E.2.3 The northwestern part of the secondary site is occupied by a concrete and tarmac slipway which opens out from the Thames embankment wall at pavement level, and slopes down from southwest to northeast towards the Thames foreshore. The rest of the site comprises an undeveloped section of the southern Thames foreshore, with the northern-most part of the secondary site lying within the Thames channel.

Topography

E.2.4 The level of the surrounding area slopes gently down to the northeast, towards the Thames embankment, from 106.9m ATD (above Tunnel Datum; the equivalent of 6.9m Ordnance Datum) on Putney High Street, c. 165m to the south of the main site, to 106.2m ATD at Lower Richmond Road, immediately south-west. The slipway within the main site slopes down to the Thames foreshore from 104.8m ATD to 101.1m ATD. The Thames embankment opposite the secondary site lies at 104.3m ATD, on a northeast slope down from c. 108m ATD at the junction of Bendemeer and Lower Richmond Road. Along the foreshore the ground level drops down towards the Thames from 100.2m ATD to 99.7m ATD at the main site, and from c. 101m ATD to c. 98m ATD at the secondary site. The river bed lies at c. 97.5m ATD along the northeastern boundary of the main site. The foreshore currently appears to be in a relatively stable condition, with no obvious deterioration to features previously identified as part of the Thames Archaeological Survey (TAS) in the 1990s.

Geology

E.2.5 The site is located on a narrow strip of shallow alluvium and gravels on the southern side of the Thames floodplain between two significant tributaries, the Beverly Brook, c. 700m to the northwest, and the Wandle c. 1.3km to the south-east (British Geological Survey digital data). The northern part of the secondary site extends a short distance into the mouth of the valley of the Beverley Brook. The Kempton Park river terrace slopes down towards the site from Upper Richmond Road, with a break in slope c. 30m to the southwest of the site onto the floodplain, which is underlain by Shepperton Gravels. The proximity of the gravel terrace to the river is significant in floodplain environments as it could have formed a focus for prehistoric human activity given the resources the river provides. Throughout all periods the well-drained terrace gravels would have been ideal for farming and occupation and beyond the level of inundation when the river was in flood.

E.2.6 The stream to the northwest of the site, now known as the Beverley Brook, was far more powerful in the late Devensian and early Holocene. It is now a small (canalised) stream within a floodplain c. 200m wide which, at the confluence with the Thames, widens to c. 2.5 km across. Although the site lies to the extreme east of this confluence, the area as a whole would have been of significance in the prehistoric period as rivers provided route ways through the thick deciduous woodlands occupying the gravel terrace to the fertile mosaic of wetlands at the convergence of the two rivers.

E.2.7 Modern bathymetric data shows the current level of the gravel foreshore/riverbed within the main site at c. 100m ATD, at the Embankment edge, to the east of Putney Bridge. This is comparable to the levels of gravel observed in the boreholes described in para E.2.8below, indicating that ground levels across this stretch of Putney foreshore (between Putney Bridge and the Beverley Brook) are relatively uniform. Levels of London Clay observed within boreholes on this stretch of the foreshore lie at c. 94.0–95.0m ATD. By contrast, the level of London Clay directly beneath Putney Bridge is significantly higher than might be expected in the floodplain in this area (c. 101.8m ATD). This indicates an area of higher topography in the immediate vicinity of Putney Bridge, which would have proved ideal for a river crossing from the prehistoric period onwards. This crossing is the reason for the development of the historic Roman, medieval and later settlement here; as reflected in the concentration of known archaeological remains along the foreshore and on land in the vicinity of the bridge at Putney and Hammersmith.

E.2.8 The majority of the available borehole logs are antiquated and poor in detail. Borehole TQ27NW36, which lies within the main site, landward of the river wall and immediately to the east of Putney Bridge, recorded c. 4.5m of made ground directly overlying London Clay at c. 101.8m ATD. Borehole TQ27NW33 is also located within the main site, within the Thames Channel beneath Putney Bridge. This borehole log records river mud (silty clay) deposits directly overlying London Clay at a depth of c. 94.0m ATD. The levels indicate a steep slope from the gravel terrace

edge at the riverbank towards the channel. Both the borehole logs date to 1862 (prior to the construction of Putney Bridge), with TQ27NW36 lying beneath or adjacent to the Chelsea Aqueduct, and TQ27NW33 within the grounds of St. Mary's Church, at the approach to Putney "Old" Bridge. Although the logs provide evidence of the levels of gravels and London Clay, they are not considered representative of the site, the majority of which lies directly on the foreshore. A more recent borehole log immediately adjacent to the southwest corner of the site, located on Putney Embankment (SR1112), records 4.9m of made ground, overlying gravel at c. 100m ATD. As the borehole is located within the Embankment and the ground has been subject to significant past construction impacts, the results are likewise not considered representative of the site.

E.2.9 An additional recent borehole within the southwest corner of the site, also located on Putney Embankment (6910), records similar deposits of made ground overlying gravel as that recorded previously in SR1112.

E.2.10 It would appear from the lack of alluvium indicated by current ground levels and the available borehole logs that alluvial deposits are unlikely to survive within the main site. The lack of alluvium west of Putney Bridge would imply a significantly reduced archaeological potential, and may reflect localised truncation associated with post-medieval construction activity, such as dredging or the construction of slipways or hardstanding. Alternatively (and more probably, considering the extent of the foreshore), it is a result of natural fluvial erosion. The site lies on the outside of a wide meander of the Thames, hard up against the gravel terrace, where erosion of the finer material such as silts and clays would be at its greatest. It lies equidistant between two significant tributaries with the largest being the Beverley Brook, which, as mentioned above, has a wide mouth at the confluence with the Thames. These areas can act as sediment traps which would further reduce the net accumulation of sediment in the main river system around the site. The scouring erosion caused by the River Thames is likely to have removed alluvial deposits earlier than post-medieval date. The shallow alluvium observed overlying the predominantly gravel surface of the foreshore is likely to have been deposited through modern silting. If deeper alluvial deposits do survive they are likely to be best preserved in close proximity to the river terrace and landward of the river wall, and not on the foreshore. It is worth noting that there is better preservation of archaeological deposits on the east side of the bridge (eg **HEA 1V** – within the main site; **HEA 45** and **HEA 79–82**). This may suggest greater erosion occurring on the western side; or possibly that construction of the embankment here means that the modern foreshore to the west lies further into the area of the former Thames channel. An archaeologically monitored geotechnical borehole proposed for the main site may clarify the survival of alluvial deposits and the potential for preservation of archaeological remains *in situ*.

E.2.11 Similarly, there is no nearby borehole evidence for the secondary site. The closest available borehole log, (SR4057), c. 400m to the northwest at the mouth of the Beverley Brook floodplain, records alluvium lying at c. 100–102.4m ATD, above the gravel terrace. The surface of gravel here lies at c. 100m ATD, with London Clay lying at a depth of c. 95.0m ATD,

similar to the levels recorded in borehole TQ27NW33. As the ground level of the gravel terrace within the slipway site lies at c. 98.0–99.5m ATD, the implication is that alluvial deposits of archaeological interest are likely to have been removed as a result of fluvial erosion. However, as at the main site, an archaeologically monitored geotechnical investigation would be needed to verify this.

E.3 Past archaeological investigations

E.3.1 Numerous archaeological investigations have been carried out on the site in the past. The Wandsworth Historical Society (WHS) have undertaken foreshore surveys since the 1970s, and the Thames Archaeological Survey (TAS) undertook walkover, or "Alpha", surveys during the 1990s. Most recently, the Thames Discovery Programme (TDP) (2009–2011) has recorded the foreshore structures to the east of Putney Bridge (**HEA 1A**), including the surviving brick abutment for the original 1729 Putney Bridge (**HEA 1V**) which lies within the main site. A TAS survey carried out in 1999 identified the remains of post-medieval flood defences in the form of a row of wooden piles (**HEA 1C**), located within the southern boundary of the main site; 19th century outfall gates (**HEA 1K**) for the Bazalgette Sewer running beneath Putney Bridge; and post-medieval piles (**HEA 1L**) beneath the bridge approach piers in the eastern part of the site. Isolated Prehistoric, Roman, medieval and post-medieval finds have also been recorded from the foreshore and the Thames channel to the east of Putney Bridge, although the context of some of these finds suggest they were not all recovered in situ (ie, not from their original depositional context).

E.3.2 The historic nucleus of Putney, around the river crossing, is a known Roman settlement. Several archaeological investigations were carried out by the WHS in the 1960s and 1970s to the south of the main site, landward of Putney Embankment. These revealed numerous finds and extensive remains of Roman features, including road surfaces (**HEA 22, 23, 28** and **31**); ditches (**HEA 22, 25, 28, 31, 32, 63**, **67** and **84**); building foundations; stakeholes or postholes (**HEA 25, 31, 63** and **67**); cremation burials (**HEA 62** and **67**); spreads of pottery sherds (**HEA 24, 26, 29, 63, 64** and **65**), and coins (**HEA 26** and **66**). The quantity of finds recovered from these investigations, which are mainly concentrated within an area c. 500m to the west of Putney Bridge and c. 50–200m inland of the present foreshore, indicate an active and prosperous settlement within the assessment area, which appears to have survived into the 5th century (WHS pers. comm.).

E.3.3 Other past investigations include an evaluation at Putney Wharf, on Putney Bridge Road (**HEA 40**), c. 35m to the south-east, which uncovered prehistoric flint and a Roman coin and structural remains, as well as medieval agricultural features cut by later 18th century domestic and agricultural features. At 2–4 Lower Road (**HEA 3**), c. 20m to the southwest, the remains of three wharfs (possibly overlying earlier timber structures), dating to the 16th–18th centuries were discovered, along with coins, pottery and other finds from the Roman, medieval and post-

medieval periods. An evaluation at ICL House on Putney High Street (**HEA 4**), c. 110m to the south-east of the main site, uncovered medieval ditches, the remains of 17th–19th century cottages, and associated agricultural features.

E.4 Archaeological and historical background of the site

E.4.1 The following section provides a detailed archaeological and historical background for the site. It should be read alongside the research framework presented in Appendix C to Vol 2 Appendix E2, which sets the overall Thames Tideway Tunnel project, and the individual site-specific assessments, within a broader historic environment context (ie, 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 Several finds dating from the Lower Palaeolithic to the Iron Age have also been discovered within the assessment area, particularly on the foreshore at Putney and Fulham, and to the west of Putney Bridge. The finds suggest activity and settlement within the area from the Neolithic (and possibly the Mesolithic) to the Iron Age period, focusing on the Thames as a river crossing and a source of food and water. Finds of flint tools, weapons and pottery provide evidence of hunting and domestic activity. The naturally fertile and well-drained gravel terrace would have provided ideal conditions for settlement. Putney was the only site between the Strand and Richmond where gravel terraces reached the river's edge, providing a firm landing area for a river crossing which was not prone to flooding. The Thames at this location, in this period, was non-tidal and it is likely that a ford and a possible trackway (Gerhold, 1994)[1] may have existed close to the site in later prehistoric periods.

E.4.3 There are few known finds dating to the Palaeolithic and Mesolithic periods within the assessment area, and those which have been recovered appear to be mainly residual. Palaeolithic flints from the main site (**HEA 1B** c. 15m north of the present Putney Embankment) and vicinity (**HEA 11** c. 15m to the northeast of the main site; and **HEA 83** c. 55m to the northeast) are chance finds redeposited within the terrace gravels or riverbed and not indicative of in situ deposits or activity at this early period.

E.4.4 There is a greater likelihood of Mesolithic and Neolithic finds being representative of activity in the vicinity. Prehistoric flint blades and a Mesolithic-Neolithic flint blade were recovered from the foreshore c. 85m to the east of site (**HEA 80**), whilst two Mesolithic axes, a blade, and two unidentified finds (**HEA 69**), were recovered from the Thames Channel, c. 55m to the northeast of the secondary site. Mesolithic remains have also been recovered at Gay Street and Felsham Road beneath Roman settlement remains, and may indicate more extensive finds/remains which

were scattered or damaged by subsequent Roman activity (Greenwood, 2012)[2].

E.4.5 Decorated Neolithic pottery is known to have been produced in Putney, and there is evidence of Neolithic settlement to the southwest of the main site. An early Neolithic flint-knappers' hearth and Neolithic pottery was discovered at Felsham Road (**HEA 84**), c. 125m to the southwest of the site, whilst pottery and flints were recovered from The Platt area, c. 170m to the southwest (outside) of the main site, and from Felsham Road/Kingsmere Close (**HEA 85**), c. 100m to the southwest. These discoveries suggest Neolithic settlement and activity in the area of the riverside west of Putney High Street (MacRobert, 2009)[3]. An excavation carried out by the WHS at 10 Bemish Road (**HEA 63**), c. 125m to the southwest of the secondary site, uncovered sherds of Neolithic pottery and flints. A Neolithic axe (**HEA 10**) was recorded by the Portable Antiquities Scheme (PAS) as having been found in the Thames channel c. 200m southeast of the main site.

E.4.6 There are no known finds dating to the Bronze Age landward of the Putney Embankment or on the Putney foreshore, although flint scrapers discovered at 10 Bemish Road (**HEA 63**) may include early Bronze Age examples (Greenwood, 2012)[4]. A concentration of around forty objects, mainly late Neolithic to late Bronze Age axes, palstaves, a Bronze Age sword, spearheads, pottery sherds, flint implements, a Bronze Age pin, a ring, a razor and a bowl, were all discovered on the Fulham side of the Thames foreshore, opposite the main site, c. 100m to the north (**HEA 21**). The quantity of finds suggests they were recovered as a result of dredging. An unclassified structure consisting of two small posts was also exposed within a peat layer at this location, at lowest tide; perhaps the remains of a trackway or river crossing. A Bronze Age ring (**HEA 39**), was recovered from the Thames channel in 1915, c. 40m to the northeast of the main site, and a Bronze Age spearhead (**HEA 79**), c. 30m to the east.

E.4.7 The closest known Iron Age remains to the site comprise two pieces of human cranial (skull) bone dating to the mid-Iron Age (**HEA 45**), which were spotted on the Thames foreshore at very low tide in 2003, c. 75m to the east of the main site. The skull bones are believed to have belonged to a mature male and were recovered from within a black-grey silty sand deposit to the east of Putney Bridge. This may indicate exposure and erosion of *in situ* prehistoric strata surviving within the foreshore to the east of the bridge.

E.4.8 There is more comprehensive evidence for Iron Age occupation within the assessment area landward of Putney Embankment. Iron Age pottery was discovered at 38 Felsham Road (**HEA 31**) c. 140m to the southwest of the main site, perhaps from an early ditch in a later Roman settlement area[5]. The excavation at 10 Bemish Road (**HEA 63**), also uncovered a scatter of Iron Age pottery sherds, as did an investigation at 22 Bendemeer Road (**HEA 65**). A late Iron Age or early Roman copper-alloy rosette or thistle-shaped brooch (**HEA 82**) was also discovered by chance in 1995 on the foreshore, c. 95m to the east of the site. Three Iron Age wooden piles were observed on the Fulham foreshore immediately to the west of Putney

Bridge as part of a TDP survey in 2009 (**HEA 54**), c. 115m to the north of the main site and may indicate a river crossing between the present Hammersmith and Putney river banks in the approximate area of the current Putney Bridge, suggesting the importance of the both riverbanks as a focal point for settlement and activity in the later prehistoric periods. Mid-late Iron Age coins have also known to have been recovered from the vicinity of Putney Bridge, although their exact findspots are unknown.

E.4.9 There have also been numerous other chance and antiquarian finds of prehistoric artefacts within the assessment area. At present, the exact locations of these finds are unknown and they are currently being documented by the WHS. They largely comprise flint artefacts; flint and antler tools and weapons, including spearheads, axes, daggers and swords, and bone artefacts such as pins. Otherwise undated finds from the assessment area include a prehistoric struck flint, discovered during an evaluation carried out at Putney Wharf, on Brewhouse Street (**HEA 40**), c. 35m to the southeast of the main site, and a struck flint tool, recovered from ICL House on Putney High Street (**HEA 4**), c. 105m to the southeast. Later remains were discovered during these investigations, including medieval ditches and post-medieval building materials and foundations, which may have removed earlier, more extensive prehistoric or Roman remains.

Roman period (AD 43–410)

E.4.10 The fertile gravel terrace soils beside the River Thames would have provided ideal farming land in the Roman period. The Thames was not tidal at this location in this period (Gerhold, 1994)[6], and the low risk of flooding made the area to the south of the site ideal for settlement. The presence of a settlement is confirmed by archaeological evidence recovered as part of numerous past investigations carried out within the assessment area to the south and southeast of the site. These include the remains of road surfaces and ditches, building material and iron production waste, large quantities of pottery and coins and cremation burials. The quantity and nature of the finds recovered suggest a prosperous settlement. Samian pottery (a glossy red-brown, highly decorated pottery used as tableware), dated from the 1st to the 3rd centuries, and very late coins, dated to the reign of the Roman emperor Arcadius (AD 395–408) (**HEA 3**), suggest the settlement was relatively long-lived and functioned until at least the early 5th century (Greenwood, 2012)[7].

E.4.11 An extensive road network existed within Roman Putney (Vol 7 Plate E.1 and Vol 7 Plate E.2). Four or five sections of a metalled road on the line of the Upper Richmond Road, which lies roughly parallel to, and c. 1.4km to the south of the main site, have been discovered from its junction with Putney High Street, heading west. Felsham Road and The Platt, both within the assessment area and to the south of the site, are also believed to have followed Roman roads (MacRobert, 2009)[8], suggesting a communication network within the area. This network is likely to have extended across the Thames to Londinium, c. 10.4km to the northeast of the site, with roads running close to the Roman foreshore (which would

have lain further north than the present foreshore, ie, within the present Thames channel). The Roman road running along Thames Place has been tracked almost as far north as Putney Embankment (HEA 7), c. 35m to the southeast of the secondary site, and lies opposite a linear feature on the same alignment within the grounds of Fulham Palace (Greenwood, 2012)[9], across the Thames, suggesting a likely crossing point at this location. It may therefore lie at the crossing point of the river, the focus of the Roman settlement, lay to the west of the modern bridge, between (but inland from) the main and secondary sites, although this is a tentative conclusion.

E.4.12 The only known find dated to this period within the site comprises a mount (**HEA 1Y**) (decorative metal plating) recorded on the PAS database as having been found on the foreshore, and is likely to be residual. However, several past investigations and chance discoveries have taken place within the assessment area. These can be divided into two main areas of previous investigation, the majority of which were carried out by the Wandsworth Historical Society during development carried out from 1962–1986 (Greenwood, 2012)[10].

E.4.13 The first is located to the south of the main site, either side of Putney High Street. This includes the remains of a road and ditch both dated to the 1st century, which were uncovered at the Hippodrome Theatre car park (**HEA 22**), c. 90m to the southwest. At 38 Felsham Road (**HEA 31**), c. 140m to the southwest, a ditch, the remains of a hut with stakeholes and rubbish pits were discovered. Quantities of slag and the remains of furnaces and iron objects, including ladles and nails, have also been recovered in the Felsham Road area (MacRobert, 2009)[11]. Roman pottery and the possible remains of a Roman ditch were also discovered at Felsham Road/Kingsmere Close (**HEA 85**), c. 100m to the southwest of the site. An evaluation at Putney Wharf, on Brewhouse Street (**HEA 2**), c. 30m to the southeast of the main site, uncovered a Roman coin and Roman structural remains. Further to the south, along Felsham Road adjacent to Wiemar Street (**HEA 33**), c. 160m to the south of the main site, a Roman pit and ditch were discovered. Late Roman coins and pottery were recovered from an excavation carried out at 2–4 Richmond Road (**HEA 3**), c. 20m to the southwest, where eleven coins dating mainly from the 370s to the 390s were discovered.

E.4.14 The second area is concentrated along Waterman Street and Bemish Road, to the south of the foreshore between the main site and the secondary site. An excavation at 4 Bemish Road (**HEA 62**), c. 110m to the south of the secondary site, revealed what is believed to be a cemetery, containing cremation urns and fragments of calcinated bone, greyware pottery, and a brooch. There is also a reference to a cremation urn from “Point Common”, at the northern end of Thames Place, c. 90m to the northwest of the site (Greenwood, 2012)[12], which was excavated in 1967, and is shown in Vol 7 Plate E.3. A Roman road and ditch were uncovered c. 130m to the south-west of the main site, at 24–38 The Platt (**HEA 28**), whilst at 6–12 The Platt (**HEA 67**), c. 100m to the south of the secondary site, the remains of a ditch system, postholes and an associated floor surface, and a cremation burial were discovered. An

excavation at 6 Waterman Street (**HEA 25**), c. 75m to the southwest of the main site, uncovered a shallow ditch, postholes and a scatter of pottery, whilst at Felsham Street (**HEA 32**), c. 90m to the south, another pit and the remains of a ditch were discovered.

E.4.15 Isolated known Roman remains recovered from the assessment area include tile, recovered from within the grounds of St. Mary's Church (**HEA 9**) and at 22 Bendemeer Road (**HEA 65**); pottery sherds and assemblages, discovered at 2–4 Lower Richmond Road (**HEA 3**), 2 and 7 Waterman Street (**HEA 24** and **26**), at the junction of 13–14 Waterman Street (**HEA 29**), 38–42 Gay Street (**HEA 30**), Spring Passage (**HEA 64**) and 22 Bendemeer Road (**HEA 65**); and coins and pottery were discovered at 2–4 Richmond Road (**HEA 3**), 7 Waterman Street (**HEA 26**), 38–42 Gay Street (**HEA 30**), and 51 Lower Richmond Road (**HEA 66**). 'Unclassified' Roman finds were also made at 2–4 Lower Richmond Road (**HEA 3**), 22–25 Waterman Street (**HEA 27**), and 37 Lower Richmond Road (**HEA 68**). The PAS database also records the discovery of a coin found on the foreshore c. 50m southeast of the main site. Roman finds have also been recovered from the foreshore to the east of the main site, including a 2nd century Samian bowl (**HEA 81**) c. 90m to the east, and a copper-alloy mid-2nd to 3rd century vessel (**HEA 78**), c. 10m to the east.

E.4.16 The GLHER records the antiquarian discovery of a "highly decorated" Roman scabbard (**HEA 71**), dredged from the Thames in 1846, c. 95m to the north of the secondary site. On the foreshore c. 105m to the north of the main site at Fulham, a scatter of Roman building material (**HEA 48**) was recovered. These finds suggest the continuation of the wider Roman settlement opposite Roman Putney on the Fulham foreshore, and the function of this stretch of the Thames as a crossing point and communication/trade route. Numerous chance and antiquarian finds have also been recovered from within the assessment area. These are likely to comprise mainly isolated finds of pottery and other artefacts. At present, the exact locations of these finds and settlement remains are unknown. They are currently being documented by the WHS.

E.4.17 The concentration of remains recovered from within a relatively small area suggest that the present riverbank to the south and southwest of Putney Bridge was a thriving settlement in the Roman period, engaged in extensive farming and trading activity. The settlement was larger and more important than typical rural settlements outside the Roman city of Londinium (Greenwood, 2012)[13]; probably due to its location by the river and ideal crossing conditions. Despite this, and the proximity of a network of Roman roads leading to the foreshore, there is no known ford or ferry crossing on the stretch of foreshore in which the site lies. This may be due to scouring erosion along this stretch of the foreshore, or the construction of post-medieval slipways along it, which may have removed earlier remains.

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

E.4.18 The main evidence of Saxon occupation of the local area is derived from place names. The current name of Putney is derived from the Anglo-Saxon name of "Puttenhythe", meaning "Putta's hythe" or "Putta's landing

place". This emphasises the importance of the area adjacent to Putney Bridge as a river crossing. It is likely that an early medieval settlement, perhaps largely engaged in fishing and farming, was present along the riverfront and potentially within the area of the site. Nearby evidence of such activity includes an early Saxon fish trap, recorded c. 200m to the east of Putney Bridge (outside the assessment area).

E.4.19 There are no known archaeological remains dated to this period within the site. A pin beater of this date was recorded on the PAS database as having been recovered from the river c. 50m southeast of the main site. It is possible that some of the undated medieval pottery and coins discovered at 2 Waterman Street (**HEA 24**), c. 65m to the west of the main site, at 22–25 Waterman Street (**HEA 31**), c. 120m to the southwest, and at 24–38 The Platt (**HEA 28**), c. 130m to the southwest, may date to this period.

Later medieval period (AD 1066–1485)

E.4.20 Putney is first mentioned in Domesday Book in 1086. The only reference relates to a toll from the fishery, received by Mortlake (now Wimbledon) manor. The ferry at Putney is mentioned as yielding 20s per annum to the lord of the manor (Lysons, 1792)[14]. The remains of a medieval ferry boat (**HEA 15**, exact date unknown) are believed to lay within the main Thames channel, beneath Putney Bridge, c. 100m to the northeast of the site. It is possible that there may have subsequently been a wooden bridge across the Thames in the latter half of this period (Weinreb et al., 2008)[15], perhaps on the site of the later wooden bridge within the eastern part of the site, constructed in 1727–1729.

E.4.21 The extent of the medieval settlement of Putney in relation to the site is uncertain, although it is likely that the site lay on the waterfront edge of the settlement itself within an area of revetments and wharves, around the ferry point and church, to the west of an area of houses and shops along the present High Street, whilst the land to the south of the site was probably farmed.

E.4.22 St. Mary's Church (**HEA 41**), c. 20m to the south-east of the main site, dates to the 13th century, and, along with the river crossing, would have formed the focus of the village. The early foundations of the church were discovered during excavations carried out in 1975–1976 (MacRobert, 2009)[16]. The remains of medieval window fittings (**HEA 16**) dating to the 15th century and presumably related to building alterations carried out at the church were recovered from the Thames beside the foreshore, c. 20m to the east.

E.4.23 Medieval ditches provide further evidence of activities carried out in this period and have been recorded as part of an evaluation at Putney Wharf on Brewhouse Street (**HEA 40**), c. 35m to the southeast of the main site, and at ICL House, on Putney High Street (**HEA 4**) c. 105m to the south-east. Chance finds of medieval pottery and coins have been recovered c. 65m to the west, (**HEA 24**), c. 120m to the south-west, (**HEA 27**), and c. 125m to the southwest (**HEA 28**). Medieval pottery was also recorded at 2–4 Lower Richmond Road (**HEA 3**), c. 20m to the southwest of the main

site, and at 2 Waterman Street (**HEA 24**), c. 60m to the southwest, whilst a medieval lynchet was recorded at 38 Felsham Road (**HEA 31**) c. 120m to the southwest. Medieval pottery dated to the 14th and 15th centuries was discovered during an excavation at Spring Passage (**HEA 64**), c. 40m to the west of the secondary site. A medieval pot sherd (**HEA 1P**), has been discovered within the site, which may be related to nearby 13th century potsherds (**HEA 17**), discovered c. 30m to the east of the main site. An iron sword with a double-edged blade dated to c. 1300, later medieval coins and several pilgrim badges (**HEA 79**) were also discovered c. 40m to the east of the site.

