Thames Tideway Tunnel
Thames Water Utilities Limited

Development Consent Order

Application Reference Number: WWO10001

Documents for Certification
September 2014

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

Lindsay Speed

Sarah Fairbrother

September 2014

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.08**

Volume 8: Dormay Street 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 8 Dormay Street site assessment.

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

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

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

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

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Appendix B: Air quality and odour

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Appendix B: Air quality and odour

B.1 Model verification

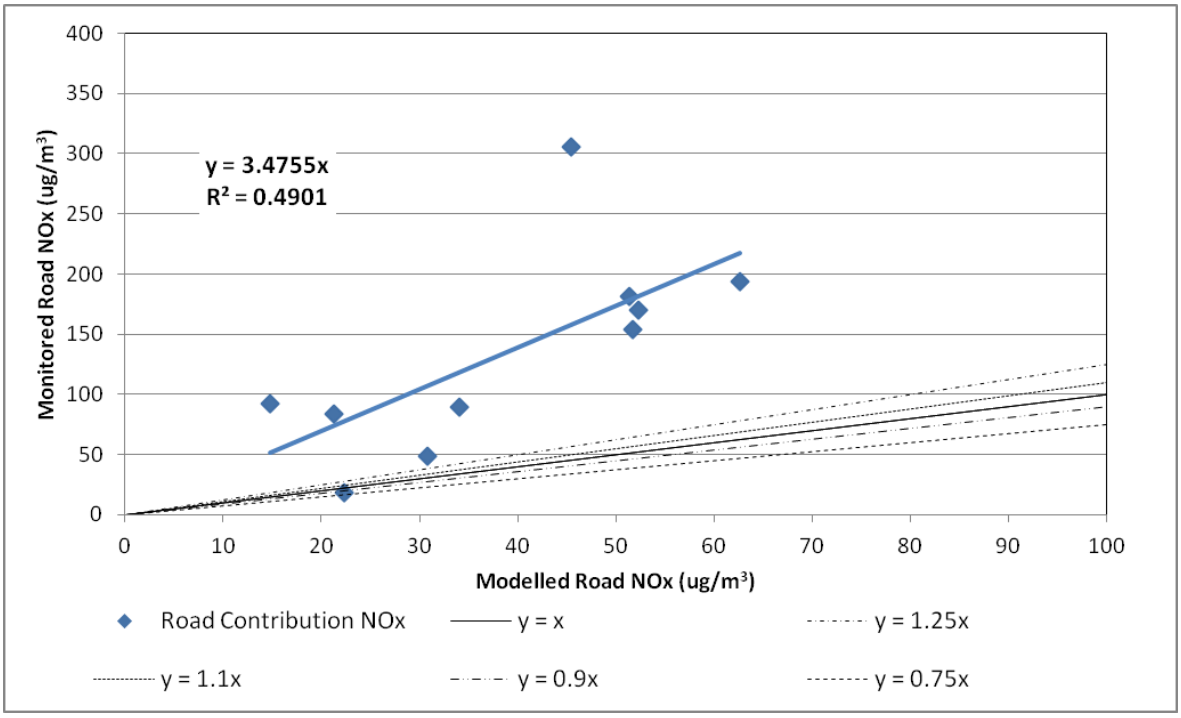
B.1.1 Modelled NO_2 concentrations have been plotted against monitored concentrations at ten diffusion tube sites (DSTM1-DSTM2, DSTM4-DSTM5, DSTM8, KGPM1-KGPM3, KGPM5and W12 / W13) as shown in Vol 8 Figure 4.4.1 (see separate volume of figures).

B.1.2 This showed that the modelled results underestimated NO_2 concentrations by between -3% and 50%. 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.