Post-medieval period (AD 1485–present)

E.4.24 In the 17th and 18th centuries the site was situated on the waterfront, to the north and west of the settled area of buildings clustered along the High Street. The site may have been used as a landing or mooring place, which is supported by the discovery of the remains of post-medieval causeways and slipways to the east of the current Putney Bridge (**HEA 1A**), including the remains of a timber structure, possibly a causeway, dated to the 18th century (**HEA 20**), c. 95m to the east of the site, and a 19th century cobbled slipway (**HEA 19**), c. 70m to the east.

E.4.25 The inland area to the south was occupied by cultivated fields and market gardens. The area to the south and south-west of the site developed rapidly as the town expanded from the area of the High Street, particularly from the mid-19th century, when the South Western Railway was constructed.

E.4.26 The earliest post-medieval buildings within the assessment area include the tower of St. Mary's Church (**HEA 41**), which dates to the mid-15th century and the chancel, dating to the 16th century (Malden, 1912)[17]. The remains of cottages, documented from 1636–1888 (when they were demolished) were discovered during an excavation carried out at ICL House on Putney High Street, (**HEA 4**), along with the foundations of a boundary wall, identifying an area in which probable refuse pits were discovered. The remains of bedding trenches were identified to the east of the wall. Foundations of a large house, represented on 17th–19th century maps, and a post-medieval road (exact dates unknown) were also discovered on the site.

E.4.27 The earliest map of the site is a pictorial estate map by Nicholas Lane, produced in 1636 (Vol 7 Plate E.4) The area of the foreshore on which the main site is situated is occupied by a linear feature; perhaps a line of mooring posts, as a boat appears to be moored to the three westernmost posts. The river wall is shown clearly within the site. Overlooking the river wall and the Thames is a row of houses, which continue eastwards from the site area and then southwards on either side of Putney High Street. The open fields to the south of the river and east and west of the High Street are divided into agricultural strips. The secondary site, lying to the northwest to the linear moorings, is situated immediately to the north of the river wall. Beyond the wall to the south, lie narrow strips of farmland with small cottages situated to the northwest and southeast.

E.4.28 An excavation carried out at 2–4 Lower Richmond Road (**HEA 3**), c. 20m to the south of the main site, revealed the remains of three timber waterfronts, indicating that the line of the 16th–17th century lay at least 20m inland of the present Putney Embankment. The earliest dating to the latter part of the 16th century and the latest to the end of the 17th or beginning of the 18th century. Traces of other, incomplete, timbers were also recovered but were not dated, and it is not known to which structures these belonged.

E.4.29 In 1726, an Act was passed to allow the construction of a wooden bridge between Putney and Fulham, immediately to the east of the current Putney Bridge. The southern brick foundations of the earlier bridge (**HEA 1V**) was exposed and identified within the eastern part of the main site, c. 20m to the east of the existing (1884) bridge during a TDP survey carried out in 2009. Also identified were the remains of a cofferdam used in the bridge construction (**HEA 1O**); along with foundation piles (**HEA 1J**). A number of 17th and 18th century finds, perhaps associated with crossings over the 1726 bridge, were recovered to the east of the present Putney Bridge in 1922 (**HEA 79**), c. 30m to the east of the main site, including a 17th century iron dagger, an 18th century iron hammer with an oak handle, and a highly decorated, inscribed gold ring.

E.4.30 Putney Old Bridge is shown on the Corris parish map of 1787 (Vol 7 Plate E.5) which shows the majority of the present town of Putney still dominated by open fields, although a number of farm buildings, houses and other buildings have spread outwards from the High Street and embankment along adjacent streets. The main site is shown lying within the Thames, with three buildings marked along the embankment within the assessment area, including Putney Point and The Eight Bells public house. The secondary site, also lying within the Thames, is situated opposite and to the north of Chapman's Brewery. To the northwest, the land remains predominantly farmland, divided into fields of varying size.

E.4.31 In 1792, the cultivated land of Putney was described as "principally arable, including 1200 acres occupied by market gardeners" (Lysons, 1792)[18]. The Tithe Map of 1846 (not reproduced) shows the site as undeveloped foreshore adjacent to the river wall. Two roads run parallel to the river wall, one along the embankment and the other along the line of the present Lower Richmond Road. Between the embankment and the road, adjacent to (outside) the site to the south, a large building and several smaller plots of land are shown. The Tithe apportionment lists the majority of the land immediately to the south of the site as "pleasure grounds", gardens and meadows.

E.4.32 The first edition Ordnance Survey (OS) 25" map of 1862 (Vol 7 Plate E.7) shows the main site situated c. 75m to the west of the wooden bridge. An aqueduct is shown on the line of the present Putney Bridge. This was built by Chelsea Waterworks in 1854 and was later incorporated into the structure of the current Putney Bridge. Circular piles, possibly the remains of the Chelsea Waterworks viaduct (**HEA 1L**) have been identified beneath Putney Bridge, adjacent to the eastern boundary of the main site. The current Lower Richmond Road, immediately south of the site is

named Windsor Street, and a public house is shown adjacent to the river wall in the location of the current Star and Garter Hotel, (**HEA 52**), c. 120m to the northwest of the main site. A short pier, labelled 'Putney Pier' (in the same location as the rebuilt, present Putney Pier; **HEA 2B**) is shown on the foreshore in the western part of the main site, immediately to the northeast of the hotel buildings. South of Windsor Street, approximately a third of the land within the assessment area is made up of gardens to the rear of terraced houses and buildings fronting the main streets (still mainly one building deep), particularly within an area bounded by Windsor Lane to the north, Gardner Lane (the present Felsham Road), to the south, River Street (the present Waterman Street) to the west, and Putney High Street, to the east. The secondary site is shown lying on the Thames Foreshore, with a narrow runway or slipway at the eastern end of the site, and a square platform or slipway at its western end. The map also shows a major development within the wider area of Putney, with the construction of the London and South-Western Railway in 1846, c. 560m to the south of the main site (outside the assessment area).

E.4.33 The second edition OS 25" map of 1894 (Vol 7 Plate E.8) shows the south-eastern corner of the main site occupied by a slipway leading down from the current embankment (**HEA 1F**). This was laid out in 1887–1888 as a recreational area focused on local rowing clubs and is shown on the map as a wide promenade planted with trees. A urinal is located between the river wall and the slipway with a descending staircase leading down to it. Within the wider assessment area, considerable change has occurred. The current Putney Bridge, (**HEA 1A**), a Grade II listed structure constructed by Sir Joseph Bazalgette in 1882–1886, has now replaced the earlier 18th century wooden bridge which had been badly damaged by the collision of a river barge in 1870. The Metropolitan Board of Works purchased the 18th century bridge in 1879 and began to replace it with the current Putney Bridge post-1880. Putney Pier, lying within the western part of the main site, has now been extended into the channel. The southwestern part of the secondary site is now occupied by a slipway in the area of the current slipway although it is narrower than the current construction.

E.4.34 The current Putney Bridge formed part of Bazalgette's new sewerage system, with an intercepting sewer extending from Putney and joining with sewers from Upper Norwood and Clapham, joining at Deptford (Walford, 1878)[19]. Outfall gates (**HEA 1K**) for excess sewer water were constructed as part of the bridge beneath its southernmost pier. An 1883 plan of the line of the sewer and a longitudinal section illustrating the outfalls are shown in Vol 7 Plate E.6.

E.4.35 The GLHER notes remains associated with the construction of the 1884 Putney Bridge, including the remains of a chalk barge bed (**HEA 1I**) and a dump deposit of stone rubble (**HEA 1M**). A group of wooden foundation piles (**HEA 1J**), observed during the MOLA Thames Tideway Tunnel project site visit.

E.4.36 The OS map of 1894 also shows that to the south, in an area previously occupied by terraced houses and garden plots, between Windsor (Lower

Richmond) Road and Gardner (Felsham) Road, the land has been divided into large plots following the clearance of cottages to the south of Windsor Street, adjacent to the southern boundary of the site.

E.4.37 The third edition OS 25" map of 1913 (Vol 7 Plate E.9) shows lavatories (separate from the existing urinal) located between the foreshore end of the slipway and the western side of Putney Bridge, as they are currently situated today (**HEA 1D**; during the site visit, it was observed through pavement lights that the lavatories extend beneath Lower Richmond Road, to the south of the site). By 1913, Lower Richmond Road has developed into a tramway, linking it to Putney Bridge and the High Street. A large housing block, called Kenilworth Court, is located across Lower Richmond Road, adjacent to the south of the site. It was constructed on the site of the terraced houses in 1901–1903, with views over the Thames and Embankment. Putney Pier has been further extended out into the foreshore.

E.4.38 The LCC Bomb Damage Maps of 1939–1945 (not reproduced) shows no damage to the immediate vicinity of the site.

E.4.39 The Ordnance Survey 25" map of 1947 (Vol 7 Plate E.10) shows no significant changes to the site, although mooring rings are now marked on the embankment, and the slipway is shown occupying the southwestern corner of the site. Land to the southwest of (outside) the site, previously occupied by houses and gardens, has been developed for engineering works and recreational facilities. Later OS maps (not reproduced) show no significant changes to the site or the assessment area.

The current site

E.4.40 The main site comprises an undeveloped section of the Thames foreshore, with part of the eastern end of a slipway with a granite cobbled surface (**HEA 1F**), including two central parallel lines of larger slabs, running almost the length of the slipway, leading down from the Putney Embankment occupying its southwestern corner. A kerb of granite blocks runs along the slipway's southern edge. It is c. 70m long and is well maintained and in good condition as it continues to provide access to the river. Putney Pier, (**HEA 2B**), a 20th century pier structure with houseboats moored to either side (one lying within the site) is located within the western boundary of the main site.

E.4.41 Subterranean toilets (**HEA 1D**) occupy an area within and adjacent to the south-eastern boundary of the site, as marked on the OS 3rd edition 25" map of 1913 (Vol 7 Plate E.9) and identified during the site visit. These facilities are now in private ownership (Vol 7 Plate E.15 to Vol 7 Plate E.17). Their extent is not currently known.

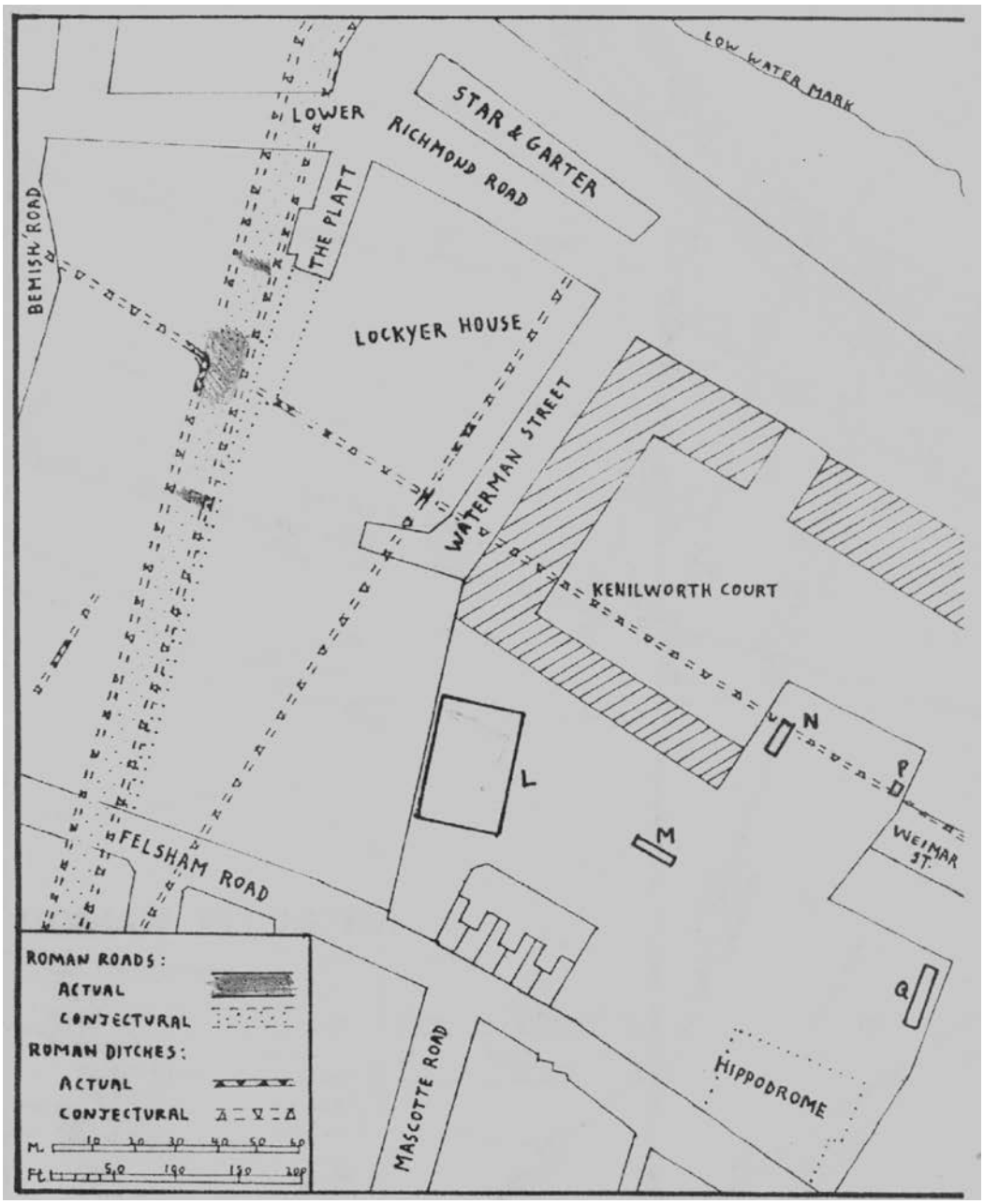
E.4.42 Structural remains and other features were observed during the site visit on the foreshore within the main site at low tide dating from the 18th and 19th centuries. Some probably relate to the construction of Putney Bridge, such as the timber pile foundations below Putney Bridge (**HEA 1J**) and a former barge bed of chalk rubble (**HEA 1I**). Also the remains of a post-medieval flood defence (**HEA 1C**), formed from timber piles have been identified within the site.

E.4.43 The secondary site comprises an undeveloped section of the Thames foreshore, with a tarmac and concrete slipway occupying its northwestern edge.

E.5 Plates

Vol 7 Plate E.1 Historic environment – the approximate boundaries of the Roman settlement at Putney, showing main Roman roads and position in relation to a Roman settlement area at Hammersmith (Wandsworth Historical Society)

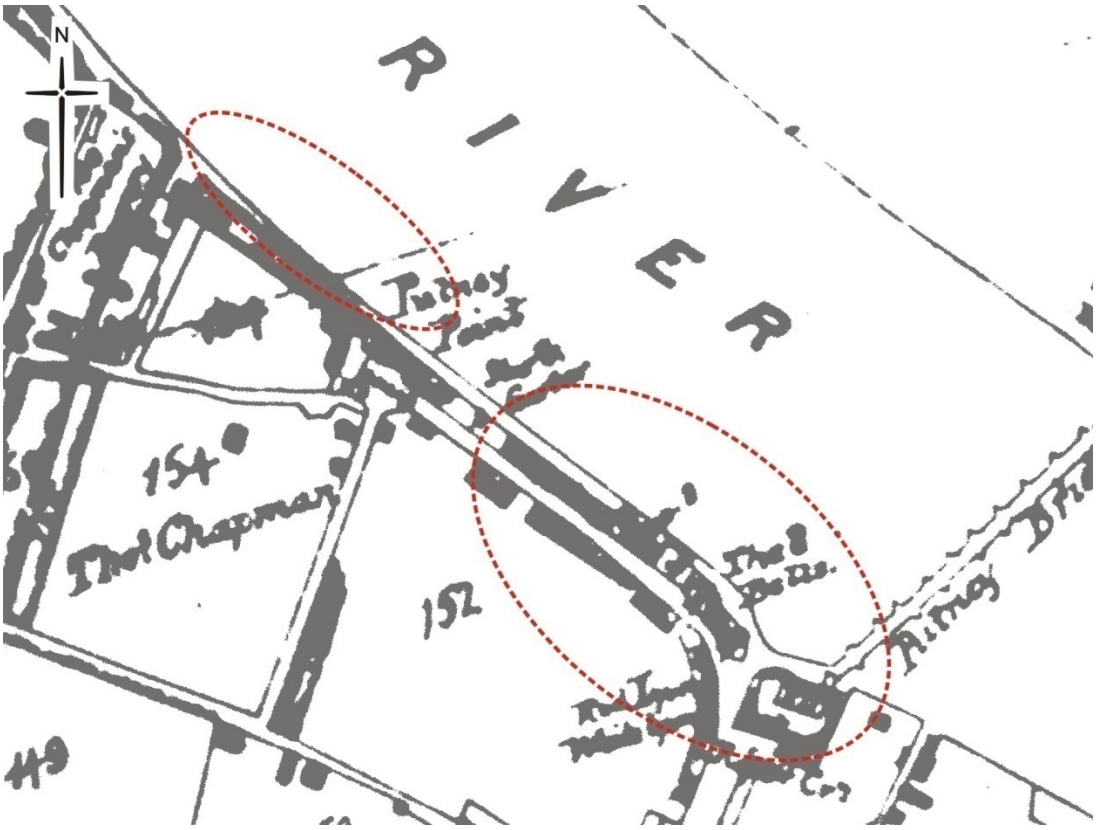
Vol 7 Plate E.2 Historic environment – main Roman roads within the assessment area to the south of the site. The line of the north-south road immediately to the south-east of the site is shown following the approximate course of the Platt (Wandsworth Historical Society)



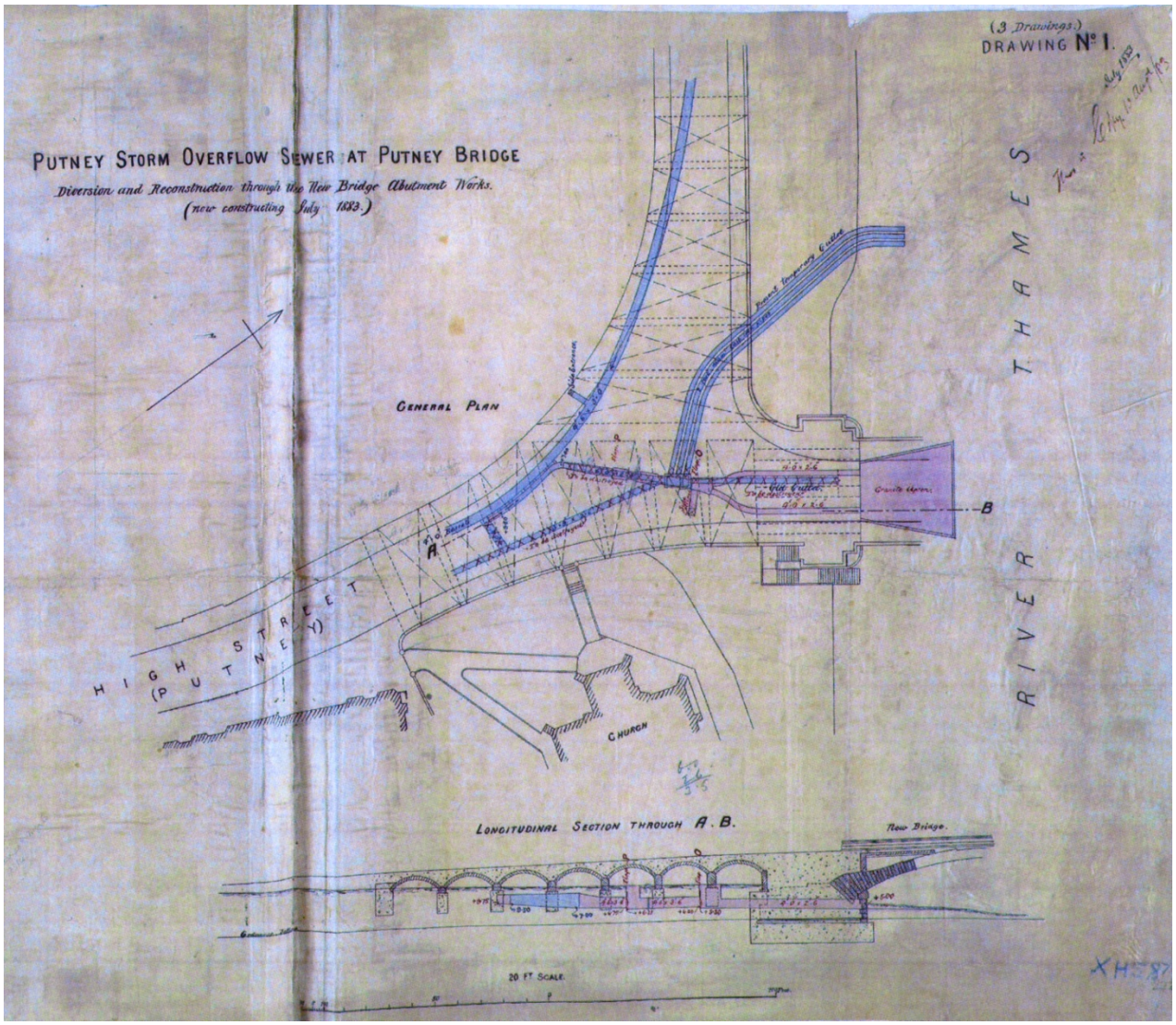
Vol 7 Plate E.3 Historic environment – a Roman cremation burial urn, discovered at the Platt (Wandsworth Historical Society; 1967)

Vol 7 Plate E.4 Historic environment – Nicholas Lane Estate map of 1636

Vol 7 Plate E.5 Historic environment – Corris Parish map of 1787

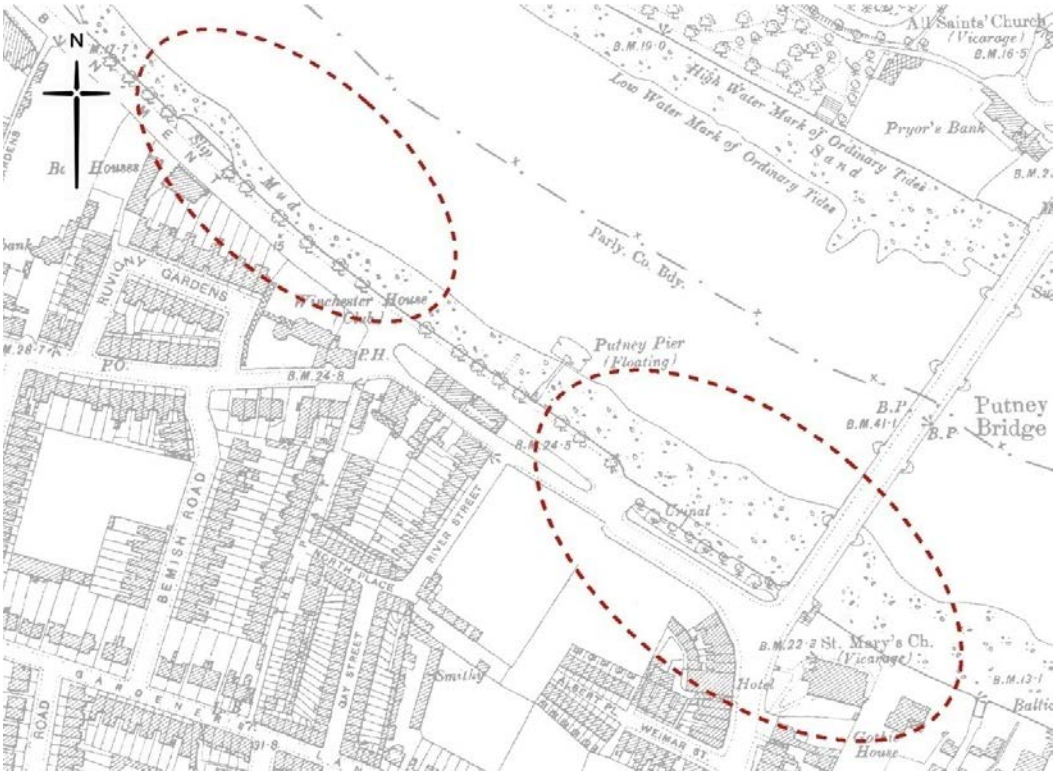


Vol 7 Plate E.6 Historic environment – a plan of the Putney Storm Overflow sewer at Putney Bridge (Thames Water; 'Abbey Mills books', Book 67, 'Low Level Sewer No. 1 Putney to Church Street Deptford', 1862)

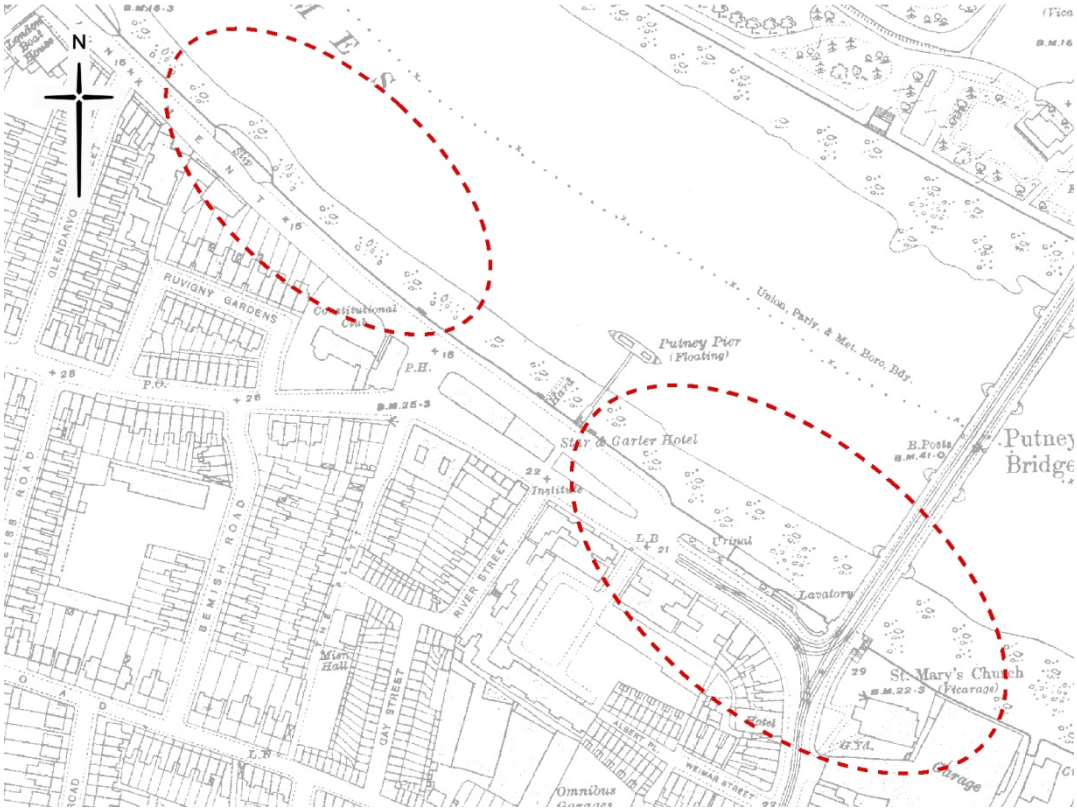


Vol 7 Plate E.7 Historic environment – ordnance Survey 1st edition 25" scale map of 1862 (not to scale)

Vol 7 Plate E.8 Historic environment – ordnance Survey 2nd edition 25" scale map of 1894 (not to scale)



Vol 7 Plate E.9 Historic environment – ordnance Survey 3rd edition 25" scale map of 1913 (not to scale)



Vol 7 Plate E.10 Historic environment – ordnance Survey 25" scale map of 1947 (not to scale)

Vol 7 Plate E.11 Historic environment – remains of a post-medieval chalk barge bed within the site

March 2011; standard lens; looking northeast (MOLA 2011)

Vol 7 Plate E.12 Historic environment – remains of wooden foundation piles beneath Putney Bridge

March 2011; standard lens; looking east (MOLA 2011)

Vol 7 Plate E.13 Historic environment – late 19th-early 20th century granite cobbled slipway and brick wall

March 2011; standard lens; looking south (MOLA 2011)

Vol 7 Plate E.14 Historic environment – late 19th century sewer outlets beneath Putney Bridge

March 2011; standard lens; looking south (MOLA 2011)

Vol 7 Plate E.15 Historic environment – late 19th century stone staircase to the west of Putney Bridge, adjacent to Putney Embankment, leading to subterranean toilets

March 2011; standard lens; looking north (MOLA 2011)

Vol 7 Plate E.16 Historic environment – modern drilling to the north side of Putney Embankment wall

March 2011; standard lens; looking southwest (MOLA 2011)

Vol 7 Plate E.17 Historic environment – brick arch revealed behind modern drill hole, believed to date to the 19th century, contemporary with Putney Bridge

March 2011; standard lens; looking southwest (MOLA 2011)

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.07**

Volume 7: Putney Embankment 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 7 Appendices: Putney Embankment Foreshore site assessment

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 4th 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 historical or ongoing contamination sources, as well as any nearby sensitive receptors.

F.1.4 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.1.5 Detailed site walkover notes are provided in Vol 7 Table F.1 below.

Vol 7 Table F.1 Land quality – site walkover report

Item (Site ref: PWH1X, Putney Embankment Foreshore)		Details
Date of walkover	4th November 2010	
Site location and access	There are two distinct areas of proposed works, both located on the foreshore of the River Thames. The first is the Putney Embankment Foreshore site situated at the junction of the B306 (Lower Richmond Road), Putney Bridge Approach/Putney High Street (A219). This worksite would also include the southern end of the Putney Bridge structure. The second site, Putney Embankment temporary slipway is located further west. Access was available across the entire site.	
Size and topography of site and surroundings	Record elevation in relation to surroundings, any hummocks, breaks of slope etc.	Topography is multileveled; the worksite encompasses the foreshore, the cobbled slipway which is at an angle to meet the street level and also includes the raised Waterman's Green Park area.
Neighbouring site use (in particular note	North	River Thames
	South	The area is populated with a mixture of retail, commercial and residential

Item (Site ref: PWH1X, Putney Embankment Foreshore)		Details
any potentially contaminative activities or sensitive receptors)		properties. The closest property is Richmond Mansions. It is occupied by retail use at ground floor level with residential properties above. Waterman's Green is located in the southern section of the main site.
	East	The area is populated with a mixture of retail, commercial and residential properties. St Marys Church is located to the east of the main site.
	West	The area is populated with a mixture of retail, commercial and residential properties.
Site buildings	Record extent, size, type and usage. Any boiler rooms, electrical switchgear?	No
Surfacing	Record type and condition	The site includes the existing cobbled slipway and Waterman's Green which leads onto the wide foreshore area consisting of mud and shingle (clay, sand and gravel).
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 below ground)	None observed
	Containment systems (eg bund, drainage interceptors). Record condition and standing liquids	None observed
	Refill points located inside bunds or on impermeable surfaces etc?	None observed
Vehicle servicing	Record locations, tanks	None observed

Item (Site ref: PWH1X, Putney Embankment Foreshore)		Details
or refuelling onsite	and inspection pits etc.	
Waste generated/stored onsite	Adequate storage and security? Fly tipping?	N/A
Surface water	Record on-site or nearby standing water	River Thames
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		No potential contaminative sources were identified during the survey.
Any other comments	Eg, access restrictions/ limitations	No

Review of historical contamination sources

F.1.6 Historical mapping (dating to between 1896 and 1988) has been reviewed in order to identify potentially contaminating land-uses at the site and within the 250m assessment area.

F.1.7 Vol 7 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.1.8 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.1.9 Items listed in the table below are also shown on Vol 7 Figure F.1.1 (see separate volume of figures). In addition, figures illustrating the historical environment of the site and surrounding area are provided in Vol 7 Appendix E.

Vol 7 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			
3	Wharf (southeast edge of the site)	c1896-c1988	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
Off-site			
1	Putney Brewery (135m southwest)	c1896-c1969	Volatile organic compounds (VOCs), total petroleum hydrocarbons, heavy metals, ethanol/methanol, ammonia, chlorinated alkalis, benzene, toluene, ethylbenzene and xylenes
2	Smithy (100m south)	c1896	Heavy metals, PAHs
4	Wharves (northern bank of River Thames-160m north)	c1896-present	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
5	Soap works (25m south)	c1896	Phenols, PAHs, aromatic

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
			hydrocarbons
6	Sawing and planing mills (110m southeast)	c1896	Heavy metals, arsenic, boron, sulphate, phenol, acetone, aromatic hydrocarbons, PAHs and cresols
7	Omnibus Garages (110m south)	c1916	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds, heavy metals and asbestos
8	Garage/Omnibus Depot (adjacent southeast)	c1916	
9	Blind and Shelter Works (130m south)	c1951-c1952	Heavy metals, arsenic, boron, nitrate, sulphate, sulphide, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
10	Electrical substation (110m southeast)	c1951-c1966	Oils, PCBs
11	Sports equipment factory (95m southeast)	c1951-c1983	Heavy metals, solvents, hydrocarbons, asbestos, VOCs
12	Engineering works (55m southeast)	c1951-c1983	Heavy metals, arsenic, boron, nitrate, sulphate, sulphide, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
13	Motor engineering works (100m south)	c1951	
14	Corporation Yard (160m	c1951-c1966	Tars, turpentine,

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
	north)		creosote, zinc chloride, hydrocarbons
15	Tank (100m southwest)	c1951	Contents unknown
16	Electrical substation (110m southwest)	c1966-present	Oils, PCBs
17	Electrical substation (170m southwest)	c1966-present	
18	Works (180m northeast)	c1962	Heavy metals, arsenic, boron, nitrate, sulphate, sulphide, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
19	Rail bridge (220m east)	c1896	PAHs, heavy metals, phenols, sulphates, fuel oil, lubricating oil, greases, PCBs, solvents, asbestos, chlorinated aliphatic hydrocarbons, herbicides, semi volatile organic compounds (SVOCs)
20	Transport depot (120m south)	c1969-c1971	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds, heavy metals and asbestos

On-site

F.1.10 The historical mapping has not identified any significant contaminative on-site uses.

F.1.11 The very south-eastern edge of the site was identified as being occupied by a former wharf. The remainder of the site has essentially remained unoccupied river foreshore.

Off-site

F.1.12 Within the 250m assessment area, the historic mapping shows pockets of industrial activities in the vicinity of the site that in most cases have ceased.

Geology

F.1.13 Data from the Thames Tideway Tunnel project ground indicates the anticipated geological succession, as summarised in Vol 7 Table F.3 below.

Vol 7 Table F.3 Land quality – anticipated site geology

Geological unit/ strata	Description	Approximate depth below ground level (m)
Made Ground	Sandy gravel with brick and concrete	On embankment only (2m)
River Terrace Deposits	Medium dense to dense to dense sand and gravel (predominantly quartz sand and flint gravel)	0.00-0.40
London Clay Formation	Locally slightly silty and sandy fissured clay, locally with selenite and pyrite	0.40-47.2

Unexploded ordnance

F.1.14 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) is sometimes encountered and requires safe disposal.

F.1.15 A desk based assessment for UXO threat was undertaken by 6 Alpha Associates Limited at the Putney Embankment Foreshore site (see Vol 7 Appendix F.3).

F.1.16 The assessment covered two areas of the Putney Embankment Foreshore site (the main and secondary (temporary slipway) sites). The assessment reviewed information sources such as the Ministry of Defence (MoD), Public Records Office and the Port of London Authority (PLA).

F.1.17 The report advises that no high explosive bomb strikes were recorded within the main site; however one bomb strike was recorded as occurring within the temporary slipway site. In addition, one bomb strike was recorded within the buffered site boundary and a further four within 100m of the buffered site boundary.

F.1.18 The site has not been subject to redevelopment work since WWII and as a result it is unlikely that buried UXO items would have been removed.

F.1.19 Taking into account the findings of this study and the known extent of the proposed works at the Putney Embankment Foreshore site, it was considered that within the main site there is an overall high threat from UXO and within the secondary site, there is a medium/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 A single borehole has been drilled within the site boundary on the Putney Embankment (borehole reference SR1112). A further borehole (SR2083) has been drilled within the River Thames immediately adjacent to the site boundary, as shown on Vol 7 Figure F.1.2 (see separate volume of figures).

F.1.22 Vol 7 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, either due to their distance from the proposed CSO drop shaft location or because certain boreholes were excavated purely for geotechnical purposes.

Soil contamination testing

F.1.23 Soil contamination was undertaken on four samples of Made Ground retrieved from SR1112. The testing included a variety of common contaminants (including heavy metals, PAHs and TPH).

F.1.24 The results when compared against human health screening values (Defra/EA, 2009)[3], (Land Quality Management/Chartered institute of Environmental Health, 2009)[4] (for light industrial/commercial land use) showed no contaminants above the relevant human health screening value in the samples that were tested.

F.1.25 See Volume 2 Environmental assessment methodology for full guidance on the criteria used.

Soil gas testing

F.1.26 Soil gas testing was undertaken on a single occasion of a monitoring well installed within the London Clay. Results of monitoring recorded 3.8 % volume of carbon dioxide, 0.2% volume of methane and 18.3% volume of oxygen. Gas flow rate was recorded at 5.4 l/hour.

Groundwater contamination data

F.1.27 No groundwater quality monitoring data was available at the Putney Embankment Foreshore site. Refer to Section 13 Water resources – groundwater of this volume for further information on groundwater quality.

Sediment quality testing

F.1.28 An investigation into the sediment quality at the Putney Embankment Foreshore site was undertaken by the Port of London Authority (PLA) hydrographic department in December 2011 (Port of London Authority, 2011)[5]. A report on the findings is presented in Mott MacDonald Limited

Thames Tunnel Foreshore Sediment Quality Interpretative Report (Vol 2 Appendix F.2).

F.1.29 Three samples of sediment were taken from the foreshore of the River Thames at the site and sent for laboratory analysis. The testing showed relatively low levels of PAHs and metals within the foreshore sediments which are typical of the sediments along the tidal River Thames.

F.1.30 The observed concentrations reflect the former industrial nature of the river and tend to be observed as these contaminants bind with soils/sediment.

F.1.31 Concentrations of arsenic, mercury, copper, lead were recorded to be generally elevated against PLA approved screening values in each sample.

F.1.32 The results were not however elevated against very conservative human health screening values used to provide context to contamination levels with the exception of one sample which recorded marginally elevated concentration of benzo(a)pyrene.

F.1.33 Three sediment samples were analysed for total coliforms of which all were found to be elevated in comparison with the benchmark that was used (and relates to bathing water quality) indicating potential impact from sewage.

Third-party ground investigation data

F.1.34 No third-party ground investigation data was available to review for the Putney Embankment Foreshore site.

Other environmental records

F.1.35 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 7 Table F.4. Pertinent records are discussed in further detail below.

F.1.36 The location of these records is shown on Vol 7 Figure F.1.3 (see separate volume of figures).

Vol 7 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	0
LA pollution prevention and control	0	2
Licensed waste management facility	0	0

Item	On-site	Within 250m of site boundary
Notification of installations handling hazardous substances	0	0
Past potential contaminated industrial uses	0	There are areas classified as past potential contaminated industrial uses within 250m.
Pollution incident to controlled water*	1	4
Registered waste transfer site	0	0
Registered waste treatment or disposal site	0	0

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

F.1.37 Inspection of the data has identified one on-site pollution incident to controlled water within the Putney Embankment temporary slipway site.

F.1.38 Within the 250m assessment, the data identifies the presence of two local authority pollution prevention and control entries located on Lower Richmond Road. These relate to a fuel filling station and dry cleaners.

F.1.39 Additionally there are a small number of recorded past potential contaminated industrial uses within 250m. Cross referencing with the historical mapping indicates that these relate to the former engineering works and wharves to the east and Corporation Yard to the north as shown on Vol 7 Figure F.1.1 (see separate volume of figures). Contaminants associated with these types of previous land-use are identified in Vol 7 Table F.2.

F.1.40 There are also a further four recorded pollution incidents to controlled water within the 250m assessment area; these are likely to be from sewage materials entering the river at the CSO (although not all of the regular CSO discharges are recorded as a matter of course).

Land quality data from local authority

F.1.41 Consultation with the London Borough (LB) of Wandsworth environmental health department was undertaken as part of the baseline data gathering exercise.

F.1.42 LB of Wandsworth has stated that it is unlikely there is an issue of land contamination at the Putney Embankment Foreshore site and that the land is not recorded within LB of Wandsworth's Register of Contaminated Land under Part IIA of the Environmental Protection Act 1990.

F.1.43 The LB of Wandsworth database did not contain any events that may indicate that there is polluted land at the site, such as discoloration of soils or malodours.

F.1.44 There were however, two high explosive bombs recorded to have fallen in the area during the World War II, although these were located away from the limits of land to be acquired and used.

Summary of contamination sources

F.1.45 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. shallow contamination of foreshore sediments with low levels of PAHs and minor metals from historic activities within the wider River Thames

b. coliforms from CSO discharge – sewage (bacteriological) contamination of sediments

c. potential UXO.

F.1.46 Following the review of the baseline data no viable off-site contamination sources have been identified that are likely to have impacted upon soil quality within the site.

F.2 Local authority consultation

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

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

Our Ref: SR153414
Your ref:
Date: 18 January 2011

Dino Giordanelli
Mott MacDonald Ltd
8-10 Sydenham Road
Croydon, CR0 2EE

Dear Mr Giordanelli

Re: Putney Bridge Foreshore, London, SW15

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

- Mapping from 1787 shows structures on the site including a public house. There are structures on the south side of Putney Bridge Road across from the site, including two more public house.
- The 1868 OS mapping shows an aqueduct in the position of the current Putney Bridge. St Mary's church in the east of the site has a graveyard.
- By the 1896 OS mapping the structures beside the preferred site have been demolished and the embankment has been landscaped with plantings and a urinal. The structures to the immediate south are also gone.
- The 1916 mapping shows the addition of a lavatory on the embankment. Residential blocks have been constructed to the south and south west (as per the current layout). The land to the east and south of St Mary's has become developed for a bus garage. Another bus garage is in place at 115m south west.
- The 1930s mapping is as per 1916 but with the addition of a brewery at 115m south.
- Relevant changes identified on the 1947 mapping are that the embankment area has been made a hard standing and the lavatory gone. The bus garage to the southwest is a motor engineering works and the brewery to the south has become a bottling plant. The bottling plant expanded into the motor engineering works during the 1950s.

- Planning permission for the redevelopment of the bus garage to the east of St Mary's to an office block was given in 1960. The structure included a two storey basement car park under much of the site. The office became the 'ICL' building and was converted to its current makeup from 2001to 2003.
- The geology of the land at the site is of Kempton Park gravels superficial deposits overlying London Clay solid geology. The gravels are classified as a minor aquifer but no abstractions are taken from them.
- Our premises database does not contain any events that may indicate that there is polluted land at the site, such as discoloration of soils or malodours.
- There were two high explosive bombs recorded to have fallen in the area during the second world war: one at 523971, 175787 and another at 524226, 175485.

Based on the information within our possession we conclude that it is unlikely that there is an issue of land contamination at this part of the Putney Bridge foreshore. The land is not recorded in our register of contaminated land under Part IIA of the Environmental Protection Act 1990 and we do not have any proposals to take any action or to carry out further investigation of the site under the Act.

I trust that this information is useful to you. If you would like to discuss any matter raised in this letter, please do not hesitate to contact me. Please note that a fee of £50 is payable for carrying out this search. Kindly send a cheque to the above address made payable to 'Wandsworth Council'.

Yours sincerely,

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

F.3 Detailed Unexploded Ordnance (UXO) risk assessment

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Detailed Unexploded Ordnance (UXO) Risk Assessment

Study Site: Work Area PWH12 – Putney Embankment Foreshore
Document Number: 336-RG-TPI-PWH12-000001
Client Name: Thames Water
6 Alpha Project Number: P2853_R9_V1.0
Date: 22nd May 2012

Originator: Max Chainey (18th May 2012)
Quality Review: Lisa Askham (22nd May)
Released by: Lee Gooderham (24th May)

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Figures

EXECUTIVE SUMMARY

Study Site	The Client has specified the Study Site as Work Area PWH12, located at National Grid Reference "524043, 175742". For the purposes of this report, the Site has been divided into **AREA A** (Foreshore and river of Work Area) and **AREA B** (Temporary Slipway).
Key Findings	In light of the research for this report, 6 Alpha has assessed the threat on this Site based on these pertinent facts: • Both **AREA A and AREA B** overlap the foreshore of the *River Thames*. • Whilst no World War Two (WWII) bombing targets have been identified within **AREA A or B**, numerous primary and "opportunistic" bombing targets have been identified to the east of the **AREAS**. • **AREA A and B** are located between *Wandsworth Metropolitan Borough* and *Fulham Metropolitan Borough*, which recorded 160 High Explosive (HE) bombs and 239 HE bombs per 1,000 acres respectively. • No HE bomb strikes occurred within **AREA A**, however one bomb strike was recorded within **AREA B**. Additionally, one bomb strike occurred within the buffered Site boundary and a further four HE bomb strikes were recorded within 100m of the buffered Site boundary. • Bomb damage was not recorded within the Work Area or buffered Site boundary, however this can be explained by the lack of structural developments within the area. • The Site has not been developed since WWII and thus is unlikely to have removed buried UXO items. Additionally, UXB entry holes within either **AREA** are unlikely to have been witnessed and recorded. The risk assessment and risk mitigation outlined below are based on the indicative engineering drawings and proposed works provided by *Thames Water*, and therefore it should be noted that any changes to the engineering drawings or proposed works may affect the risk assessment.
Potential Threat Source	The threat is primarily posed by WWII *German* HE bombs, with a secondary threat from Incendiary Bombs and *British* Anti-Aircraft Artillery (AAA) projectiles.
Risk Pathway	Given the type of munitions that might be present on Site, all types of aggressive intrusive engineering activities may generate a significant risk pathway.
Risk Level	**AREA A** **HIGH** **AREA B** **MEDIUM/HIGH**
Recommended Risk Mitigation	**The following actions are recommended before undertaking any activity on the Study Site:** **ALL AREAS** 1. **Operational UXO Risk Management Plan;** appropriate site management documentation should be held on site in the event of a suspected or real UXO discovery. 2. **UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of explosive ordnance encounter and are a vital part of the general safety requirement. 3. **On-Site Banksman;** all open excavation works should be accompanied by an UXO Specialist to monitor works down to the maximum bomb penetration depth. 4. **Non-intrusive Magnetometer Survey**; Prior to any dredging or piling of the foreshore and slipway, 6 Alpha recommend a non-intrusive magnetometer survey. Any magnetic contacts that model as UXO should either be investigated or avoided.

ASSESSMENT METHODOLOGY

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

STAGE ONE – SITE LOCATION AND DESCRIPTION

Study Site	The Client has specified the Study Site as Work Area PWH12. The Site is located at National Grid Reference 524043, 175742. For the purposes of this study, a 50m assessment radius will be applied to the work area to provide flexibility should it need to be relocated. Additionally, the Site has been divided into **AREA A and B** for the purpose of this report. See *Figures 1* and *2* for the Site location and area divisions.
Location Description *(Figure 3)*	The Work Area is situated to the southwest of the *City of London* between *Wandsworth and Fulham Metropolitan Borough*. Current aerial photography has identified the following within each area: **AREA A:** The *River Thames* and foreshore, *Putney Pier (floating)*, *Putney Bridge* and a partial area of public highway. **AREA B:** The *River Thames* and foreshore, as well as a partial area of public highway.
Proposed Engineering Works	*Thames Water* have specified a summary of the proposed engineering works, including working draft plans with drawing no. 100-DA-CNS-PWH12-245105_AA; 100-DA-CVL-PWH12-345000_AA; and 100-DA-CVL-PWH12-345022_AA. These works have been divided between **AREAS A and B**, however where not explicitly stated, 6 Alpha has made an assumption of which area the work will be carried out. **Area A** • Construction of a 6m internal diameter shaft, approximately 32m deep, in the foreshore of the River Thames. It is anticipated that the shaft be constructed with sprayed concrete primary lining with a cast in-situ concrete secondary lining. • Construction of a 2.2m internal diameter connection tunnel, approximately 57m long, between the CSO shaft and the main tunnel. • An interception chamber beneath the southern arch of the Putney Bridge structure. • A connection culvert beneath the river foreshore between the interception chamber and the shaft, including a chamber along the route. • Construction of a permanent hard standing area to facilitate operational access • Provision of a control kiosk for the operation of a penstock. • A ventilation column approximately 10m high. • Installation, maintenance and removal of a suitable temporary construction working area to facilitate the construction of the above. A temporary cofferdam will be installed to create the working area. The area enclosed within the cofferdam will be drained of river water and dredged before being filled with imported material. **Area B** • Temporary slipway constructed from prefabricated steel, with non-slip steel decking supported on circular steel piles to be augered through foreshore. • Temporary slipway level to match existing foreshore.
Ground Conditions	*Thames Water* have indicated the following ground conditions for the Work Areas as: See table below. It is important to establish the ground conditions within this report to determine both the maximum *German* UXB bomb penetration depth (BPD) as well as the potential for other types of munitions to be buried on this Site.

Site Geology	Depth Below Ground Level (m)	Thickness (m)
River Terrace Deposits	0.00	0.40
London Clay	0.40	46.80
Harwich Formation	47.20	Not Proven

STAGE TWO – REVIEW OF HISTORICAL DATASETS	
Sources of Information Consulted	The following primary information sources have been used in order to establish the background UXO threat: 1. Home Office WWII Bomb Census Maps; 2. WWII & post-WWII Aerial Photography; 3. Official Abandoned Bomb Register; 4. National Archives in Kew; 5. Internet based research; 6. Historic UXO information provided by 33 Engineer Regiment (Explosive Ordnance Disposal) at Carver Barracks, Wimbish.
Site History and Use	According to the County Series (CS) & Ordnance Survey (OS) historical mapping, the following site history can be recorded immediately prior to and post-WWII: **1938 CS mapping – AREA A** is located on a prominent foreshore overlapping the *River Thames*, with *Putney Pier (floating)* to the west and *Putney Bridge* to the east. **AREA B** contains no development. **1949 OS mapping** – There are no significant or noticeable changes to the areas.
1945 Aerial Photography ***(Figure 4)***	**ALL AREAS:** The 1945 aerial photography confirms the Site remained unchanged pre- and post-WWII.
WWII Luftwaffe Bombing Targets ***(Figure 5)***	**ALL AREAS**: Primary targets have been identified as *Wandsworth, Wimbledon and Epsom Gas Works* and a "generating station" located 1.4km to the east, as well as *Fulham Power Station* located 1.9km to the east. "Opportunistic" targets include "railway stations" and railway infrastructure, "depots", "goods sheds", "works", "factories" and "wharves" all located within 2km of the Site.
WWII HE Bomb Strikes ***(Figure 6)***	Air Raid Precaution (ARP) reports indicate the following: **AREA A:** No bomb strikes. **AREA B:** One HE bomb strike. One bomb strike occurred within the buffered Site boundary and four strikes occurred within 100m of the buffered Site boundary.
WWII Bomb Damage ***(Figure 7)***	*London County Council* (LCC) bomb damage maps indicate the following: **AREA A**: No bomb damage. **AREA B:** No bomb damage. No bomb damage was recorded within the buffered Site boundary. Bomb damage was typically only recorded for building structures and not for damage done to land features. This may explain the lack of damage recorded within the Site, as no building structures are present.
WWII HE Bomb Density ***(Figure 8)***	The Study Site is located between *Wandsworth Metropolitan Borough* and *Fulham Metropolitan Borough,* which recorded 160 HE bombs and 239 HE bombs per 1,000 acres respectively. This figure does not include incendiary devices, as they were often released in such large numbers that they were seldom recorded.
Abandoned Bombs	The Official Abandoned Bomb Register recorded one abandoned 500kg HE bomb located 800m to the north of the Site.

STAGE THREE – DATA ANALYSIS	
Was the ground undeveloped during WWII?	**AREA A:** Mostly; the Work Area predominantly consists of the *River Thames* and foreshore, although *Putney Pier (floating)* and *Putney Bridge* were also situated within this area and a small portion of the Work Area overlaps the public highway. **AREA B:** Yes; this area overlaps the *River Thames* and was undeveloped except for a small portion of the area that overlaps the public highway.
Is there a reason to suspect that the immediate area was a bombing target during WWII?	**ALL AREAS:** Yes; numerous primary *Luftwaffe* bombing targets existed within proximity of the Work Area, however most of these targets are located to the east of the Site.
Is there firm evidence that ordnance landed on Site?	**AREA A:** No; but unlikely to have been recorded given the environment. **AREA B:** Yes; an HE bomb strike was recorded within this area. There is also evidence of one bomb strike within the buffered Site boundary.
Is there evidence of damage sustained on Site?	**AREA A:** No. **AREA B:** No. However, damage to land features, public highways and bridges was not recorded on the *LCC* bomb damage maps.
Is there any reason to suspect that military training may have occurred at this location?	**ALL AREAS:** There is no evidence to suggest that military training may have occurred at this location.
Would an UXB entry hole have been observed and reported during WWII?	**ALL AREAS:** Unlikely; UXBs falling in the *River Thames* are unlikely to have been observed and reported. Additionally, any impact craters of UXBs falling on the foreshore during low tide would have been masked and covered by the high tide. However, any UXB entry holes on the embankment would most likely have been witnessed and recorded. **AREA A:** In addition, this area contained *Putney Pier,* which would have shown obvious signs of a UXB had one hit this feature.
What is the expected UXO contamination?	**ALL AREAS:** The most likely source of UXO contamination is from *German* aerial delivered ordnance, which ranges from small incendiary bombs through to large HE bombs (of which the latter forms the principal threat).
Would previous earthworks have removed the potential for UXO to be present?	**AREA A:** No; no significant earthworks have occurred. **AREA B:** No; no significant earthworks have occurred.