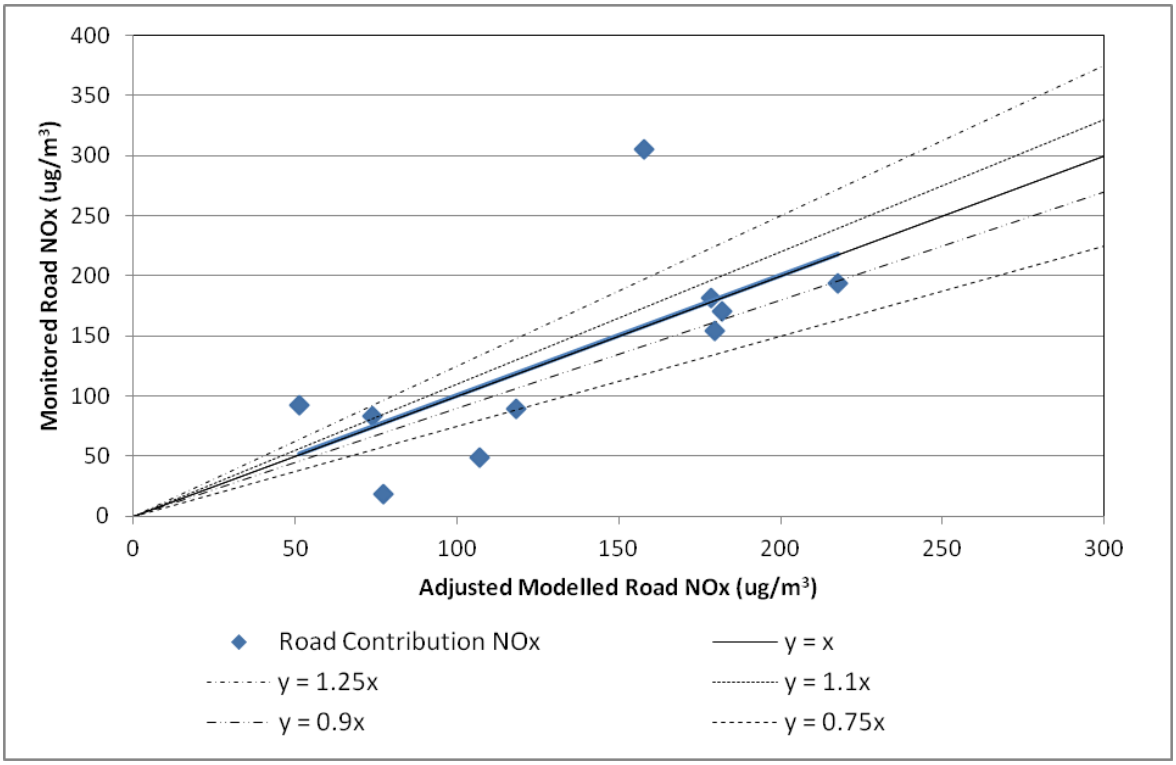
B.1.3 To derive the adjustment factor, modelled road NO_X concentrations were plotted against calculated monitored road NO_X concentrations (see Vol 8 Plate B.1 below). An adjustment factor of 3.48 was calculated for adjusting modelled roadside NO_X concentrations, in accordance with LAQM.TG(09) (Defra, 2009)[1] and subsequently applied. This factor was also applied to the PM_{10} results as no local PM_{10} monitoring data were available for an area where traffic data were also available.

B.1.4 Applying the NO_X adjustment factor and then calculating NO_2 concentrations, as shown in Vol 8 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 8 Plate B.3, indicated that six of the ten modelled concentrations were within 10% of the measured value and that one was within 25% of the modelled value.