STAGE FOUR – RISK ASSESSMENT		
Explanation For Non-Division Of Site	The Site has a slight overlap at street level off the foreshore. However this street level overlap is considered too marginal to warrant the division of the Site. Additionally, the area under the bridge does not represent a decreased probability of UXO encounter due to the J-curve effect, whereby a UXBs sub-surface trajectory can be lateral and come to rest up to 15m from the original entry hole position.	
Threat Items	The threat is predominately posed by WWII *German* HE bombs and incendiary bombs. Additionally, *British* Anti Aircraft Artillery (AAA) projectiles may also be present. However, AAA does not have the potential for deep burial, and thus is unlikely to be encountered at depths greater than 1m bgl.	
Maximum Penetration	The general ground conditions (highlighted in Stage 1) of **AREA A** and **AREA B** that are relevant consist of River Terrace Deposits and London Clay, and thus the most likely Bomb Penetration Depth (BPD) for a 250kg bomb is assessed to be a maximum of 8m bgl, dependant on the depth of any rock sediment. As the **AREAS** overlap with the foreshore of the *River Thames* and the river itself, the BPD will vary due to the softer ground conditions and the water causing a deceleration of the impacting bomb. It is important to note that strong river currents, sedimentation build-up and erosion over time can significantly alter the depth of UXO. Whilst the *Luftwaffe* used larger bombs, their deployment was so few and only used against notable targets, therefore to use them within this risk assessment would not be justified. Additionally, smaller items such as *German* incendiary bombs and *British* AAA projectiles would have a significantly reduced penetration capability and would not be expected to be encountered at depths greater than 1m.	
Risk Pathway	Intrusive engineering activities are likely to be in the form of excavations. Although for the purposes of this report 6 Alpha will use a range of generic construction activities for the risk assessment.	
Consequence	**Potential consequences of UXO initiation**	1. Kill and/or critically injure personnel 2. Severe damage to plant and equipment 3. Blast damage to nearby buildings 4. Rupture and damage underground services
	Potential consequences of UXO discovery	1. Delay the project 2. Disruption to local community/infrastructure 3. Incurring of additional costs
Site Activities	A number of construction methodologies have been identified for analysis on this Site. There is a large amount of variation in the probability of encountering, or initiating items of UXO when conducting different activities on Site. Additionally the consequences of initiating UXO vary greatly depending on how the item of UXO was initiated on Site.	

STAGE FOUR – RISK ASSESSMENT (…continued)

UXO RISK CALCULATION TABLE

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

Activity	**AREA A**		
	Probability (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Enabling Works	2x1=2	3x2=6	2x6=12
Tunnelling	1x2=2	1x2=2	2x2=4
Shaft Installation	2x2=4	1x2=2	4x2=8
Open Excavations	2x2=4	2x2=4	4x4=16
Cofferdam (Sheet Piles)	2x3=6	2x2=4	6x4=24
Dredging	2x3=6	3x2=6	6x6=36

Activity	**AREA B**		
	Probability (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Enabling Works	2x1=2	3x2=6	2x6=12
Temporary Slipway (Piling)	2x3=6	2x2=4	6x4=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** – The suitability for an effective non-intrusive method of mitigation is largely dependent on the depth and composition of made ground, as any magnetometer results are highly likely to be affected by ferro-magnetic contamination due to previous construction activities within the Study Site location. This method is likely to be effective on the foreshore and within the cofferdam as this is area is undeveloped, however any scrap metal may mask buried items of UXO. **Intrusive Methods of Mitigation** – Intrusive magnetometry is expected to be possible on this Site. It should be noted that ferro-contamination of any made ground/fill material, particularly at the fill layer, is likely to adversely affect detection capability of the equipment.

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

Report Figures

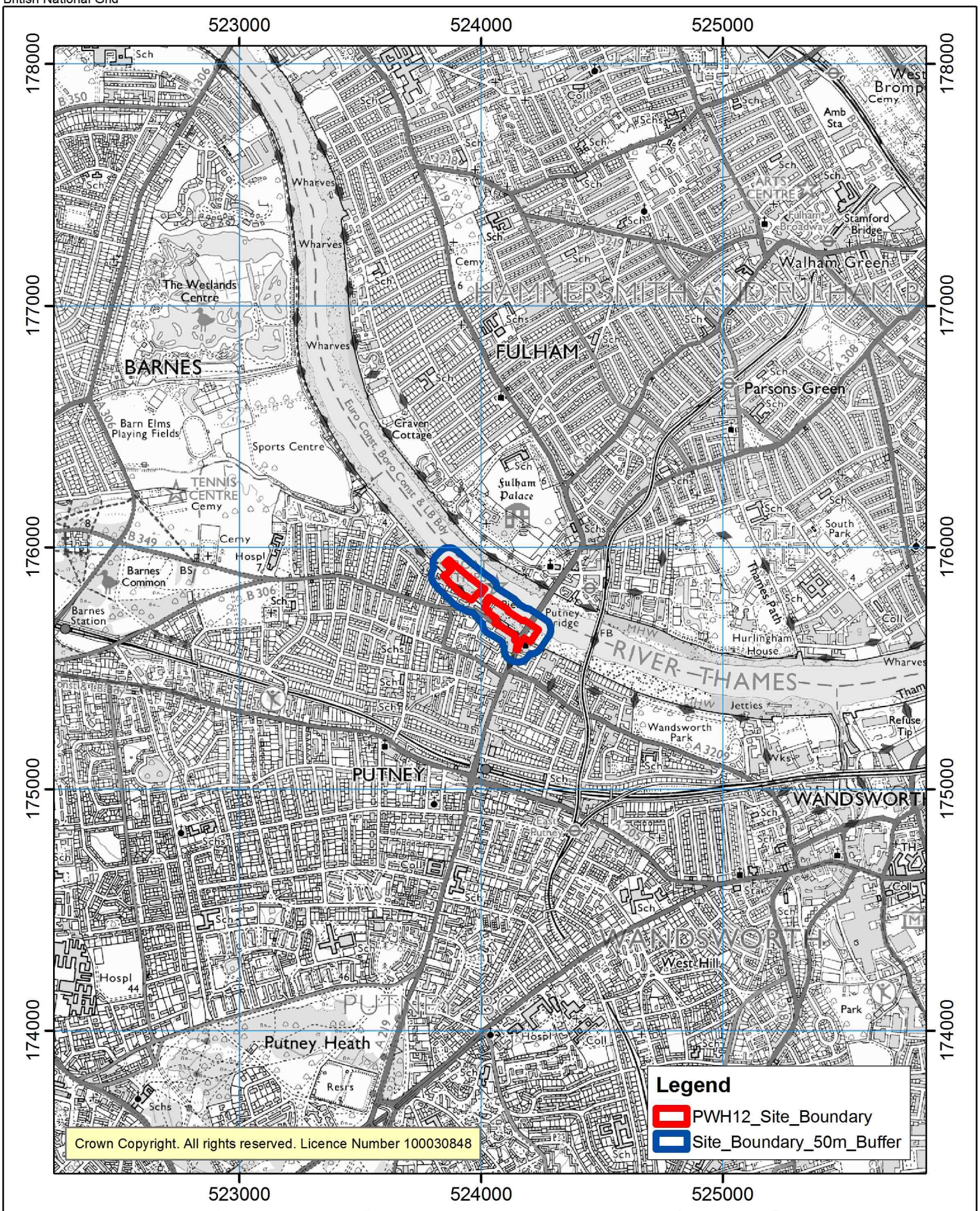
Figure One

Site Location

Thames Tideway Tunnel - Work Area PWH12
Site Location

Figure 1

British National Grid



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www.6alpha.com
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0 100 200 400 600 800 1,000 Meters

N

Project Number: P2853_PWH12
Drawn By: Dominique René
Checked by: Lee Gooderham
Date: 16th May 2012

Figure Two

Site Plan

Thames Tideway Tunnel - Work Area PWH12 Site Boundary

Figure 2

British National Grid

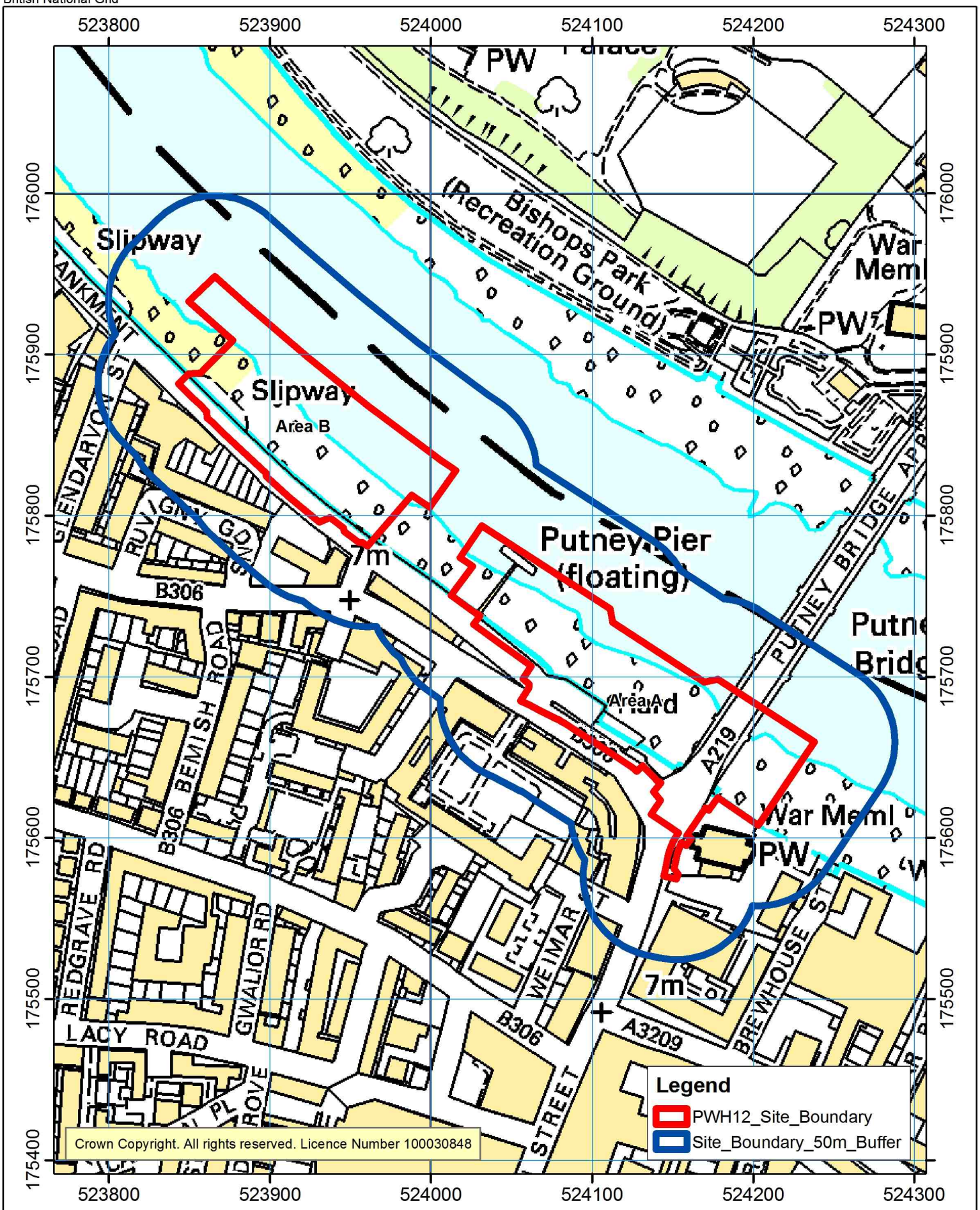

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Figure Three

Current Aerial Photography

Thames Tideway Tunnel - Work Area PWH12
Current Aerial Photography

Figure 3

British National Grid

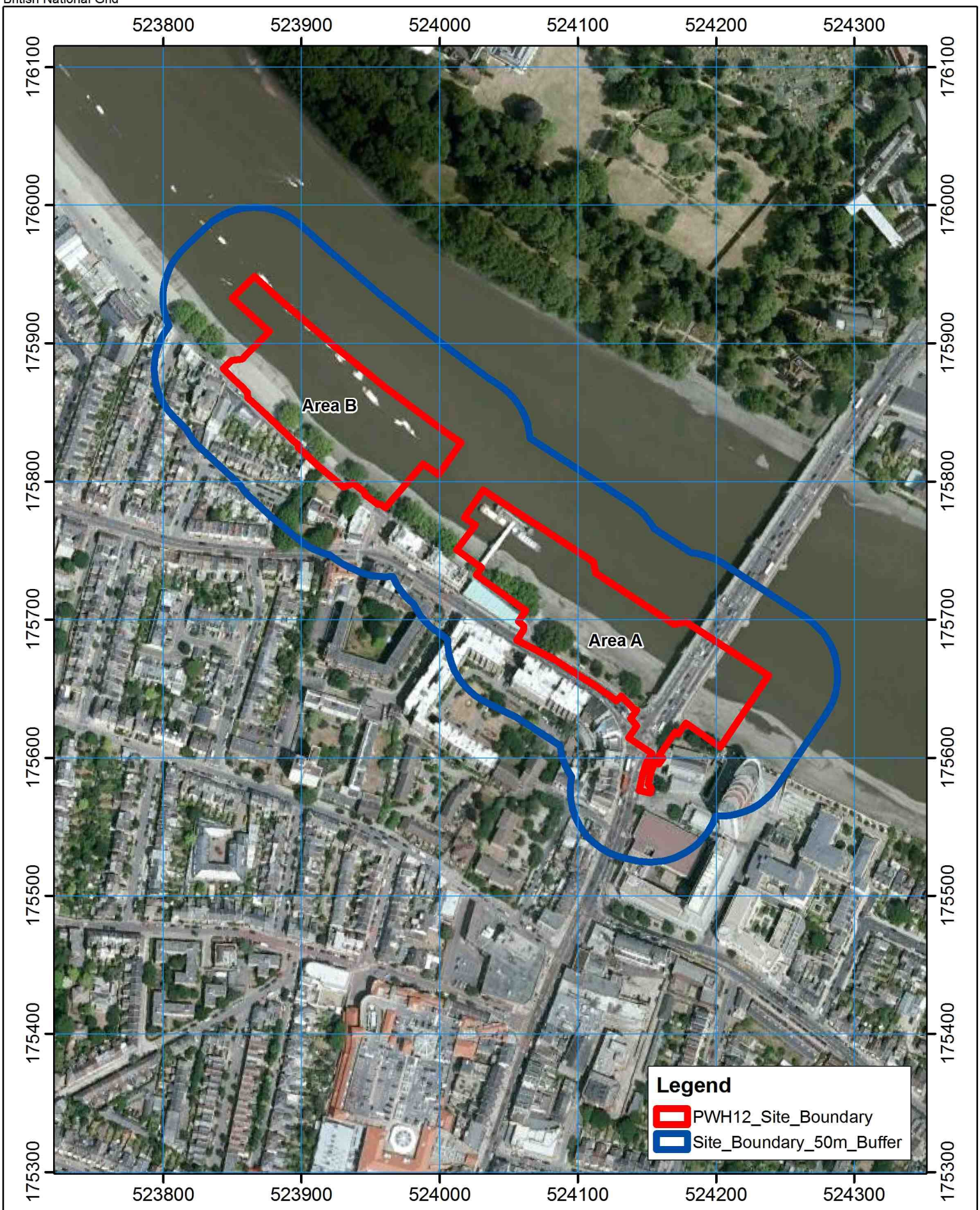

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Figure Four

1945 Aerial Photography

Thames Tideway Tunnel - Work Area PWH12
1945 Aerial Photography

Figure 4

British National Grid

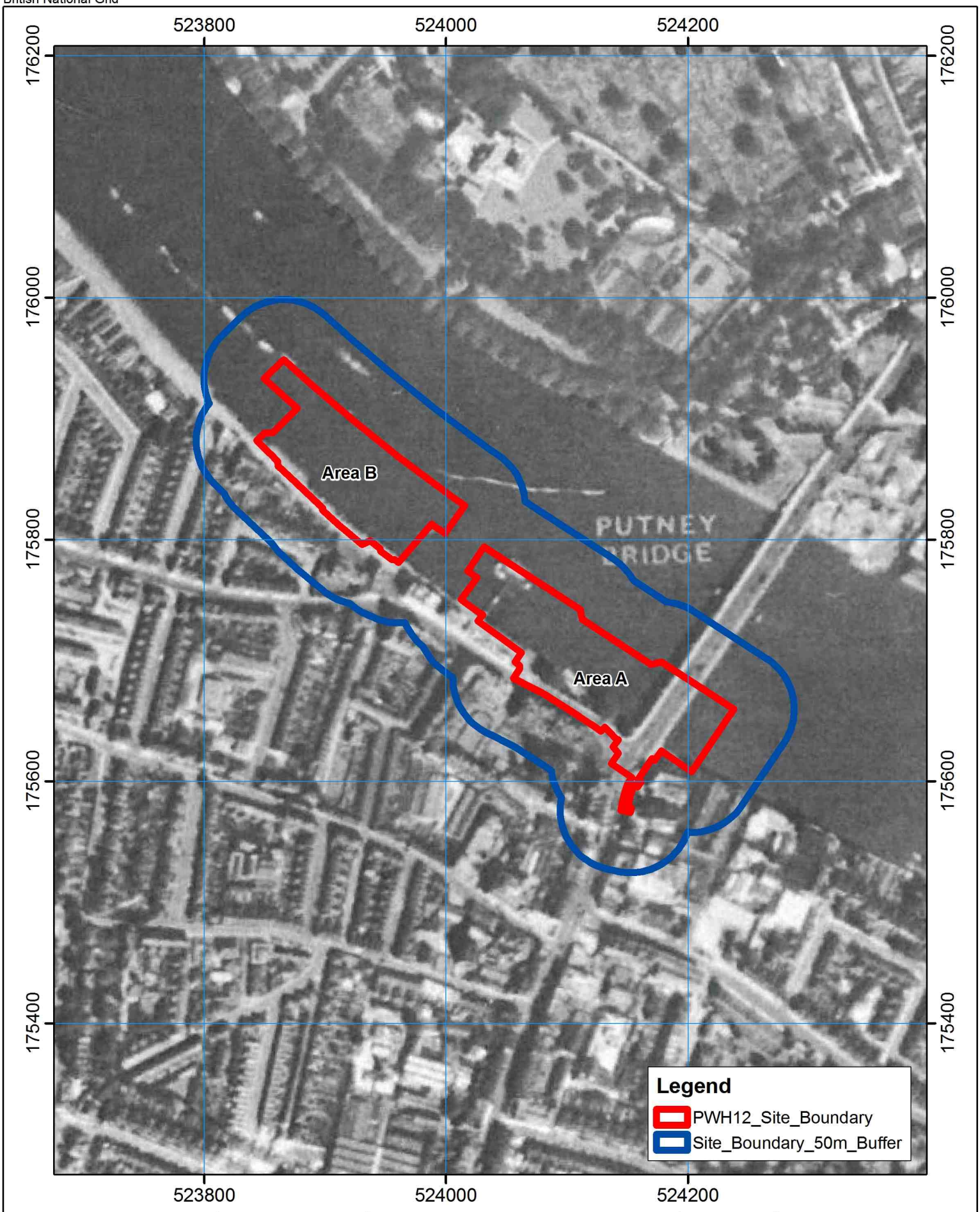

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Figure Five

WWII Luftwaffe Bombing Targets

Thames Tideway Tunnel - Work Area PWH12
WWII Luftwaffe Bombing Targets

Figure 5

British National Grid

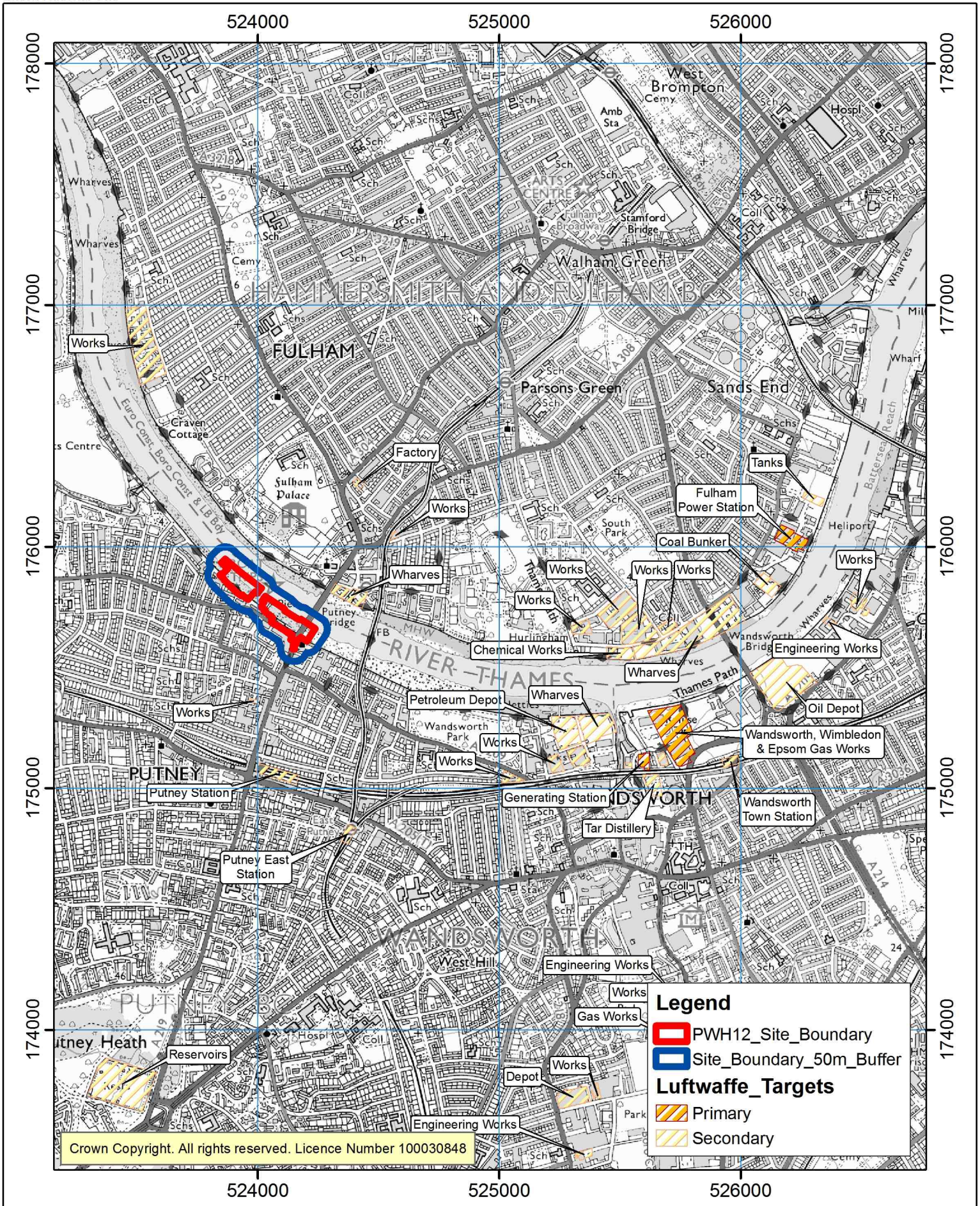

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Figure Six

WWII High Explosive Bomb Strikes

Thames Tideway Tunnel - Work Area PWH12
WWII High Explosive Bomb Strikes

Figure 6

British National Grid

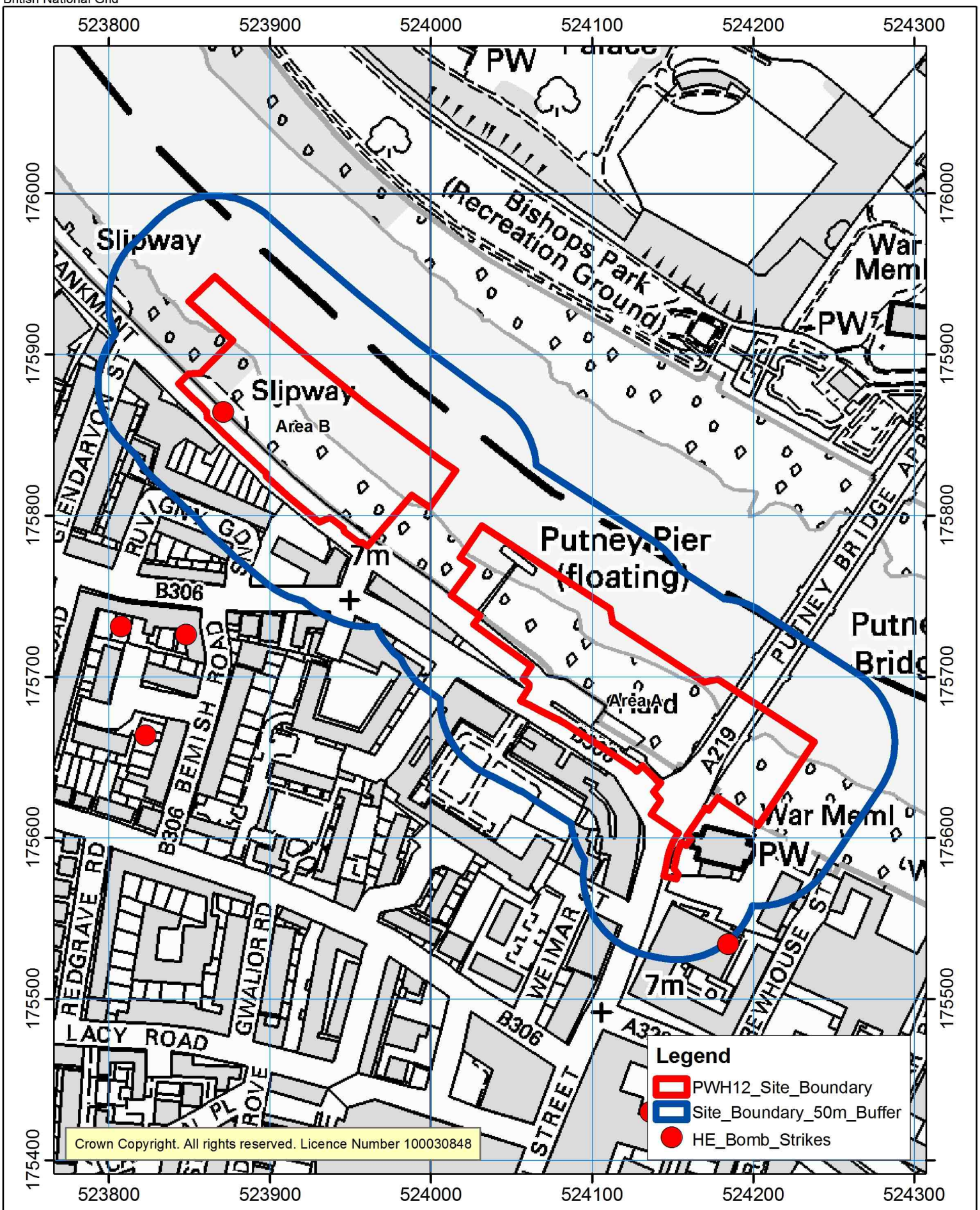

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Figure Seven

London County Council Bomb Damage Mapping

Thames Tideway Tunnel - Work Area PWH12
London County Council Bomb Damage Map

Figure 7

British National Grid

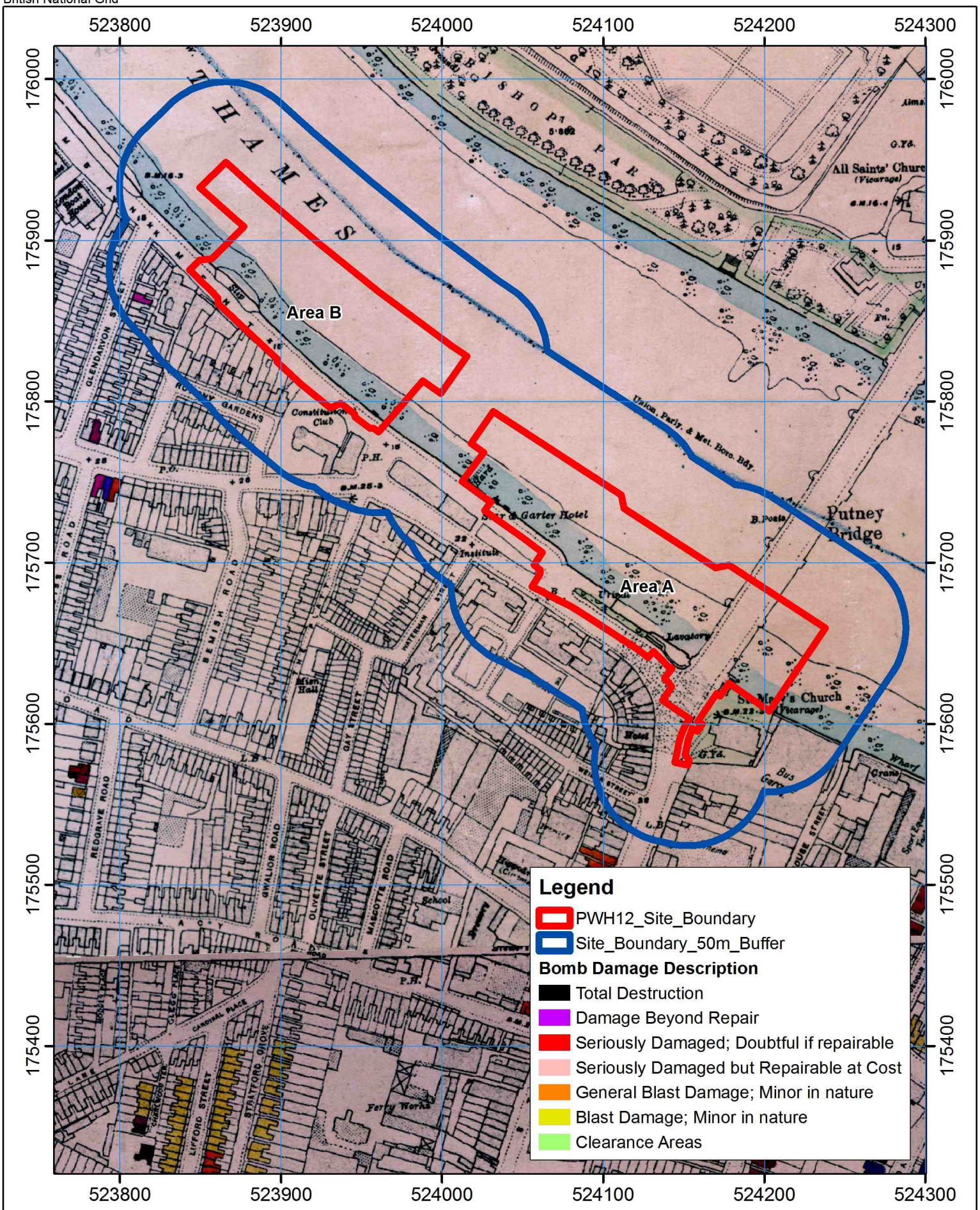

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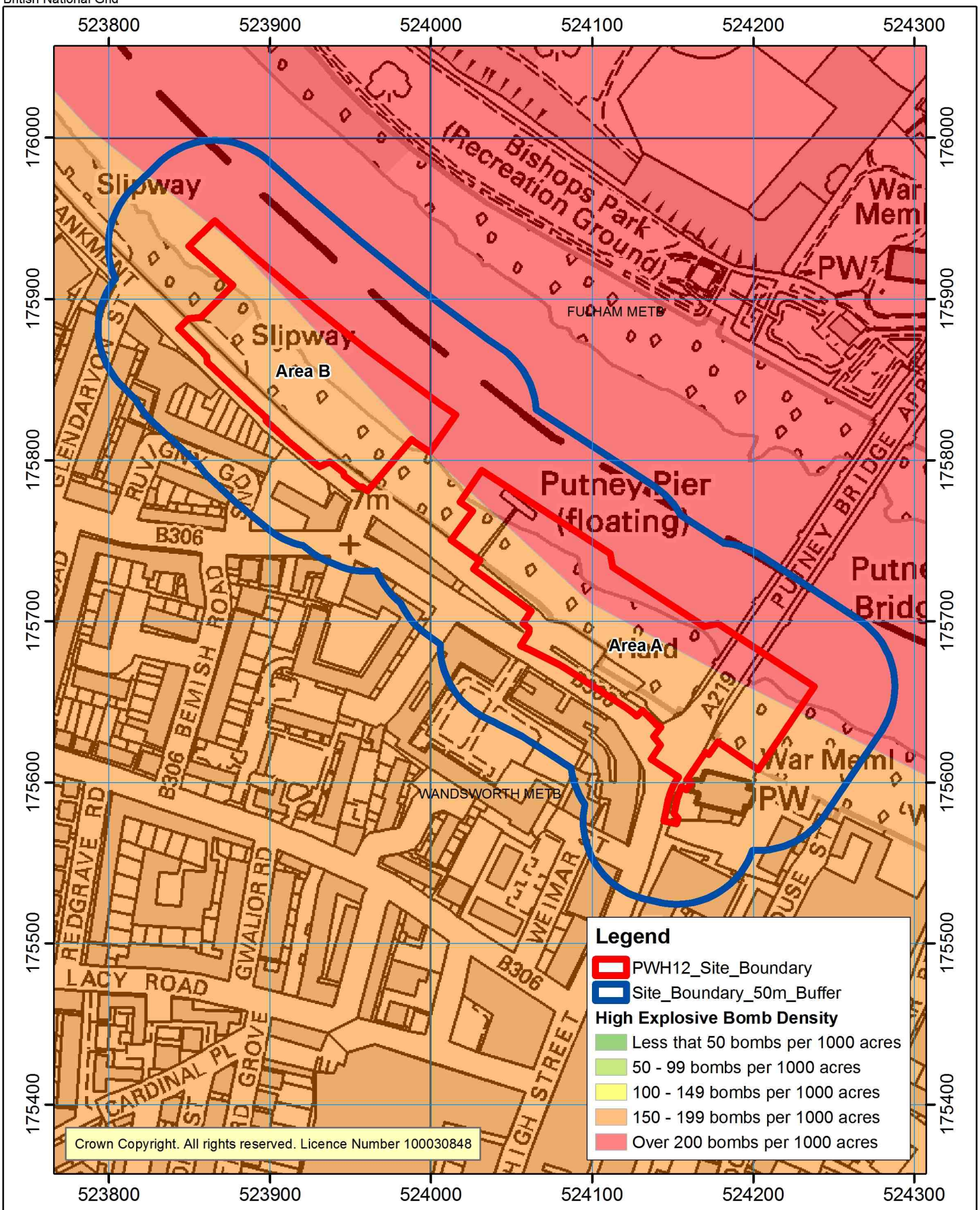
Figure Eight

WWII High Explosive Bomb Density

Thames Tideway Tunnel - Work Area PWH12
WWII High Explosive Bomb Density

Figure 8

British National Grid



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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).

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.07**

Volume 7: Putney Embankment 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 7 Putney Embankment Foreshore appendices

Appendix G: Noise and vibration

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Appendix G: Noise and vibration

G.1 Model verification

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 noise sensitive receptors to Putney Embankment Foreshore are the residential moorings situated to the northwest of the site at Putney Pier. In addition, the residential properties at Kenilworth Court and Richmond Mansions are located south of the site, to the west are the Star and Garter Mansions and to the southeast is the new Putney Wharf Tower development.

Survey methodology

G.1.3 The survey methodology originally covered the collection of weekday daytime measurements only. As the scheme design progressed, additional surveys were undertaken to collect representative weekday evening and night-time data, along with representative weekend daytime and night-time data. The initial baseline noise survey was completed on 6th April 2011 and additional baseline data was collected on 30th October to 1st November 2011.

G.1.4 The London Borough of Wandsworth has been consulted regarding the noise assessment and monitoring locations, prior to completing the surveys.

G.1.5 Short term attended noise monitoring has been completed at all measurement locations. Measurements were undertaken during the interpeak periods of 10:00-12:00, 14:00-16:00 and 20:00-22:00 on a typical weekday, and 14:00-18:00 and 00:00-04:00 on a typical weekend day, so that the baseline data is representative of the quieter periods where any disturbance from construction would be most noticeable.

G.1.6 Vol 7 Table G.1 describes the survey equipment that was used to collect the baseline data at the site.

Vol 7 Table G.1 Noise – survey equipment

Item	Type	Manufacturer	Serial Number(s)	Laboratory Calibration Date
Initial baseline survey: 6th April, 2011				
Hand-held analyzers	2250	Brüel & Kjær	2626230 2626231	19/01/2010* 20/01/2010
½ " microphones	4189	Brüel & Kjær	2621208 2621209	19/01/2010 20/01/2010
B&K sound calibrator	4231	Brüel & Kjær	2619372 2619373	13/01/2011 10/02/2011
Additional baseline survey: 30th October through 1st November 2011				
Hand-held analyzers	2250	Brüel & Kjær	2626210 2626230	20/12/2010 19/01/2010**
½ " microphones	4189	Brüel & Kjær	2626657 2621209	20/01/2010
B&K sound calibrator	4231	Brüel & Kjær	2619372	13/01/2011

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

G.1.7 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.1.8 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.1.9 The prevailing weather conditions observed for both attended baseline surveys are described in Vol 7 Table G.2.

Vol 7 Table G.2 Noise – weather conditions during baseline noise surveys

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation?	Description
Initial baseline survey – 6th April, 2011 (daytime, 10:00-12:00)				
Maximum: 2.0-3.7 Average: 0.5-1.0	WSW; SW	15-18	No	Warm and sunny with occasional light breeze
Initial baseline survey – 6th April, 2011 (daytime, 14:00-16:00)				
Maximum: 2.3-4.5 Average: 0.6-1.4	WSW; SW	17-25	No	Warm and sunny with occasional light breeze
Additional baseline survey – 30th October, 2011 (daytime, 14:00-18:00)				
Maximum: 1.1-2.6 Average: 0.3-2.8	S, SW	15-17	Yes - light drizzle observed between 15:00-16:30	Overcast and mild with occasional light breeze
Additional baseline survey – 31st October, 2011 (night-time, 00:00-04:00)				
Maximum: 0.7-2.8 Average: 0-0.6	Southerly	15-16	No	Dry and cloudy with occasional light breeze
Additional baseline survey – 31st October, 2011 (evening, 20:00-22:00)				
Maximum: 1.3-2.5 Average: 0.5-0.8	S, SE	14-15	No	Dry and mild with occasional light breeze
Additional baseline survey – 1st November, 2011 (night-time, 00:00-04:00)				
Maximum: 0.4-3.4 Average: 0.2-0.9	S, SE	14-15	No	Generally clear, dry and mild with occasional light breeze

Measurement locations

G.1.10 Vol 7 Table G.3 details the measurement locations which are also presented in Vol 7 Figure G.1 Noise – measurement locations (see separate volume of figures), and shown in Vol 7 Plate G.1 to Vol 7 Plate G.4.

Vol 7 Table G.3 Noise – measurement locations

Measurement location number	Description	Co-ordinates	
		X	Y
PEF01	On public footpath adjacent to Putney High Street, near to St Mary's Church	524153	175580
PEF02	On public footpath adjacent to Lower Richmond Road, outside entrance to Kenilworth Court	524061	175674
PEF03	On public footpath adjacent to Lower Richmond Road, in front of University Mansions	523978	175727
PEF04	On public footpath adjacent to Embankment, overlooking River Thames	524032	175728

Results

G.1.11 The range of values for each of the parameters collected during the baseline surveys are summarised in Vol 7 Table G.4 to Vol 7 Table G.8.

Vol 7 Table G.4 Noise – sampled noise survey results

Location Detail: PEF01, on public footpath adjacent to Putney High Street, within south-west corner of St Mary's Church grounds						
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)	104	64	69-77	73	76*	75
Evening (20.00-22.00)	96	63	67-77	74	77*	75
Night (00.00-04.00)	85	50	61-65	64	67*	65
Weekend day (14.00-18.00)	99	63	68-73	71	74*	75
Weekend night (00.00-04.00)	82	50	59-65	63	66*	65

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

Vol 7 Table G.5 Noise – sampled noise survey results

Location Detail: PEF02, on public footpath adjacent to Lower Richmond Road, outside entrance to Kenilworth Court						
Measurement period	**Noise level (dB(A) free-field)**			**Averaged ambient noise level, $dBL_{Aeq,15min}$**		**$dBL_{Aeq,15min}$ (rounded to nearest 5dB)**
	L_{AFmax}	**$L_{A90,15min}$**	**$L_{Aeq,15min}$**	**Free field**	**Façade**	**Façade**
Daytime (10.00-12.00, 14.00-16.00)	97	65	70-72	71	74*	75
Evening (20.00-22.00)	84	58	67-69	68	71*	70
Night (00.00-04.00)	83	44	55-62	60	63*	65
Weekend day (14.00-18.00)	90	61	68-70	69	72*	70
Weekend night (00.00-04.00)	83	48	55-64	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*

Vol 7 Table G.6 Noise – sampled noise survey results

Location Detail: PEF03, on public footpath adjacent to Lower Richmond Road, in front of University Mansions						
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)	98	63	69-74	71	74*	75
Evening (20.00-22.00)	85	56	68-69	68	71*	70
Night (00.00-04.00)	82	48	61-63	62	65*	65
Weekend day (14.00-18.00)	106	63	69-78	73	76*	75
Weekend night (00.00-04.00)	82	48	60-65	62	65*	65

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

Vol 7 Table G.7 Noise – sampled noise survey results

Location Detail: PEF04, on public footpath adjacent to Embankment, overlooking River Thames						
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)	88	58	61-65	64	67*	65
Evening (20.00-22.00)	76	55	59-60	59	62*	60
Night (00.00-04.00)	62	42	45-46	45	48*	50
Weekend day (14.00-18.00)	88	55	61-63	62	65*	65
Weekend night (00.00-04.00)	77	48	52-57	55	58*	60

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

Vol 7 Table G.8 Noise measurements near embankment (for river-based traffic assessment)

Sensitive receptor locations	**Measurement location**	**Measurement period**	**Noise level (dBL_{Aeq}, facade)**
Embankment	PEF04	Day/evening (07.00-23.00)	65
Lower Richmond Road	PEF02	Day/evening (07.00-23.00)	67

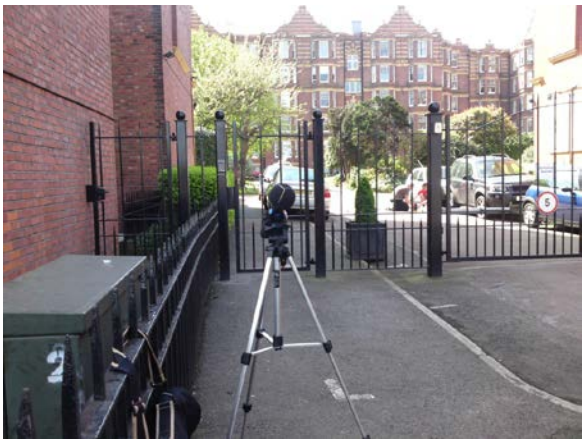
Plates of noise measurement locations

G.1.12 The following plates (Vol 7 Plate G.1 to Vol 7 Plate G.4) illustrate the noise measurement locations.

Vol 7 Plate G.1 Noise measurement location PEF01

Note: On public footpath adjacent to Putney High Street, within southwest corner of St Mary's Church grounds, looking south

Vol 7 Plate G.2 Noise measurement location PEF02



Note: On public footpath adjacent to Lower Richmond Road, looking south towards entrance to Kenilworth Court

Vol 7 Plate G.3 Noise measurement location PEF03

Note: On public footpath adjacent to Lower Richmond Road, looking east

Vol 7 Plate G.4 Noise measurement location PEF04

Note: On public footpath adjacent to Embankment, looking east

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.9.

G.2.4 Time histories of the predicted daytime construction noise levels across the programme of construction works are shown in Vol 7 Plate G.5 to Vol 7 Plate G.17.

Vol 7 Table G.9 Noise – typical construction plant schedule

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
Hoarding **General site equipment NOT applicable during this phase**	Excavator digging post holes for hoarding	1	105	30	BS5228-1[i]: Table C.2, Item 2	Tracked excavator, 71 t
	Generator 35kVA	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Circular saw cutting timber	1	113	10	BS5228-1: Table D.7, Item 71	Circular bench saw,
	Cutting equipment (diamond saw)	1	108	10	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	Nail guns for erection of hoarding	2	101	10	BS5228-1: Table C.4, Item 95	Handheld cordless nail gun, 15 to 50 mm nails
	Compressor 250cfm	1	93	30	BS5228-1: Table D.5, Item 5	Compressor for hand-held pneumatic breaker,
	Hand tools (e.g. drills and wrenches)	4	95	20	Estimated	Impact wrench and compressor,
	Hand-held percussive breaker	1	111	30	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker,
	Waste collection via skip or tipper lorry	1	106	10	BS5228-1: Table C.8, Item 21	Skip wagon,
	Oxyaceteline cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
Site set up	Oxyaceteline cutting equipment	1	93	10	BS5228-1: Table C.3,	Hand-held gas cutter,

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
and general site					Item 35	230 bar
	JCB with hydraulic breaker	1	116	20	BS5228-1: Table C.5, Item 1	Backhoe mounted hydraulic breaker,
	Cutting equipment (diamond saw)	2	108	10	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	Compressor 250cfm	1	93	50	BS5228-1: Table D.5, Item 5	Compressor for hand-held pneumatic breaker,
	Generator - 200 kVA	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Fuel delivery vehicle	1	104	5	BS5228-1: Table C.4, Item 15	Fuel tanker lorry,
	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	Manufacturer	Dirty water plant,
	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	119	20	BS5228-1: Table D.2, Item 4	Tracked excavator fitted with breaker, 200 kg·m
	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
	Concrete crusher	1	101	80	BS5228-1: Table C.1, Item 15	Tracked crusher,
Cofferdam construction General site equipment also applicable during this phase note: piling and backfilling will be concurrent however the two operations	400 cfm compressor	1	93	50	BS5228-1: Table C.5, Item 5	Compressor for hand-held pneumatic breaker, 1 t
	50t crawler crane	1	103	60	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	25t excavator	1	105	80	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Barges	1	101	5	Measured	Barges arriving and slurry loading,
	Generator	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Jack-up barge	1	100	20	Measured	Jack up barge,

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
will be separated by some distance.	Oxyaceteline cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
	Dewatering pumps - cofferdam	2	96	100	BS5228-1: Table C.4, Item 88	Water pump,
	Vibratory piling rig	1	116	60	BS5228-1: Table C.3, Item 8	Vibratory piling rig, 52 t
	Secant pile rig	1	107	60	BS5228-1: Table C.3, Item 16	Crane mounted auger
	Silent piler	1	91	60	BS5228-1: Table C.3, Item 9	Piling, 10 t
	Plate compactors	2	108	10	BS5228-1: Table C.2, Item 41	Vibratory plate (petrol)
	Vibrating rollers	2	101	50	BS5228-1: Table C.2, Item 38	Roller, 18 t
Piling for culvert support	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	25 tonne mobile crane	1	98	50	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	Vibratory piling rig	1	116	80	BS5228-1: Table C.3, Item 8	Vibratory piling rig, 52 t
Shaft sinking	Concrete deliveries (aggitating)	1	99	80	BS5228-1: Table C.4, Item 19	Cement mixer truck (idling),

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
General site equipment also applicable during this phase	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging),
	12t excavator	1	97	100	BS5228-1: Table C.2, Item 25	Tracked excavator, 14 t
	100t crawler crane	1	103	80	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	25t mobile crane	1	98	20	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	25t excavator	1	105	20	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Vent fans	1	90	100	Measured	Ventilation plant,
	Sump pump	4	95	100	BS5228-1: Table D.7, Item 65	Water pump,
	Pneumatic breakers	4	111	15	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker,
	400 cfm compressor	1	93	50	BS5228-1: Table C.5, Item 5	Compressor for hand-held pneumatic breaker, 1 t
	Waste collection via skip or tipper lorry	1	106	10	BS5228-1: Table C.8, Item 21	Skip wagon,
Connection tunnel	Concrete deliveries (aggitating)	1	99	80	BS5228-1: Table C.4, Item 19	Cement mixer truck (idling),

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
construction General site equipment also applicable during this phase	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging),
	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	25t mobile crane	1	98	25	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	Tunnel ventilation fans	1	100	100	Measured	Ventilation fans,
	25t excavator	1	105	50	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	400 cfm compressor	1	93	50	BS5228-1: Table C.5, Item 5	Compressor for hand-held pneumatic breaker, 1 t
	Waste collection via skip or tipper lorry	1	106	10	BS5228-1: Table C.8, Item 21	Skip wagon,
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
	Concrete deliveries (discharging)	1	108	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

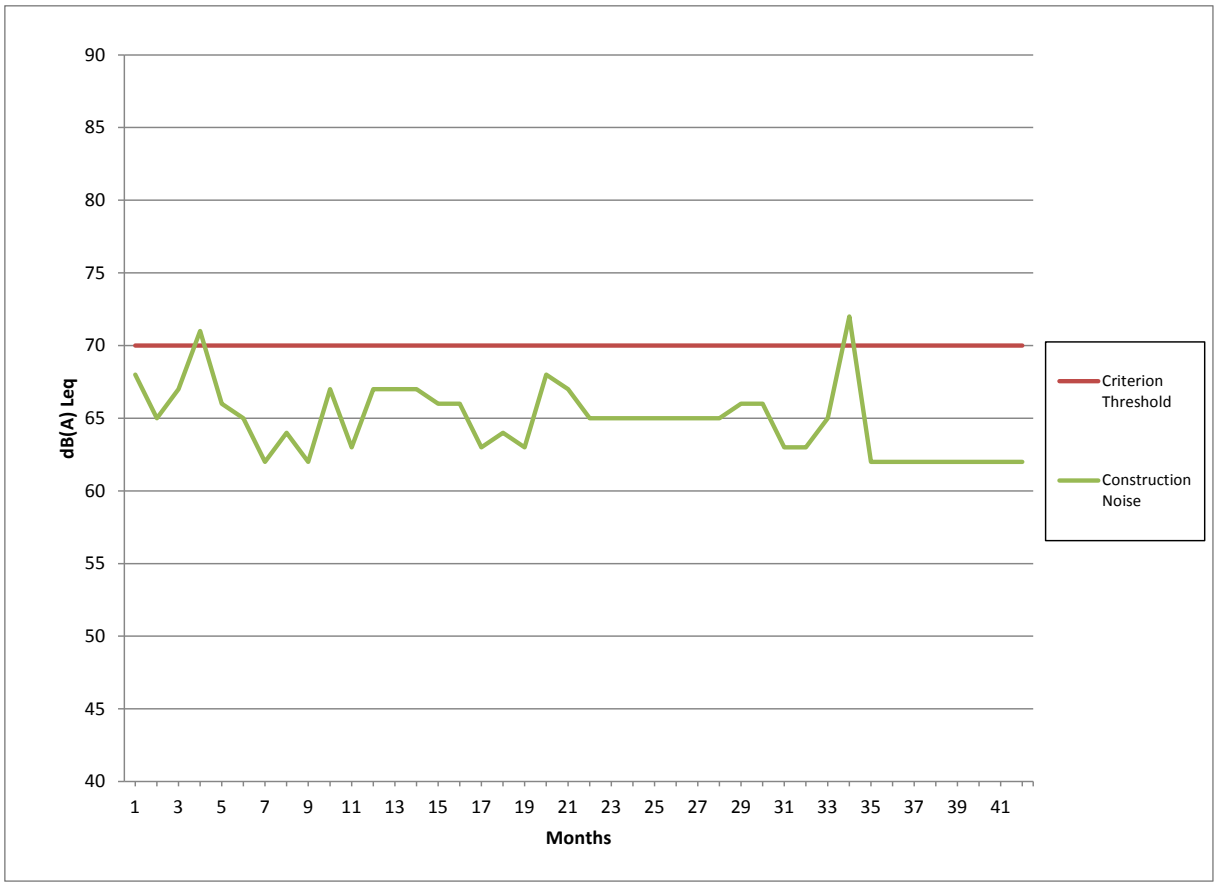
Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
Culvert works General site equipment also applicable during this phase	Service crane - 100T mobile crane	1	99	50	BS5228-1: Table C.4, Item 41	Wheeled telescopic crane, 100 t
	25t excavator	1	105	50	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
	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
Landscaping General site equipment NOT applicable during this phase	25t excavator	1	105	50	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Dumper	1	104	70	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Telescopic Handler/FLT	1	99	30	BS5228-1: Table C.2, Item 35	Telescopic handler, 10 t
	Hiab lorry/crane	1	105	5	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Compressor for hand-held breaker	1	102	10	BS5228-1: Table C.1, Item 8	Hydraulic breaker power pack, 63 kg/ 138 bar