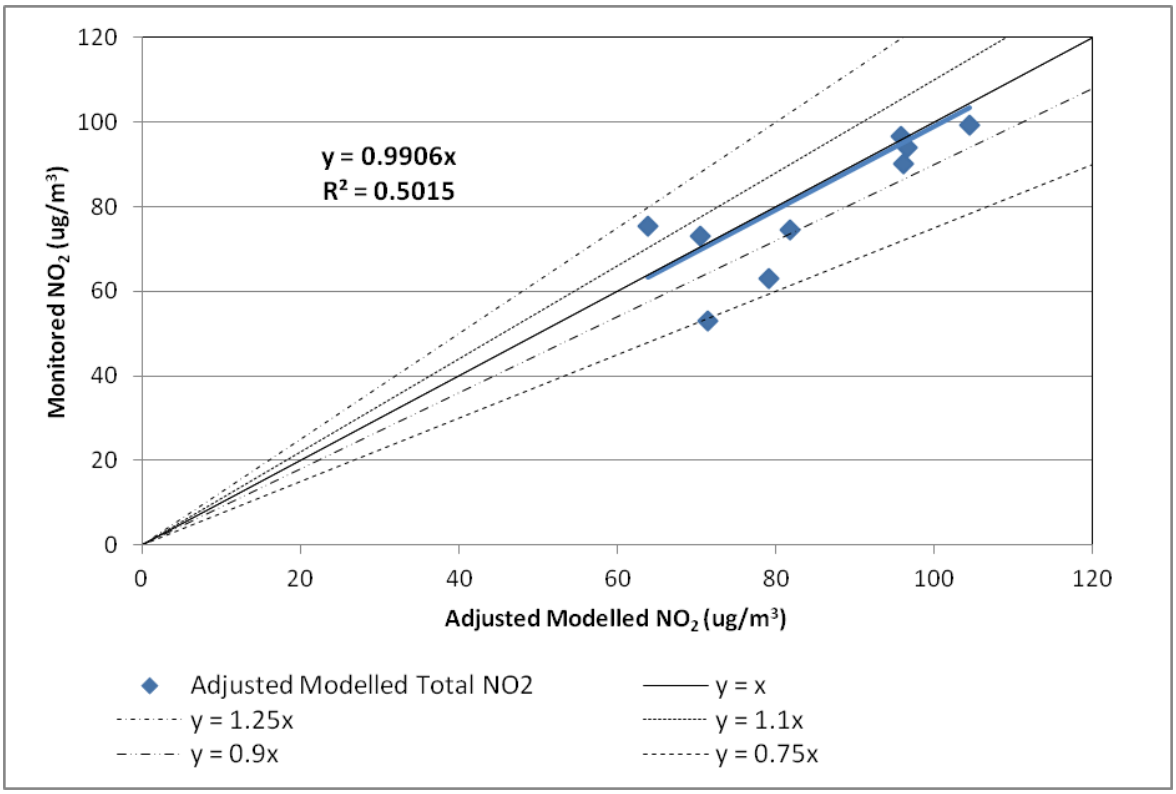
Vol 8 Plate B.1 Air quality – monitored road NO_X vs. modelled road NO_X



Vol 8 Plate B.2 Air quality – monitored road NO_X vs. adjusted modelled road NO_X



Vol 8 Plate B.3 Air quality – total monitored NO_2 vs. total adjusted modelled NO_2



B.2 Traffic data

B.2.4 The traffic data used in the air quality modelling for the Dormay Street site are shown in Vol 8 Table B.1.

Vol 8 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 construction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construction year development case AADT % HGV (>3.5t)
CTC** survey	Dormay Street	898	24.5	30	30.0	4.7	941	18	959	25.9
CTC survey	The Causeway	251	25.8	30	30.0	4.7	262	0	262	25.8
CTC survey	Armoury Way A217	44821	10.4	30	27.9	4.7	46941	16	47029	10.4
CTC survey	Armoury Way A217	44782	10.4	30	27.9	4.7	46900	16	46988	10.4
CTC survey	Ram Street	8540	14.7	30	6.9	4.7	8944	6	8953	14.8
CTC survey	Old York Road A217	38317	10.9	30	9.7	4.7	40129	7	40205	10.9
ATC*** survey	Swandon Way A217	28975	12.2	30	32.1	4.7	30345	11	30356	12.3
TFL model	Fairfield Street A3	38672	3.2	30	18.5	4.7	40501	5	40540	3.2