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

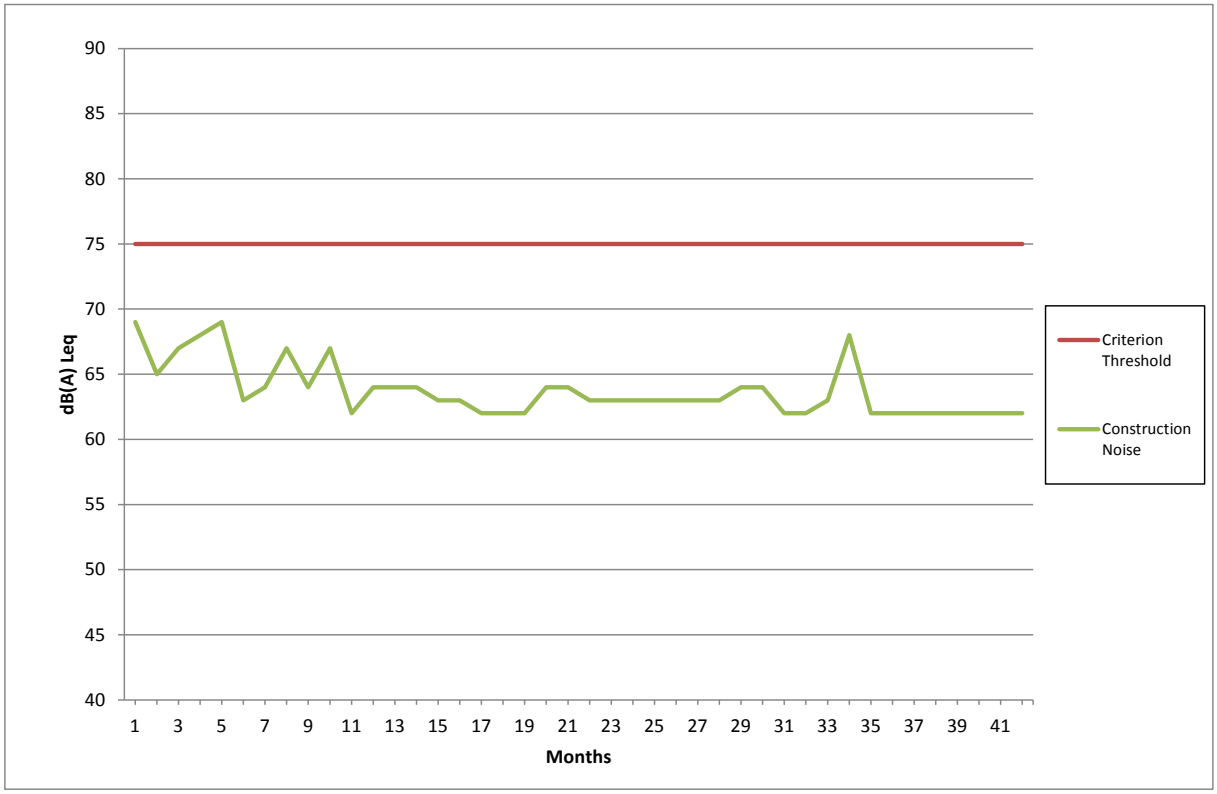
Note: This schedule provides an illustration of typical plant that could be used in the construction of the Thames Tideway Tunnel at this site. The appointed Contractor must comply with section 6 of the CoCP but may vary the method and plant to be used. This schedule therefore represents the most reasonable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

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

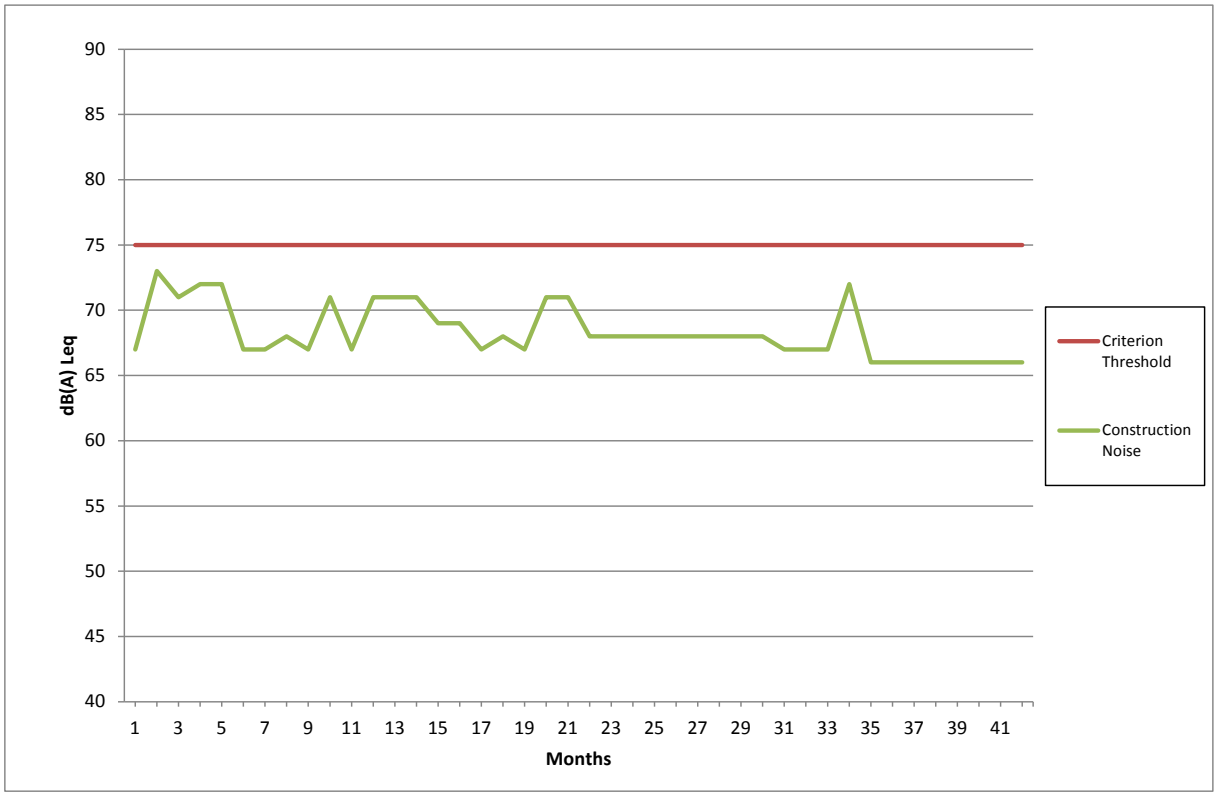
Vol 7 Plate G.5 Average monthly daytime noise level over duration of construction – Star & Garter Mansions (residential and PH) (PE1)



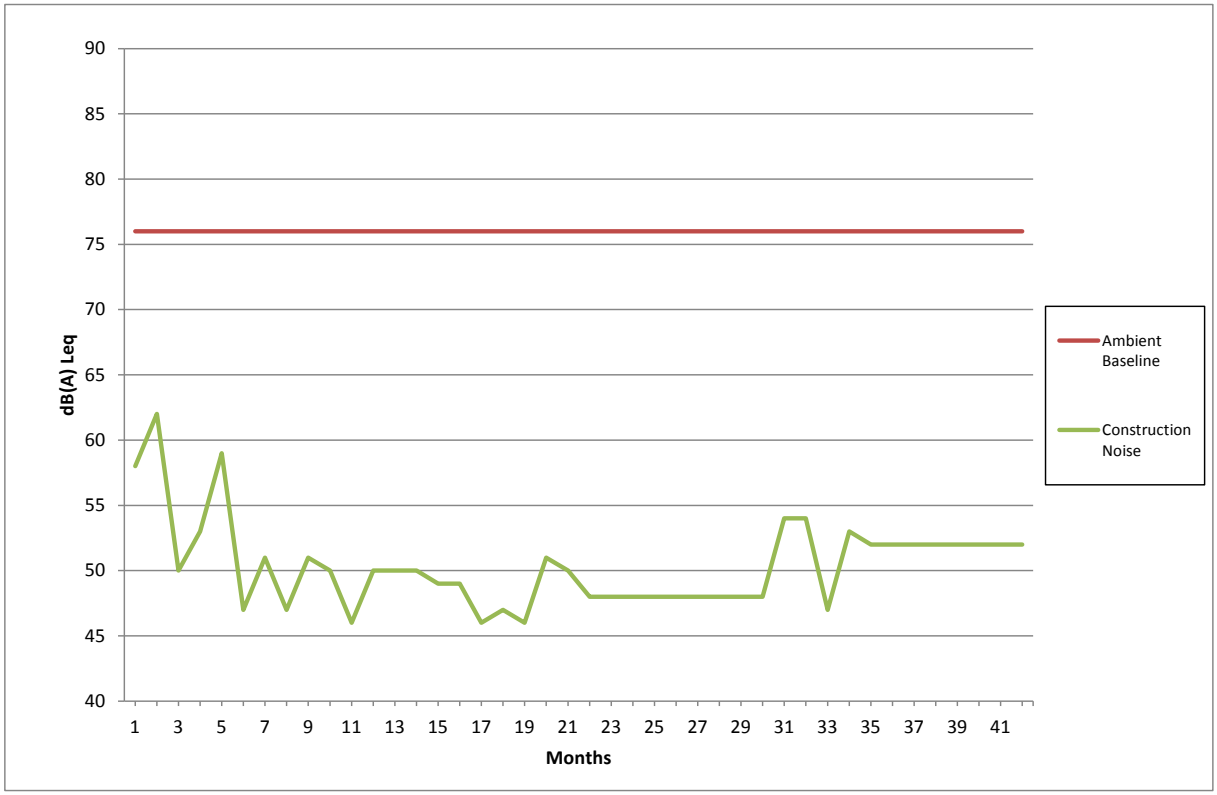
Vol 7 Plate G.6 Average monthly daytime noise level over duration of construction – 1-24 Kenilworth Court (residential) (PE2)



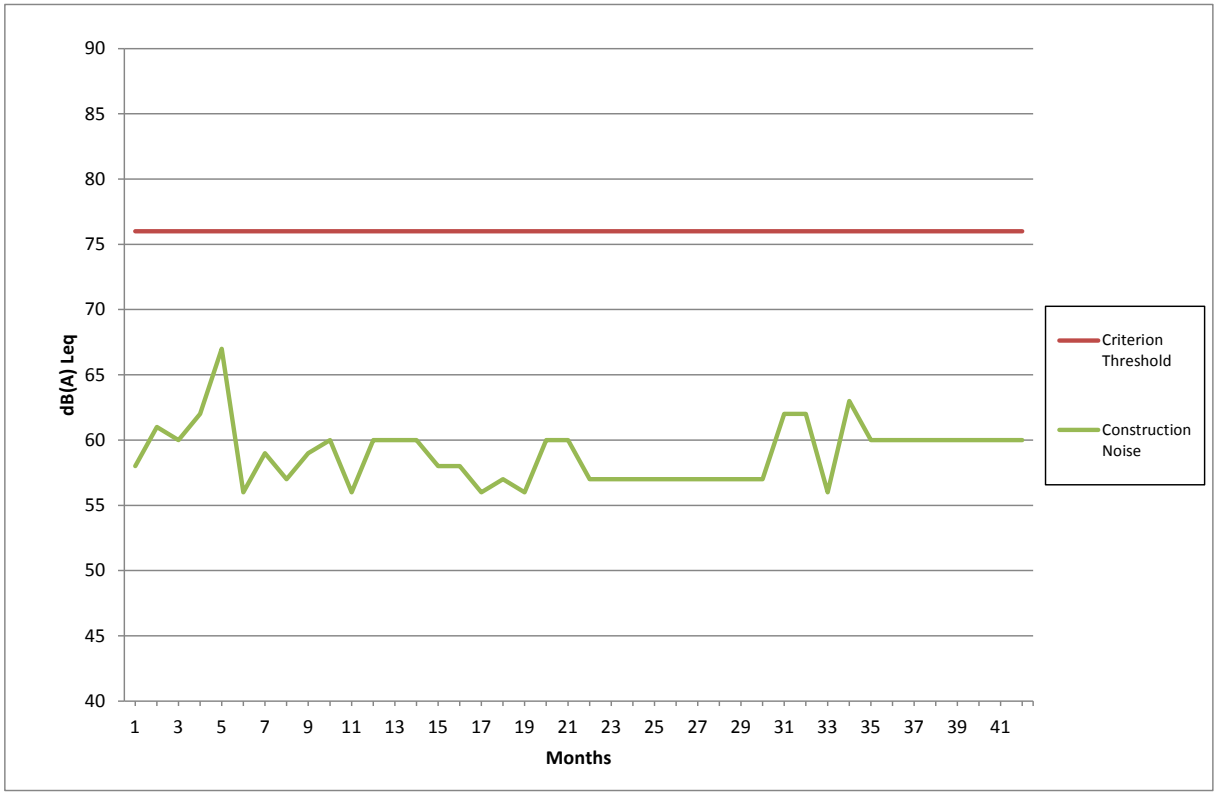
Vol 7 Plate G.7 Average monthly daytime noise level over duration of construction – 31-78 Kenilworth Court (residential) (PE3)



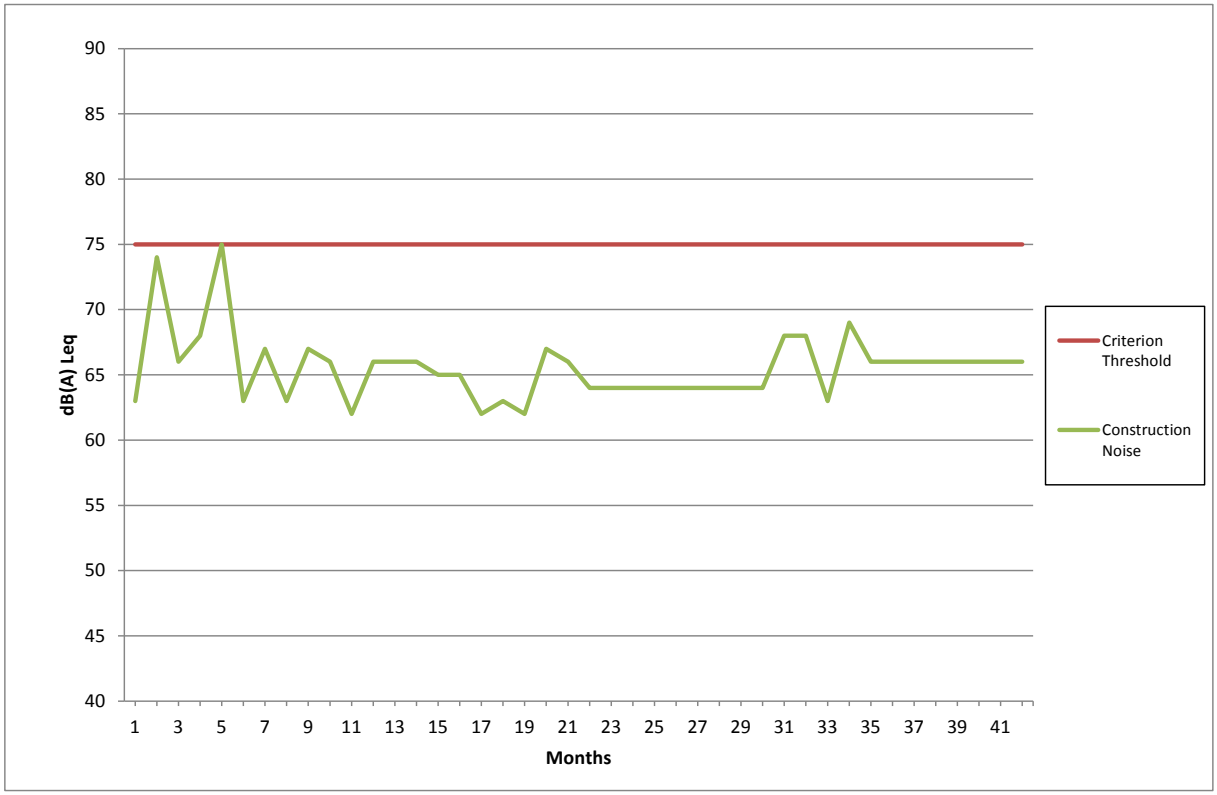
Vol 7 Plate G.8 Average monthly daytime noise level over duration of construction – St Mary's Church (PE4)



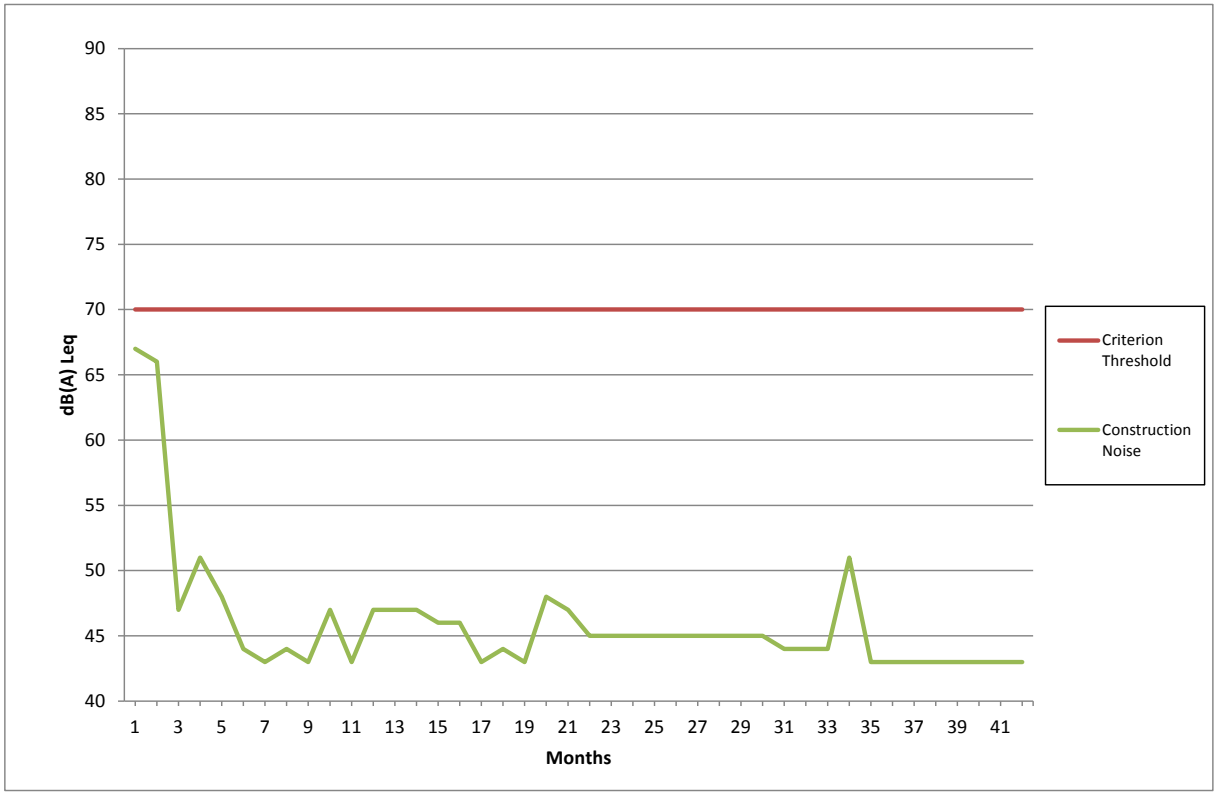
Vol 7 Plate G.9 Average monthly daytime noise level over duration of construction – 1-67 Putney Wharf Tower (PE5)



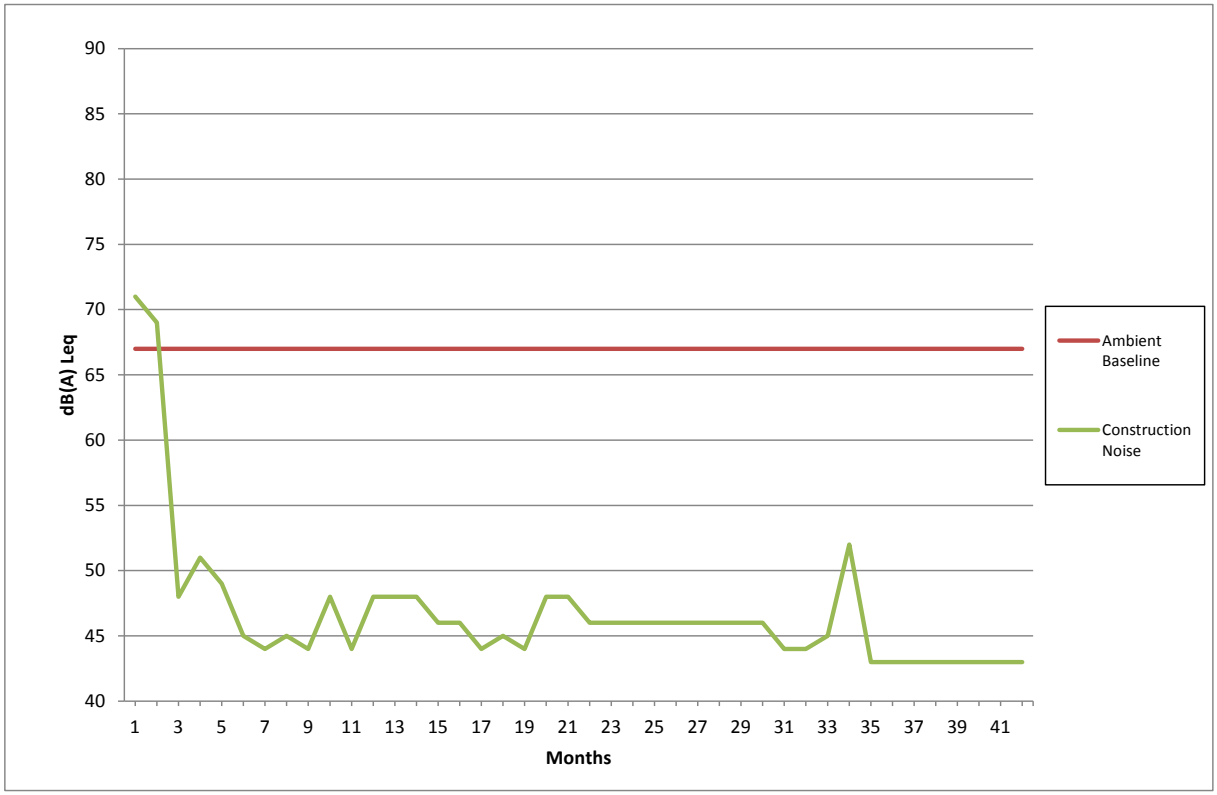
Vol 7 Plate G.10 Average monthly daytime noise level over duration of construction – Richmond Mansions (PE6)



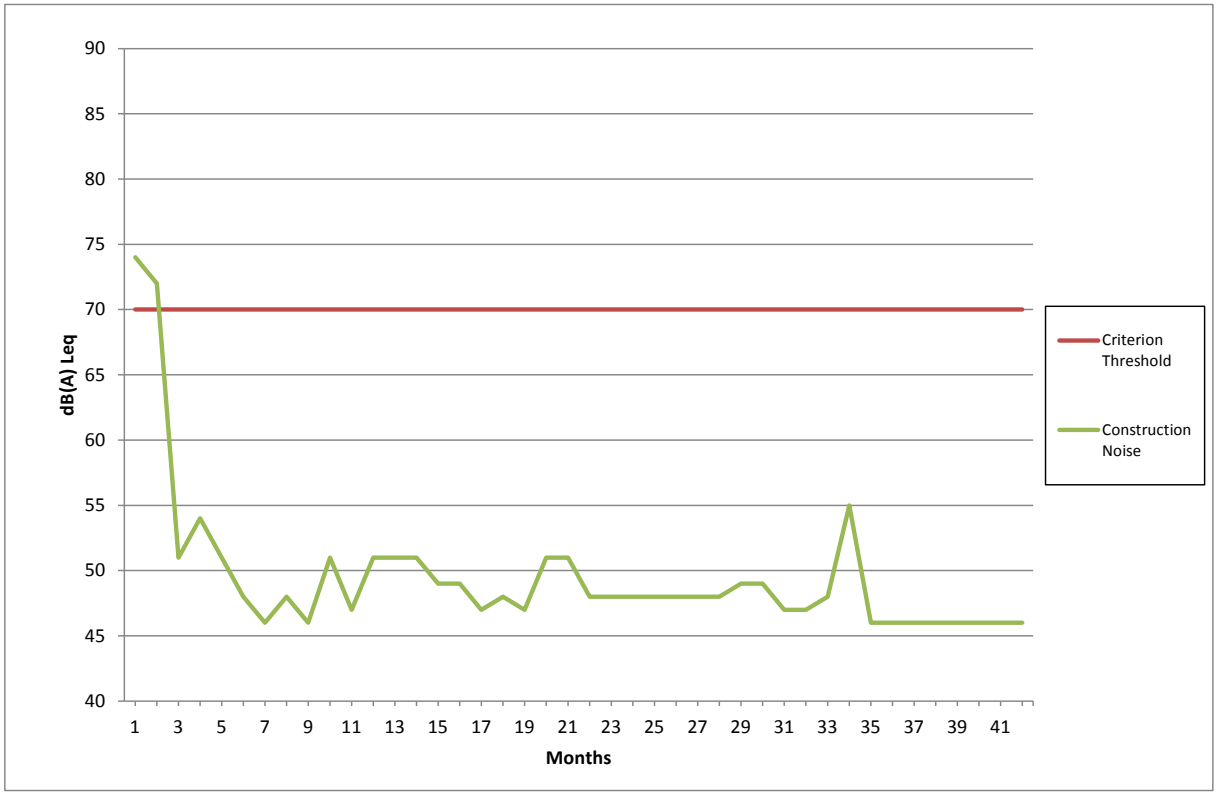
Vol 7 Plate G.11 Average monthly daytime noise level over duration of construction – Ruvigny Mansions (residential) (PE7)



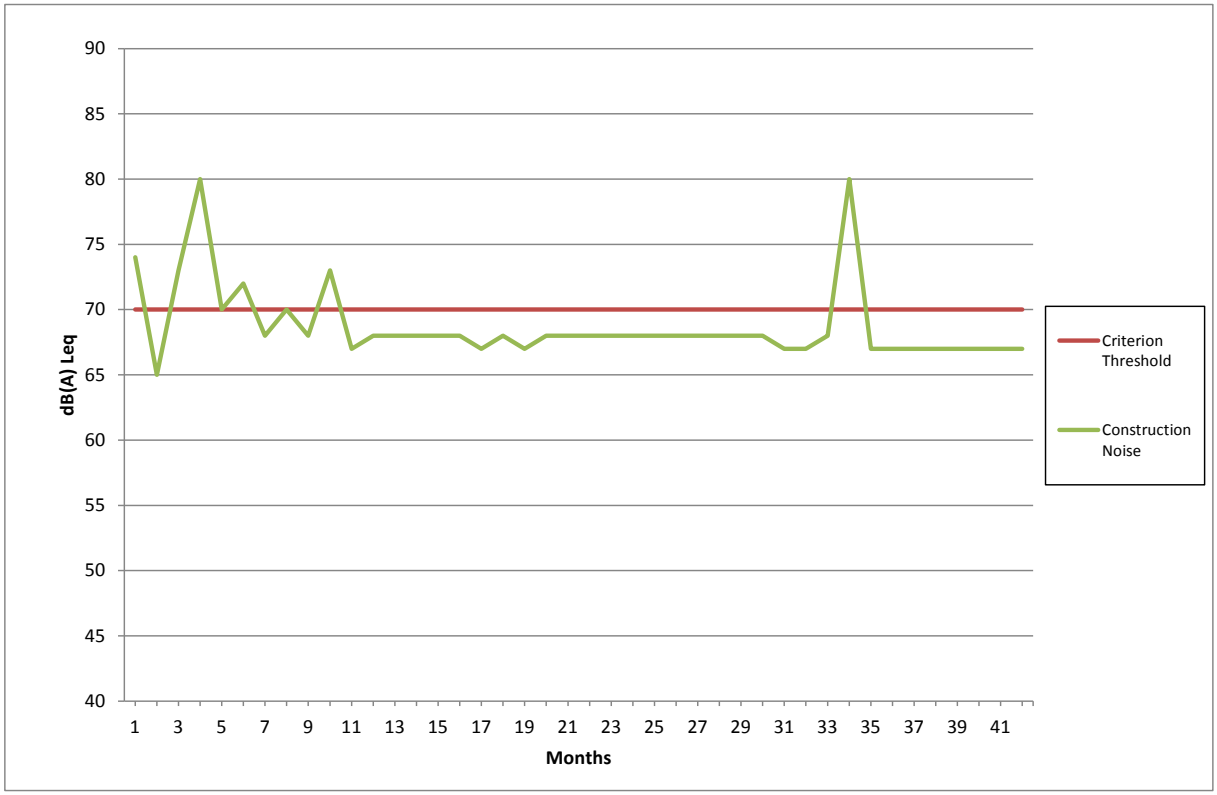
Vol 7 Plate G.12 Average monthly daytime noise level over duration of construction – Chas Newens Marine (retail) (PE8)



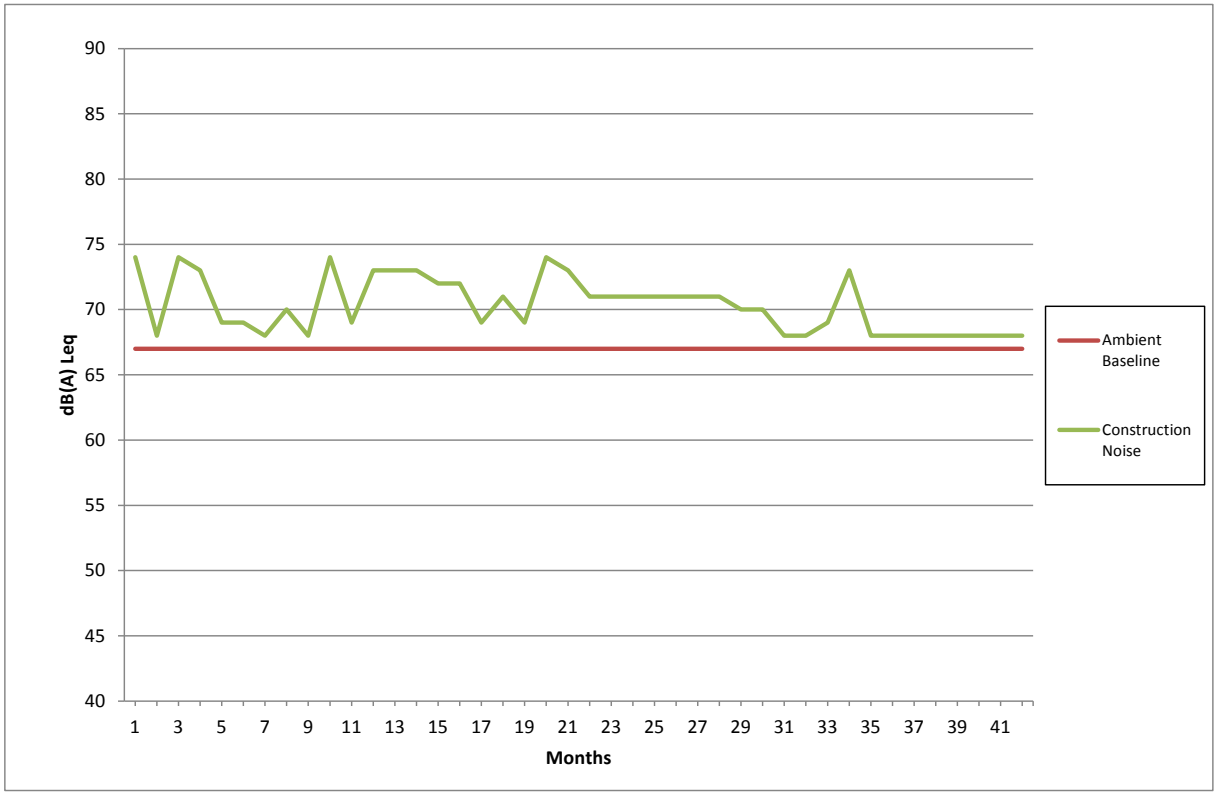
Vol 7 Plate G.13 Average monthly daytime noise level over duration of construction – 10 Ruvigny Gardens (residential) (PE9)



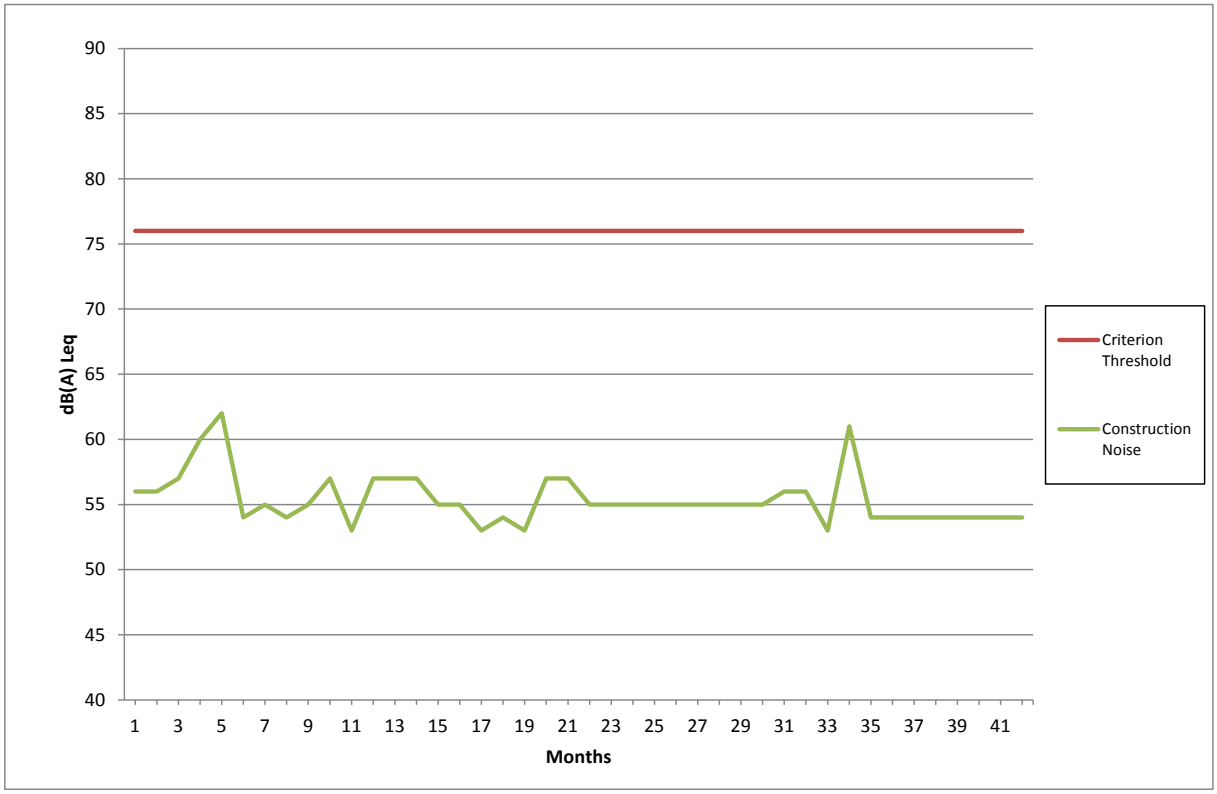
Vol 7 Plate G.14 Average monthly daytime noise level over duration of construction –Houseboats (residential) (PE10)



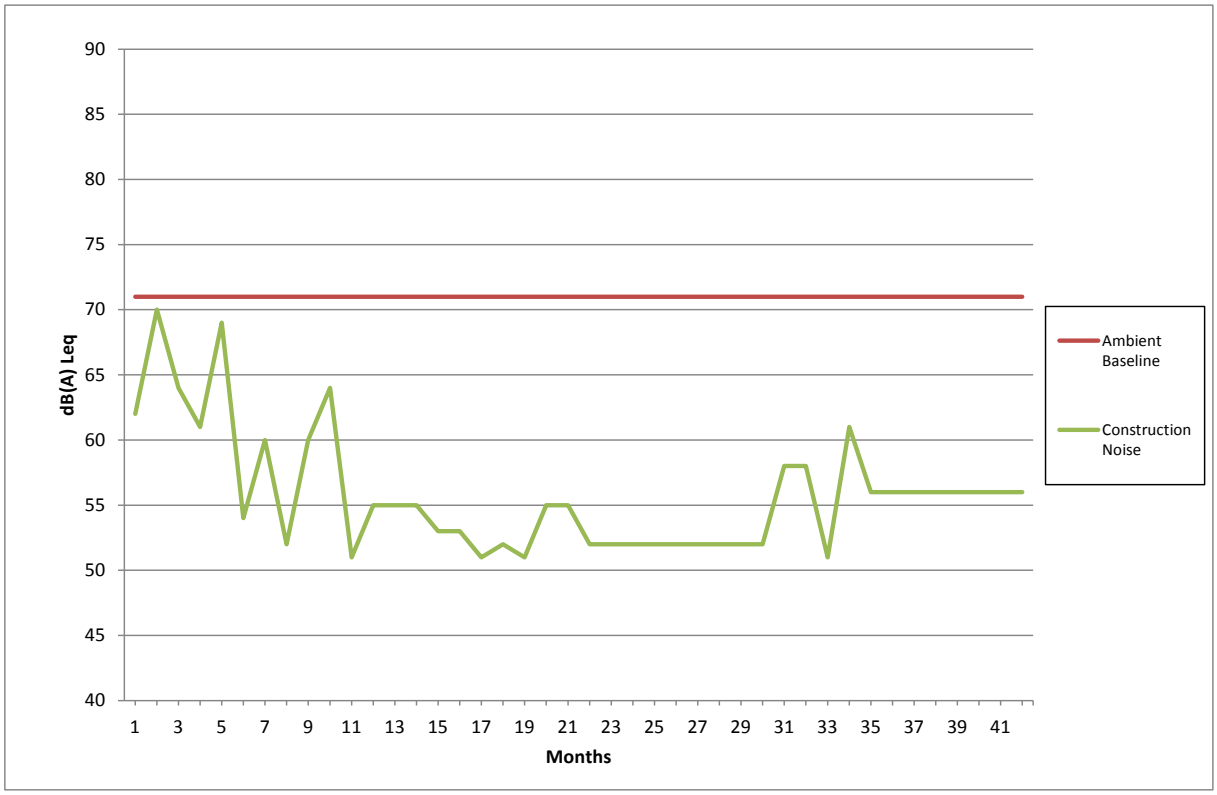
Vol 7 Plate G.15 Average monthly daytime noise level over duration of construction – Thai Square (restaurant) (PE11)



Vol 7 Plate G.16 Average monthly daytime noise level over duration of construction – Fulham High Street (residential) (PE12)



Vol 7 Plate G.17 Average monthly daytime noise level over duration of construction – Café at 2 Putney High Street (PE13)



References

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

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.07**

Volume 7: Putney Embankment Foreshore appendices

Appendix H: Socio-economics

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

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Thames Tideway Tunnel

Environmental Statement

Volume 7 Appendices: Putney Embankment Foreshore site assessment

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

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

H.1.3 The main protected characteristic group concentrated within the 250m and 1km assessment areas surrounding the proposed construction site are persons aged over 65 years old.

Resident population

H.1.4 The resident population was approximately 2,825 within 250m of the site and approximately 29,275 within 1km at the time of the last census.

Gender and age

H.1.5 Of the total population within 250m of the site 51.8% of residents are female. Females are also slightly more predominant than males within 1km (52.7%) and the LB of Wandsworth (52.5%), and broadly in line with the Greater London proportion (51.6%).

H.1.6 Vol 7 Table H.1 outlines age breakdown by assessment area, it illustrates that the proportion of under 16 year olds within 250m (10.3%) is slightly lower than within 1km (13.7%) and approximately half that of the Greater London average (20.2%).

H.1.7 Within 250m and 1km, the proportion of over 65 year olds is the same (both 11.4%), slightly higher than the borough wide proportion (10.4%) and slightly lower than the Greater London proportion of over 65 year olds (12.4%).

[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.

Vol 7 Table H.1 Socio-economics – age breakdown by assessment area

Age group	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
Under 16 years old	10.3%	13.7%	16.3%	20.2%
Over 65 years old	11.4%	11.4%	10.4%	12.4%

Ethnicity

H.1.8 Vol 7 Table H.2 outlines ethnicity by assessment area, showing that within 250m of the site, White residents comprise over 90% of the population (90.6%) with Black and Minority Ethnic (BME) groups making up the remaining 9.4% of residents.

H.1.9 The proportion of White residents within 250m (90.6%) is broadly similar to that within 1km (89.7%), with these proportions being moderately higher than both the borough and Greater London proportions (78.0% and 71.2% respectively).

H.1.10 Within 250m, the proportion of Black residents (2.6%) is similar to within 1km (3.1%), with both being considerably lower than the LB of Wandsworth (9.6%) and the Greater London averages (10.9%). The proportion of Asian residents within both 250m (2.3%) and 1km (2.8%) of the site is considerably lower than the LB of Wandsworth (7.0%) and the Greater London averages (12.1%).

Vol 7 Table H.2 Socio-economics – ethnicity by assessment area

Ethnicity	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
White	90.6%	89.7%	78.0%	71.2%
BME	9.4%	10.3%	22.1%	28.8%
Asian	2.3%	2.8%	7.0%	12.1%
Black	2.6%	3.1%	9.6%	10.9%
Other	1.7%	2.1%	2.1%	2.7%
Mixed	2.8%	2.4%	3.4%	3.2%

1.1.1 *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.1.11 Within 250m and 1km of the site and at a borough wide level, people identifying themselves as Christians are the predominant religious group

at 65.0%, 67.7% and 61.8% respectively. Muslims are the second most predominant religious group, comprising 1.7% of residents within 250m. Within 1km, the proportion of Muslims (2.2%) is slightly higher. The proportions of Muslims within the above assessment areas are considerably lower than that recorded for Greater London (8.5%).

H.1.12 Within 250m those residents who do not follow a religion amount to 31.4%, somewhat higher than within 1km (27.5%) and higher still than the Greater London average (24.3%).

Health indicators

H.1.13 Vol 7 Table H.3 outlines health indicators by assessment area, noting that within 250m of the site, the proportion of residents suffering from long term limiting illness amounts to 11.2%, broadly in line with the proportion within1km (10.8%), though moderately lower than within Greater London (15.5%).

H.1.14 The proportion residents who claim disability living allowance within 250m (2.5%) is broadly in line with claimant levels within 1km (2.2%). These proportions are both somewhat lower than those recorded for the LB of Wandsworth (3.9%) and Greater London (4.5%).

Vol 7 Table H.3 Socio-economics – health indicators by assessment area

Health indicator	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
Long term limiting sick	11.2%	10.8%	13.4%	15.5%
Disability living allowance	2.5%	2.2%	3.9%	4.5%

H.1.15 In the Middle Layer Super Output Area (MSOA)[iii5] in which the site falls within, levels of adult obesity fall within the lowest quintile (ie, the lowest being the best) relative to Greater London. Child obesity, measured at a borough level, falls within the middle quintile relative to other Greater London boroughs.

H.1.16 In terms of adults undertaking physical activity as measured borough wide, the LB of Wandsworth falls within the highest quintile (ie, the highest being the best) relative to Greater London. By contrast, the proportion of children undertaking physical activity falls within the lowest quintile relative to Greater London.

[iii] 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.

H.1.17 Mortality rates by heart disease, circulatory disease, strokes and heart disease within the MSOA in which the site falls are in the lowest quintile (ie, the lowest being the best) within the borough. Deaths by respiratory disease are slightly more prevalent and fall within the second lowest quintile. By contrast, death rates by cancer fall within the highest quintile.

H.1.18 Male life expectancy in the MSOA within which the site falls is in the highest quintile within the borough (ie, the highest being the best) and female life expectancy falls within the second highest quintile. Average life expectancy for male residents is 84.9 to 93.1 years and for female residents is 83.2 to 84.9 years old.

Lifestyle and deprivation indicators

H.1.19 Vol 7 Table H.4 outlines lifestyle and income deprivation indicators by assessment area, showing that the proportions of households which do not own cars within 250m of the site (38.6%) and 1km (37.1%) are broadly in line with the Greater London average (37.5%).

H.1.20 The incidence of overall deprivation[iv], measured by income, within 250m and 1km are recorded at 0%, both the borough (15.4%) and Greater London (30.8%) levels are considerably higher. Income deprivation is also recorded at 0% within both 250m and 1km, both the LB of Wandsworth (10.1%) and Greater London levels (24.5%) are considerably higher.

Vol 7 Table H.4 Socio-economics – lifestyle and income deprivation levels by assessment area

Indicator	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
No car households	38.6%	37.1%	40.7%	37.5%
Income deprivation	0.0%	0.0%	15.4%	30.8%
Overall deprivation	0.0%	0.0%	10.1%	24.5%

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

H.2 Baseline economic profile

H.2.1 This section presents a profile of the economy local to the proposed construction site at Putney Embankment Foreshore.

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

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

Employment and businesses

H.2.4 Within approximately 250m of the site there are approximately 4,600 jobs.[vi] Vol 7 Table H.5[vii] below illustrates the breakdown of employment by sector based on the UK Standard Industrial Classification (SIC) 2007[7]. It shows data for those sectors which account for more than 5% of total employment within approximately 250m. It can be seen that:

a. Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles account for 20% of employment within 250m, considerably more than within both the LB of Wandsworth (14%) and somewhat more than within Greater London (16%).

b. Accommodation and Food Services activities account for 15% of employment within 250m, considerably more than within both the LB of Wandsworth (9%) and almost double that within Greater London (8%).

c. Professional, Scientific and Technical Services account for 9% to 12% of employment at all three geographical levels.

d. Other Service Activities account for 11% of employment within 250m, considerably more than within both the LB of Wandsworth (6%) and Greater London (4%).

e. Information and Communication accounts for 10% of employment within 250m, almost double that within the LB of Wandsworth (5%) and considerably more than in Greater London (7%).

f. Administrative and Support Service Activities account for 9% of employment within 250m, slightly more than within the LB of Wandsworth and Greater London (both 8%).

[v] 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.

[vi] 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.

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

Vol 7 Table H.5 Socio-economics – employment by top six sectors (2012)

	Assessment area		
Sector (Standard Industrial Code 2007)	**Immediate area (250m)**	**Borough wide (LB of Wandsworth)**	**Greater London**
Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles	20%	14%	16%
Accommodation and Food Service Activities	15%	9%	8%
Professional, Scientific and Technical Activities	12%	9%	11%
Other Service Activities	11%	6%	4%
Information and Communication	10%	5%	7%
Administrative and Support Services Activities	9%	8%	8%
Other (including unclassified)	23%	49%	46%

H.2.5 Within approximately 250m of the site there are approximately 700 businesses (defined here as business locations[viii]). The split of businesses by sector within 250m generally reflects the breakdown of employment by sector set out above, with a relatively high number of businesses engaged in Professional and Technical Activities (15%), Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles (14%), Information and Communication Activities (10%), Other Service Activities (9%), and Administrative and Support Services Activities (7%). However, Accommodation and Food Service Activities accounts for 8% of businesses, while generating 15% of employment.

H.2.6 Vol 7 Table H.6 below illustrates the size of businesses in terms of the number of employees at each business location / unit. At all geographical levels, businesses within the smallest size band (one to nine employees) account for the majority and, overall, the size banding profile of businesses within 250m of the site is generally similar to the LB of Wandsworth and Greater London.

H.2.7 For sectors accounting for the greatest proportions of jobs and businesses within approximately 250m, the size banding profile of businesses also follows a similar pattern to the three geographical levels. An exception is that 54% of businesses within the Accommodation and Food Service Activities sector employ one to nine employees, compared to an average across all sectors of 87%. Also around 35% of businesses in this sector employ ten to 24 employees, compared to an average across all sectors of 10%.

[viii] 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.

Vol 7 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)		87%	10%	2%	1%	0%	0%
	Professional Scientific and Technical Activities	87%	11%	2%	0%	0%	0%
	Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles	80%	13%	5%	1%	0%	1%
	Other Service Activities	87%	10%	2%	0%	2%	0%
-	*Accommodation and Food Service Activities*	54%	35%	7%	4%	0%	0%
Borough wide (LB of Wandsworth)		90%	7%	2%	1%	0%	0%
Greater London		88%	8%	2%	1%	1%	0%

H.3 Baseline usage surveys

H.3.1 Please refer to Vol 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. Tuesday 2nd August 2011, 11am to 11.30am and 3pm to 3.30pm (sunny, 27°C)

b. Sunday 14th August 2011, 12pm to 1pm and 4pm to 4.30pm (partly sunny, 20°C)

c. Friday 2nd September, 6pm to 8pm (warm and dry evening, 22°C)

d. Wednesday 14th September 2011, 11am to 11.30am and 3pm to 3.30pm (sunny, 17°C).

Autumn

a. Saturday 8th October 2011, 3pm to 3.30pm (partly sunny, 15°C)

b. Tuesday 11th October 2011, 11.30am to 12pm and 4pm to 5pm (partly sunny, 15°C).

Survey zones

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

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

Name	Location	Survey times	Frequency
Survey zone 1	Waterman's Green: west	30 minutes (concurrently with Survey zone 2) (Point in time on Friday 2nd September)	See survey times above
Survey zone 2	Waterman's Green: east	30 minutes (concurrently with Survey zone 1) (Point in time on Friday 2nd September)	

Key findings and observations

Survey zones 1 and 2 – Waterman's Green

H.3.4 The spaces were observed being used on only three occasions. Users recorded were White, young (18 to 39 years old) adults, who were using the space for passive recreation activities.

Other findings

H.3.5 During a summer evening survey undertaken on Friday 6th September, the use of the Embankment to the west of the proposed construction site was observed. The following findings were recorded:

a. The Thames Path, particularly at the riverside, was well used by people with 57 walkers, joggers or cyclists being recorded in one 10 minute period.

b. Seating areas were generally well used, with benches on the riverside of the Thames Path being mostly fully occupied during each observation period. Diners were observed using outdoor dining space at Thai Square and the Duke's Head public house.

c. Patrons of the Star and Garter Pub (generally numbering four or five during each 10 minute observation period) were observed standing outside the establishment.

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

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

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.07**

Volume 7: Putney Embankment Foreshore appendices

Appendix I: Townscape and visual

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

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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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Appendix J: Transport

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Appendix J: Transport

J.1 Introduction

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Appendix K: Water resources - groundwater

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Appendix K: Water resources – groundwater

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Appendix K: Water resources – groundwater

K.1 Geology

K.1.1 A summary of the anticipated geological succession at the Putney Embankment Foreshore site is shown in Vol 7 Table K.1.

Vol 7 Table K.1 Groundwater - anticipated geological succession

Period	Series	Group	Formation
Quaternary	Holocene	Superficial deposits	Made Ground
			Alluvium
	Pleistocene		River Terrace Deposits
Palaeogene	Eocene	Thames	London Clay

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 7 Figure13.4.1 and Vol 7 Figure 13.4.2 respectively (see separate volume of figures).

K.1.3 The ground investigation undertaken for the Thames Tideway Tunnel project has involved drilling boreholes both on the banks and within the main river channel for the purposes of understanding the geology and hydrogeology within the assessment area. The depths and thicknesses of geological layers are based on ground investigation boreholes drilled up to 50m from the Putney Embankment Foreshore site; these are boreholes SR1112 and SR2083. The locations of boreholes around the site are shown in Vol 7 Figure13.4.1 (see separate volume of figures). The anticipated ground conditions at the site are summarised below in Vol 7 Table K.2.

Vol 7 Table K.2 Groundwater - anticipated ground conditions

Formation	Top elevation* mATD**	Depth below river bed (m)	Thickness (m)
River Terrace Deposits	100.0	0.0	0.4
London Clay			
B	99.6	0.4	22.1
A3ii	77.5	22.5	12.2
A3i	65.3	34.7	1.9
A2	63.4	36.6	10.6

** Top elevation of over-water boreholes is approximately 5m below assumed ground level*

** *mATD = metres above tunnel datum. A commonly used term for sub-surface construction projects, which defines height above a datum set at -100mAOD (above Ordnance Datum).*

K.1.4 The CSO drop shaft and base slab at the Putney Bridge site would extend down to approximately 69.43mATD and 67.43mATD respectively and would pass through the River Terrace Deposits and into the London Clay Formation, units B and A3ii.

K.1.5 The connection tunnel would be constructed within the London Clay Formation, unit A3ii.

K.1.6 The interception chamber and culvert approximately 4.3m deep, as assumed for the purposes of this assessment, would extend down to 95.7mATD into the London Clay Formation, unit B.

K.1.7 The River Terrace Deposits are formed of extensive alluvial sand and gravel deposits laid down in river terraces by a braided river system of approximately 5km in width since the Anglian glaciation. The River Terrace Deposits are expected to be 0.4m thick at the site.

K.1.8 The borehole log from SR1112 (taken on land) indicates that Made Ground containing brick-like rubble may be up to a depth of 4.9m. Although fine-grained sand, silt and clayey silt 'Brickearth' deposits are commonly found above River Terrace Deposits, the thickness of the River Terrace Deposits at the site and geological descriptions indicate the Brickearth is not significant at this site.

K.1.9 The London Clay comprises firm to very stiff clay, slightly sandy and slightly gravely in places and fissured in places. The London Clay Formation is divided into sub-units referred from oldest to youngest as A to E, with some of these sub-units dividing further, for example A2, A3i-iii, B in decreasing age order. The London Clay formation is expected to be 46.8m thick at the Putney Embankment Foreshore site.

K.2 Hydrogeology

K.2.1 A summary of the anticipated hydrogeological conditions at the Putney Embankment Foreshore site is shown in Vol 7 Table K.3.