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak construction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construction year development case AADT % HGV (>3.5t)
TFL model	Wandsworth High Street A3	51226	5.4	30	12.7	4.7	53648	7	53726	5.4
TFL model	Garratt Lane A217	18398	1.7	30	32.4	4.7	19268	0	19283	1.7
TFL model	Wandsworth Plain A217	6639	4.5	30	9.6	4.7	6953	2	7005	4.5
TFL model	Wandsworth High Street A3	56235	4.9	30	14.1	4.7	58894	14	58933	5.0
TFL model	Putney Bridge Road A3209	52410	4.6	30	30.2	4.7	54889	13	54922	4.7
TFL model	Armoury Way A217	51865	3.6	30	12.5	4.7	54318	14	54356	3.6
TFL model	Merton Road	54458	3.8	30	24.6	4.7	57033	0	57036	3.8
TFL model	Wandsworth Hill A3	83830	3.7	30	10.8	4.7	87794	24	87822	3.7
CTC survey	Neville Gill Close	3148	2.0	30	30.0	4.7	3297	0	3297	2.0
CTC survey	Buckhold Road A218	18398	7.4	30	27.7	4.7	19268	0	19307	7.3

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak construction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construction year development case AADT % HGV (>3.5t)
CTC survey	Buckhold Road A218	18629	7.5	30	27.7	4.7	19510	6	19555	7.5
CTC survey	Wandsworth High Street A3	36965	8.5	30	15.0	4.7	38713	16	38797	8.6
CTC survey	Wandsworth High Street A3	38134	8.6	30	15.0	4.7	39937	16	40021	8.6

** AADT – annual average daily traffic; ** CTC – classified traffic count; *** ATC – automatic traffic count.*

B.3 Construction plant emission factors

B.3.4 For the purpose of the assessment, the following listed equipment in Vol 8 Table B.2 has been modelled for the peak construction year at the Dormay Street site.

Vol 8 Table B.2 Air quality – construction plant assessment model inputs

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NOX emission rate (g/s/m^2)	PM10 emission rate (g/s/m^2)
Site set up and general site	Ground level behind hoarding	Compressor 250cfm*	1	50	104	4.3×10^{-7}	2.7×10^{-8}
	Ground level behind hoarding	Generator - 200kVA	1	100	160	1.3×10^{-6}	8.3×10^{-8}
	Ground level behind hoarding	JCB with hydraulic breaker	1	50	67	2.8×10^{-7}	1.7×10^{-8}
	Ground level behind hoarding	Cutting equipment (diamond saw)	2	10	2.3	9.7×10^{-9}	2.1×10^{-8}
	Ground level behind hoarding	Telescopic handler/FLT**	1	30	60	1.5×10^{-7}	9.3×10^{-9}
	Ground level behind hoarding	Hiab lorry/crane	1	5	56	2.3×10^{-8}	1.4×10^{-9}
	Ground level behind hoarding	Well drilling rig	1	50	403	1.7×10^{-6}	1.0×10^{-7}
Shaft sinking by sprayed concrete lining	Within excavation	Shotcrete robot	1	20	14	3.7×10^{-7}	3.5×10^{-8}
	Ground level behind hoarding	Concrete deliveries (aggitating)	1	80	223	1.5×10^{-6}	9.2×10^{-8}

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NOX emission rate (g/s/m^2)	PM10 emission rate (g/s/m^2)
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	223	3.7×10^{-7}	2.3×10^{-8}
	Within shaft	12t excavator	1	80	66	4.4×10^{-7}	2.7×10^{-8}
	Ground level behind hoarding	100t crawler crane	1	80	240	1.6×10^{-6}	9.9×10^{-8}
	Ground level behind hoarding	25t mobile crane	1	20	275	4.5×10^{-7}	2.8×10^{-8}
	Ground level behind hoarding	25t excavator	1	50	125	5.2×10^{-7}	3.2×10^{-8}
	Ground level behind hoarding	400cfm compressor	1	50	104	4.3×10^{-7}	2.7×10^{-8}
Long connection tunnel drives from Dormay Street	Within excavation	100t crawler crane	1	50	240	9.9×10^{-7}	6.2×10^{-8}
	Ground level behind hoarding	100t mobile (TBM*** assembly only)	1	25	610	1.3×10^{-6}	7.9×10^{-8}
	Ground level behind hoarding	500t mobile (TBM assembly only)	1	25	610	1.3×10^{-6}	7.9×10^{-8}
	Ground level behind hoarding	Air compressor 600cfm	1	50	129	5.3×10^{-7}	3.3×10^{-8}
	Within excavation	Dumper	1	25	81	1.7×10^{-7}	1.0×10^{-8}
	Ground level behind hoarding	Emergency generator - 200kW	1	5	200	8.3×10^{-8}	5.2×10^{-9}
	Ground level behind hoarding	Flatbed trucks for materials haulage	1	20	56	9.3×10^{-8}	5.8×10^{-9}