Vol 7 Table K.3 Groundwater – anticipated hydrogeological units

Group	Formation	Hydrogeology
Superficial deposits	River Terrace Deposits	Upper aquifer
Thames	London Clay Formation	Aquiclude[i2]

K.2.2 The upper aquifer (River Terrace Deposits) is defined by the Environment Agency (EA) as a secondary A aquifer. These deposits are described as

[i] *Aquiclude - a geological formation through which virtually no water moves (USGS website, 2012).*

"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)[3].

K.2.3 The lower aquifer, comprising of the Upnor Formation, the Thanet Sands and the Chalk, is not expected to be encountered by the Thames Tideway Tunnel project at the Putney Embankment Foreshore site.

K.2.4 The CSO drop shaft would pass through the upper aquifer and into the London Clay Formation (B and A3ii sub divisions). The London Clay Formation (B to A2) is generally acknowledged as an aquiclude between the upper and lower aquifers. Any groundwater present in a majority of the London Clay Formation is likely to consist of localised seepages and/or minor flows. It is anticipated that below the River Terrace Deposits the drop shaft would be excavated in predominantly dry London Clay Formation with the exception of minor seepage at various horizons, namely silt or claystone horizons at least down to unit B. In unit A3ii, the presence of fine sand laminea/lenses at this horizon, may act as horizontal conduits for migration of groundwater from a nearby source.

K.3 Groundwater level monitoring

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

K.3.2 For the Environmental Statement (ES), there are no groundwater level monitoring boreholes specifically dedicated to the Putney Bridge drop shaft site. Information on groundwater levels for this assessment was therefore collected from an off-site monitoring point (SA1115) located at the Barn Elms site, approximately 480m to the northwest as shown in Vol 7 Figure 13.4.1. This borehole has a response zone[ii] (EA, 2006)[4] and monitors groundwater levels in the River Terrace Deposits. The response zone depth, the monitored strata and the frequency of monitoring are detailed in Vol 7 Table K.4. The logger data collected from this monitoring borehole is shown in Vol 7 Table K.5.

Vol 7 Table K.4 Groundwater - monitoring boreholes

Borehole (location)	Response zone (mATD)	Strata	Monitoring type and frequency
SA1115 (480m northwest)	101.4-95.4	River Terrace Deposits	15 minute logger data

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

Vol 7 Table K.5 Groundwater – summary level data

Borehole	Period of record	Maximum Month Year		Minimum Month Year		Average over period of record	
		mbgl	mATD	mbgl	mATD	mbgl	mATD
SA1115	01/01/10 – 05/04/12	2.53 (Feb 2010)	101.38 (Feb 2010)	3.39 (Dec. 2011)	100.52 (Dec. 2011)	3.07	100.84

K.3.3 The recorded water levels in the River Terrace Deposits at SA1115 range between 100.52 to 101.38mATD during the monitoring period. These levels remain below the top of the formation at 101.69mATD, suggesting that the River Terrace Deposits are not fully saturated here. The water levels show seasonal variation and fluctuate with the tidal cycle.

K.3.4 There is only one borehole in the River Terrace Deposits on the site and as such it is difficult to determine the direction of groundwater flow within this waterbody. However it is expected that the direction of groundwater movement is from southwest to northeast, towards the River Thames in these shallow deposits.

K.3.5 The EA network does not include any groundwater level monitoring boreholes sufficiently close by to provide representative water level in the upper aquifer at the site.

K.4 Groundwater abstractions and protected rights

Groundwater licensing policy

K.4.1 The London Catchment Abstraction Management Strategy (CAMS), (EA, 2006)[5] does not identify a condition status for the upper aquifer.

K.4.2 The status of the lower aquifer is not relevant for this assessment as the construction would not reach to this depth at the Putney Embankment Foreshore site.

K.4.3 No dewatering of the upper or lower aquifers is anticipated at the Putney Embankment Foreshore site. Any water entering the excavation from either the superficial deposits or from minor seepages through silt layers in the London Clay would be pumped to the River Thames via appropriate settlement tanks.

Licensed abstractions

K.4.4 The EA licenses abstractions from groundwater within London for all sources in excess of 20m^3/d. Groundwater abstractions within 1km of the site have been identified.

K.4.5 The nearest licensed abstraction from the River Terrace Deposits or upper aquifer is approximately 0.7km to the east (see Vol 7 Table K.6). The

licensed abstraction source (28/39/39/0177) is held by the Trustees of the Hurlingham Club and is used for sports ground and facilities.

K.4.6 The licensed abstractions from the lower aquifer (Chalk) would be unaffected due to construction taking place entirely within the upper aquifer and the London Clay.

K.4.7 There are no known unlicensed groundwater abstractions within 1km of the site.

Vol 7 Table K.6 Groundwater - licensed abstractions

Licence number	Licence holder	Purpose	Aquifer	Licensed volume [m3/annum]
28/39/39/0177	Trustees of the Hurlingham Club	Sports ground and facilities	River Terrace Deposits	15,000

K.5 Groundwater source protection zones

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

K.5.2 The Putney Embankment Foreshore site does not lie within a SPZ for a Chalk source. The nearest SPZ is 4.6km away to the northeast and is designated to safeguard an abstraction within the lower aquifer.

K.6 Environmental designations

K.6.1 There are no environmental designations relevant to groundwater, such as SSSI, SAC or SNCIs within 1km of the Putney Embankment Foreshore site.

K.7 Groundwater quality and land quality assessment

K.7.1 Historical land use mapping, reviewed as part of the land quality assessment, at the Putney Embankment Foreshore site has identified wharves just within the eastern edge of the construction site which may contain potentially contaminative land uses or potential contaminant sources (Vol 7 Section 8). Land quality may impact on groundwater quality through the creation or promotion of preferential pathways for existing contamination during construction of the proposed development.

K.7.2 The groundwater quality data presented in Vol 7 Table K.7 has been sourced from the ground investigation and monitoring works undertaken as part of the Thames Tideway Tunnel project and includes data from one monitoring borehole located off site (SA1115A) (for locations see Vol 7 Figure13.4.1 in separate volume of figures). Any exceedances of the UK

drinking water standards (The Water Supply Regulations, 2000)[6] or relevant Environmental Quality Standards – EQS (River Basin Districts Typology…, 2010)[7] are shaded in blue in this table.

K.7.3 The data shows only one exceedance of the relevant standards within the River Terrace Deposits for nitrate at SR1115A.

K.7.4 The EA monitors groundwater quality at number of points across London, mainly the Chalk and Lower London Tertiaries (Lambeth Group). The water quality information provided from this network is not relevant to the Putney Embankment Foreshore site, where construction would be entirely with the London Clay.

K.7.5 The land quality data from the ground investigation boreholes used in the groundwater quality assessment show few exceedances of the human health screening values[8] (soil guideline values designed to be protective of human health) with respect to heavy metals within the River Terrace Deposits. Further detail is provided in the land quality assessment (see Vol 7 Appendix F).

Vol 7 Table K.7 Groundwater – groundwater quality

Source of data*				SI
Name				SA1115A
Hydrogeological unit**				RTD
Distance from site	**EQS Criteria**			712m
Chemical	**Value**	**Units**	**Source**	2009
1,1,1 - Trichloroethane	100	ug/l	SW Regs 98	-
1,1,2 - Trichloroethane	400	ug/l	SW Regs 98	-
1,2 - Dichloroethane {Ethylene Dichloride}	3	ug/l	WS Regs 20	-
2,4 - Dichlorophenol	20	ug/l	WFD 2010	<0.1
2,4 - Dimethylphenol {2,4-Xylenol}	-	ug/l	-	<0.1
2,4,6 - Trichlorophenol	-	ug/l	-	<0.1
2,6 - Dichlorophenol	-	ug/l	-	<0.1
4 - Chloro - 3- Methylphenol {P-Chloro-M-Cresol}	40	ug/l	WFD 2010	<0.1
Acenaphthene	-	ug/l	-	<0.01
Acenaphthylene	-	ug/l	-	<0.01
Aliphatics >C10-C12	-	ug/l	-	<1
Aliphatics >C12-C16 (Aqueous)	-	ug/l	-	3
Aliphatics >C16-C21 (Aqueous)	-	ug/l	-	7
Aliphatics >C21-C35 (Aqueous)	-	ug/l	-	10
Aliphatics >C6-C8	-	ug/l	-	<0.1
Aliphatics >C8-C10	-	ug/l	-	<0.1
Aliphatics C5-C6	-	ug/l	-	<0.1
Alkalinity (Carbonate)	-	mg/l as CaCO3	-	-
Alkalinity Ph 4.5 - As CaCO3	-	mg/l as CaCO3	-	290
Aluminium Total	200	ug/l as Al	DWS 2010	-
Ammonia - As N	0.39	mg/l as N	WS Regs 20	-
Ammoniacal nitrogen	-	mg/l	-	0.34
Anthracene	0.1	ug/l	SW WFD	<0.01
Aromatics >C7-C8	50	ug/l	WFD 2010	<0.1
Aromatics >EC10-EC12	-	ug/l	-	4
Aromatics >EC12-EC16 (Aqueous)	-	ug/l	-	5
Aromatics >EC16-EC21 (Aqueous)	-	ug/l	-	7
Aromatics >EC21-EC35 (Aqueous)	-	ug/l	-	14
Aromatics >EC8-EC10	-	ug/l	-	<0.1
Aromatics C6-C7	1	ug/l	DWS 2010	<0.1
Arsenic Total	10	ug/l as As	DWS 2010	<1
Atrazine { }	0.1	ug/l	DWS 2010	-
Bentazone	0.1	ug/l	DWS 2010	-
Benzene	1	ug/l	DWS 2010	<1
Benzo (a) anthracene	-	ug/l	-	<0.01
Benzo[a]Pyrene	0.01	ug/l	DWS 2010	<0.01
Benzo[b]Fluoranthene	0.03	ug/l	WFD D 10	<0.01

Source of data*				SI
Name				SA1115A
Hydrogeological unit**				RTD
Distance from site	**EQS Criteria**			712m
Chemical	**Value**	**Units**	**Source**	2009
Benzo[g,h,i]Perylene	0.002	ug/l	WFD D 10	<0.01
Benzo[k]Fluoranthene	0.03	ug/l	WFD D 10	<0.01
Boron Total	1000	ug/l as B	DWS 2010	290
Bromate	10	ug/l as BrO3	DWS 2010	-
Cadmium Total	5	ug/l as Cd	DWS 2010	<2
Calcium Total	250	mg/l as Ca	DWS 2010	-
Carbendazim / Benomyl	0.1	ug/l	FW List II	-
Carbetamide	-	ug/l	-	-
Carbon tetrachloride	3	ug/l	DWS 2010	-
Chlorfenvinphos	0.1	ug/l	DWS 2010	-
Chloride	250	mg/l as Cl	DWS 2010	91
Chloroform	100	ug/l	WS Regs 20	-
Chlortoluron	2	ug/l	FW List II	-
Chromium Total	50	ug/l as Cr	DWS 2010	<5
Chrysene	-	ug/l	-	<0.01
Clopyralid	-	ug/l	-	-
Conductivity @ 20°C	2500	uS/cm	WS Regs 20	960
Copper Total	2000	ug/l as Cu	DWS 2010	3
Cresols	-	ug/l	-	<0.1
Cyanazine	0.1	ug/l	DWS 2010	-
Cyanide (Free)	50	ug/l as CN	DWS 2010	<20
Cyanide (Total)	50	ug/l as CN	DWS 2010	<40
Cypermethrin	0.0001	ug/l	WFD 2010	-
Dalapon	-	ug/l	-	-
Diazinon	0.1	ug/l	DWS 2010	-
Dibenz-[A,H]-Anthracene	-	ug/l	-	<0.01
Dichloromethane	20	ug/l	WFD 2010	-
Dichlorprop	0.1	ug/l	DWS 2010	-
Diuron	0.1	ug/l	DWS 2010	-
Ethylbenzene	-	ug/l	-	<1
Fluoranthene	0.2	ug/l	EEC MAC	<0.01
Fluorene	-	ug/l	-	<0.01
Fluoride	1.5	mg/l as F	DWS 2010	-
Glyphosate	-	ug/l	-	-
Indeno-[1,2,3-Cd]-Pyrene	0.002	ug/l	WFD D 10	<0.01
Isoproturon (Diip1,3Dithiolan-2-Ylidenemalonate)	0.1	ug/l	DWS 2010	-
Lead Total	10	ug/l	WS Regs 20	<4
Magnesium Total	50	mg/l as Mg	EEC MAC	14
MCPA {2-methyl-4-chlorophenoxyacetic acid }	0.1	ug/l	DWS 2010	-
Mecoprop { }	0.1	ug/l	DWS 2010	-
Mercury Total	1	ug/l Hg	WS Regs 20	<0.05
Metazachlor	-	ug/l	-	-
MTBE {Methyl Tert-Butyl Ether}	-	ug/l	-	<1
Multi Residual Scan	-	ug/l	-	-

Source of data*				SI
Name				SA1115A
Hydrogeological unit**				RTD
Distance from site	**EQS Criteria**			712m
Chemical	**Value**	**Units**	**Source**	2009
Naphthalene	1.2	ug/l	WFD D 10	<0.01
Nickel Total	20	ug/l as Ni	DWS 2010	<10
Nitrate - N	11.3	mg/l as N	WS Regs 20	21
Permethrin (Cis + Trans)	0.01	ug/l	WFD D 10	-
pH	10	pH units	DWS 2010	6.8
Phenanthrene	-	ug/l	-	<0.01
Phenol	0.5	ug/l	EEC MAC	<0.1
Phenol (Pentachlorophenol (PCP))	-	ug/l	-	-
Phenols Total For SWAD (7 Compounds)	-	ug/l	-	-
Polynuclear Aromatic Hydrocarbons (Total)	0.1	ug/l	DWS 2010	<0.2
Potassium Total	-	mg/l as K	-	-
Propazine	0.1	ug/l	DWS 2010	-
Propetamphos	0.1	ug/l	DWS 2010	-
Pyrene	-	ug/l	-	<0.01
Selenium	10	ug/l as Se	DWS 2010	<3
Simazine	0.1	ug/l	DWS 2010	-
Sodium Total	200	mg/l as Na	DWS 2010	44
Sulphate	250	mg/l as SO4	DWS 2010	99
Sulphide	-	ug/l	-	<10
Terbutryn	0.1	ug/l	DWS 2010	-
Tetrachloroethylene	-	ug/l	-	-
Toluene (Methylbenzene)	50	ug/l	WFD 2010	<1
Total Aliphatic TPH	-	ug/l	-	20
Total Aromatic TPH	-	ug/l	-	29
Total Chemical Oxygen Demand	-	mg/l	-	25
Trichloroethene (Trichloroethylene)	10	ug/l	DWS 2010	-
Trietazine	-	ug/l	-	-
Trifluralin	0.1	ug/l	DWS 2010	-
Turbidity	1	FTU	WS Regs 20	-
Xylene (Meta & Para){1,3+1,4-Dimethylbenzene}	30	ug/l	WFD 2010	<1
Zinc Total	50	ug/l as Zn	DWS 2010	6
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: LCK – Lewes Nodular Chalk, CK – Chalk, SCK – Seaford Chalk, RTD – River Terrace Deposits, ALV - Alluvium*

K.8 Groundwater status

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

K.8.2 The Thames River Basin Management Plan (RBMP)[9] shows no groundwater body designation for either the upper or lower aquifers within the area in which the Putney Embankment Foreshore site is located; therefore no baseline assessment of quantitative or chemical status is available.

K.8.3 The baseline assessment for groundwater status classification for the nearby Greenwich Chalk and Tertiaries (consisting of the Lambeth Group, Thanet Sands, Blackheath Formation and Chalk Formation) shows poor quantitative status and poor quality status for 2009. The predicted quantitative and chemical quality was poor for 2015 due to treatment or improvement being disproportionately expensive or technically infeasible.

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

K.8.5 Only eight out of forty-six groundwater bodies within the Thames River basin district are at good status overall; this is not expected to change by 2015 (EA, 2009)[9].

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

a. The control of pollution to groundwater that may arise from any development which takes place on land

b. Prevent input of nitrates to groundwater body.

c. Prevent inputs to and mitigate potential mobilisation of copper, other metals and hazardous substances in groundwater.

d. 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.

e. Prevent direct discharges of pollutants to groundwater.

K.9 Data sources

K.9.1 A list of data used for the Putney Embankment Foreshore site assessment is given in Vol 7 Table K.8.

Vol 7 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 (SPZ)	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 (last updated 15th October 2012)	

** LBs – London Boroughs*

References

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

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

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

[4] Environment Agency. Guidance on the design and installation of groundwater quality monitoring points Science Report SC020093 (2006). Available at: http://publications.environment-agency.gov.uk/PDF/SCHO0106BKCT-E-E.pdf.

[5] Environment Agency. *The London Catchment Abstraction Management Strategy (CAMS*). Final Strategy Document (2006). Available at: http://publications.environment-agency.gov.uk/PDF/GETH0406BKRM-E-E.pdf.

[6] The Water Supply (Water Quality) Regulations, 2000. Available at: http://www.legislation.gov.uk/uksi/2000/3184/contents/made.

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

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

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

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.07**

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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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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

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Appendix M: Water resources - flood risk

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Appendix M: Water resources – flood risk

M.1 Policy considerations

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

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

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

Local policy

Strategic Flood Risk Assessment

M.1.4 The Putney Embankment foreshore site lies within the London Borough (LB) of Wandsworth. The LB of Wandsworth has produced a Level 1 and Level 2 Strategic Flood Risk Assessment (SFRA) (Scott Wilson Ltd, 2009)[2]. These outline the main flood sources to the borough. The residual risk of breaches in the Thames Tideway Defences at a number of locations along the River Thames was also investigated as part of the Level 2 study.

M.1.5 The Wandsworth SFRA confirms that the Thames Tidal Defence network (Thames Barrier and Tidal flood defence walls) reduces the annual probability of flooding from the River Thames to less than 0.1%. The risk of flooding (behind the flood defence walls) is therefore a residual risk associated with a breach in the defences.

M.1.6 According to the SFRA:

a. The site overlies London Clay.

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

c. There have been 'between 1-2' sewer flooding incidences recorded by Thames Water in the last 10 years in the vicinity.

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

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

Surface Water Management Plan

M.1.8 The Council, in partnership with the Greater London Authority (GLA), Thames Water and the EA has produced a Surface Water Management Plan (SWMP) (GLA, 2011)[3] as part of the Drain London project. The

SWMP sets out the preferred surface water management strategy for the borough.

M.1.9 According to the SWMP:

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

b. The site does not lie along an identified flow path for the 1% Annual Exceedance Probability (AEP)ii rainfall event including an allowance for the impact of climate change (ie, + 30% increase).

Regional policy

Thames Estuary 2100

M.1.10 Putney lies within the Barnes and Kew Policy Unit which has been assigned 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 tidal flooding from the River Thames, and 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 network)

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

c. flood forecasting and warning.

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

M.1.14 There is an acknowledgement in the TE2100 Plan that natural accretion of the river bed is occurring in Putney which may lead to opportunities for ecological and frontage improvements.

London Regional Flood Risk Appraisal

M.1.15 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. Development should

[i] Area susceptible to surface water flooding.

[ii] A rainfall event with a 1% Annual Exceedance Probability (AEP) has a 1 in 100 year probability of occurring in a given year

be designed in such a way as to take opportunities to reduce flood risk and include resilience.

M.1.16 There is particular concern surrounding confluences of tributaries into the River Thames and the interactions between tidal and fluvial flows in the future due to climate change. This should be taken into consideration during the development process.

M.1.17 The RFRA indicates that SuDS should be included within developments to reduce surface water discharge.

References

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

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

[3] Greater London Authority. *London Borough of Wandsworth Surface Water Management Plan Final Report.* (Aug 2011).

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

[5] Greater London Authority. *London RFRA (London Regional Flood Risk Appraisal.* (Oct 2009)

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

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Volume 7: Putney Embankment Foreshore appendices

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 7 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 7 Table N.1 Development schedule for Putney Embankment 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)	2018 (peak construction traffic year)	2023 (Year 1 of operation)		
No. 2 Putney High Street Note: not Mayoral referral but included due to proximity to site (possible new sensitive receptors)	Adjacent	2010/3543	Mr A Nurunnabi	Development of vaults to provide additional cafe floorspace within existing basement vault and provision of an opening in the river wall with flood barrier to provide access onto Watermans Green (between steps and bridge) for outside seating.	B	100% complete & operational	100% complete & operational	100% complete & operational	Assumed that it would be implemented by Site Year 1 of construction	Base case (all years)
No. 4 - 6 Putney High Street Note: not Mayoral referral but included due to proximity to site (possible new sensitive receptors)	Adjacent	2012/1998 (Listed building consent)	Mr Cliff Gardener	Formation of arched opening in listed river wall for each vault to No 4 and No 6 to provide additional café floorspace; installation of glazed assembly with side louvre panels with new opening. Installation of spring dam flood barrier system to each new opening. Formation of new opening between vaults installation of newton 500 drained cavity membrane system to both vaults	C	100% complete & operational	100% complete & operational	100% complete & operational	Assumed that it would be implemented by Site Year 1 of construction	Base case (all years)
45-53 Putney High Street & 329-339 Putney Bridge Road	Approx 170m south	2012/1833	Princes Securities Ltd and Zurich Assurance Ltd	Application for full planning permission to redevelop 45 - 53 Putney High Street and 329 - 339 Putney Bridg Road for a building of part 15 storeys and part 7 storeys (plus 2 storey basement) to provide 3528 sqm retail (Class A1/A2) 389 sqm offices (Class B1) and 96 units of residential 10,808 sqm (Class C3), with associated landscaping and access works.	C	Under construction	100% complete & operational	100% complete & operational	No information is available from the planning application on phasing or dates, including application plans and documentation. However, in the Transport Assessment it is suggested that at the earliest, construction could begin between	**2016:** Cumulative **2018 & 2023:** Base case

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2018 (peak construction traffic year)	2023 (Year 1 of operation)		
									April 2013 and December 2014. Given the application has not yet been granted and construction is anticipated to take 2-3 years, it is assumed that it will still be under construction in 2016 but complete by 2018.	
Former Putney Hospital	Approx 270m west	2012/0758	Director of Children's Services, Wandsworth Council	Demolition of all existing buildings. Erection of a two-storey primary school (with roof top playground) for 420 pupils with associated parking and drop off/pick up area; erection of part three/part four-storey building at northern end of site comprising 24 flats with basement level car and cycle parking. Formation of a new vehicular access off Lower Richmond Road and associated landscaping. This revised application includes an Addendum to the Transport Assessment, Addendum to the Energy and Sustainability Strategy and a Revised Environmental Noise Report. The proposal has been amended to include an increase in the number of rooftop solar panels to 93 on the school and 63 on the residential building and increased cycle parking provision to total 88 which would consist of 60 for the school and 28 for the flats.	C	100% complete & operational	100% complete & operational	100% complete & operational	LB Wandsworth online planning applications database No phasing information available. Assumed 100% completed by Site Year 1 of construction.	Base case (all years)
113 Upper Richmond Road	Approx 700m south	2012/4046	London Square	Demolition of existing building. Erection of a building up to 12-storeys (41.2m) comprising of 76 residential units (Class C3), 1817sq. m of commercial floorspace at ground and first floor (Class B1/A1/A2/A3) together with a new public space, vehicular access off of Upper Richmond Road and basement car and cycle parking.	C	100% complete & operational	100% complete & operational	100% complete & operational	No information is available from the planning application on phasing or dates. On the basis of the size of the development, it has been assumed that it will be built by Site Year 1 of	Base case (all years)

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2018 (peak construction traffic year)	2023 (Year 1 of operation)		
									construction.	
131-133 Upper Richmond Road	Approx 700m south	2010/3019	Tileman House Investments (Putney) Ltd	Demolition of existing offices and retention of attached residential block. Erection of new building up to ten-storeys comprising 2403sq.m of commercial/retail space at ground, mezzanine and first floor levels with 40 residential units above. Formation of basement parking accessed from Upper Richmond Road. Retention, refurbishment and alteration to existing service core and attached residential building (comprising 18 existing flats of which 10 will be affordable units). Erection of additional floor over the retained building. (Renewal of p.p. granted 15.9.2005 ref. 2005/0175.)	B	100% complete & operational	100% complete & operational	100% complete & operational	No information is available from the planning application on phasing or dates, including plans and decision notice. On the basis that the application has been permitted and needs to commence within three years, it has been assumed that it will be built by Site Year 1 of construction.	Base case (all years)
77-83 Upper Richmond Road and Carlton Court, 26 Carlton Drive	Approx 800m southeast	2011/0054	St James Group Ltd	Demolition of all existing buildings. Erection of a new building comprising 3 blocks 12-13 storeys high (up to 41m), 4-9 storeys (up to 29m) and 1-2 storeys (up to 5.5m) to provide 104 residential units, office accommodation, retail, cafe/restaurant uses, together with a new public piazza, vehicular access, and basement car and cycle parking.	B	100% complete & operational	100% complete & operational	100% complete & operational	No information is available from the planning application on phasing or dates, including plans and decision notice. On the basis that the application has been permitted and needs to commence within three years, it has been assumed that it will be built by Site Year 1 of construction.	Base case (all years)

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2018 (peak construction traffic year)	2023 (Year 1 of operation)		
84-88 Upper Richmond Road	Approx 800m southeast	2010/5483	Orchid Putney Limited	Demolition of existing office buildings (class B1a) and redevelopment to comprise of the erection of 4 buildings ranging in height from 11-storeys (up to 40.6m), 8-storeys (up to 30.2m), 5-storeys (up to 19.5m) and 7-storeys (up to 25.7m) to provide a mixed-use scheme comprising: 148 residential units; 1215sq.m offices (class B1a); 600sq.m flexible retail/financial and professional services/restaurant/café/offices/non-residential institutions/assembly and leisure (A1/A2/A3/B1a/D1/D2); 65 basement car parking spaces; 2 car club spaces at ground floor; 178 cycle parking spaces; landscaping including a new pedestrian route from Woodlands Way to Upper Richmond Road; play area; allotments; communal gardens; ancillary plant and associated works.	B	100% complete & operational	100% complete & operational	100% complete & operational	Committee report Completion of the final block in 2014	Base case (all years)
Carlton House, 27a Carlton Drive	Approx 800m southeast	2012/0312	AMBEC Ltd	Demolition of existing office buildings (class B1a) and redevelopment to comprise the erection of 2 linked buildings of up to 5-storeys (16.5m high) and 10-storeys (32.5m high) to provide a mixed-use scheme comprising: 52 residential units; 665sq.m offices (class B1a); 700sq.m flexible retail/café/bar/restaurant (A1/A3/A4); 35 basement car parking spaces; 70 cycle parking spaces and landscaping including a concourse to Upper Richmond Road	C	Under construction	100% complete & operational	100% complete & operational	No information is available from the planning application on phasing or dates, including plans and decision notice. Given the application has not yet been granted and construction is anticipated to take 2-3 years, it is assumed that it will still be under construction in 2016 but complete by 2018.	**2016:** Cumulative **2018 & 2023:** Base case

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

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