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NOX emission rate (g/s/m^2)	PM10 emission rate (g/s/m^2)
	Ground level behind hoarding	Flatbed trucks for segment haulage	1	20	56	9.3×10^{-8}	5.8×10^{-9}
	Ground level behind hoarding	Loading shovel	1	30	325	8.1×10^{-7}	5.0×10^{-8}
	Ground level behind hoarding	Telehandler 5t	1	80	60	4.0×10^{-7}	2.5×10^{-8}
	Within tunnel	Locomotives	3	100	180	1.7×10^{-4}	1.1×10^{-5}

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 *** TBM – tunnel boring machine.*

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.1.26 A Phase 1 Habitat Survey was carried out on 17 May 2011 at the Dormay Street site as shown on Vol 8 Figure 6.4.1 (see separate volume of figures). Based on this, surveys for the following species have been undertaken:

a. bats

b. breeding birds

c. wintering birds

d. black redstart (*Phoenicurus ochruros*)

e. invertebrates

f. invasive plants.

D.1.27 The purpose of the surveys is to determine the presence or likely absence of these species at and around the site.

D.1.28 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.1.30 to D.1.44). The results from the surveys are then presented (paras D.1.45 to D.1.64). The final section provides an interpretation of the results (paras to D.1.65 to D.1.75). Figures referred to in this report are contained within Vol 8 Dormay Street Figures (separate volume of figures).

D.1.29 Information on legislation, policy and methodology can be found in Volume 2 Environmental assessment methodology of the *Environmental Statement*. Information on site context can be found in Section 2 of this site assessment volume

Survey area

Bats

D.1.30 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.1.31 A Phase 1 Habitat Survey identified the potential for roosting bats within the structures on site such as the brick substation building immediately adjacent to Bell Lane Creek (on the south side). The trees are generally considered to be sub-optimal as roosting habitat, comprising immature to semi-mature trees with no suitable cracks or crevice features that could be used by roosting bats. However, there is the potential for tree and scrub

lines, tall ruderal vegetation, and ephemeral/short perennial vegetation both on and adjacent to the site to be utilised by bats for commuting and foraging. The Bell Lane Creek corridor was also considered to have potential for foraging and commuting. Therefore, bat surveys were undertaken.

D.1.32 The survey area included the site and habitats adjacent and in close proximity to the site that are likely to be used by foraging and commuting bats and that could potentially be disturbed by lighting and noise during construction. Of particular potential interest for bats was the River Wandle and Bell Lane Creek, with associated bankside vegetation, and the railway arches to the north of the site. The survey area for the bat activity (dawn) surveys, is shown in Vol 8 Figure 6.4.2(see separate volume of figures).

D.1.33 A two stage bat survey was carried out. The first survey was a remote recording (bat triggering) survey using remote Anabat™ recording devices. Based on the habitat types identified during the Phase 1 habitat survey and their potential to support foraging, commuting or roosting bats, two locations were chosen for the installation of the remote recording devices shown on Vol 8 Figure 6.4.2 (see separate volume of figures).

D.1.34 Location one is on the northern side of Bell Lane Creek, attached to a tree. This location was selected to record potential bat activity associated with foraging and commuting along the Bell Lane Creek and to record the movement of bats entering and leaving the site along this boundary.

D.1.35 Location two is on the southern side of Bell Lane Creek. The device was attached to a building at this location. This location was selected to gain an understanding of bat activity associated with foraging and commuting within the industrial area on site.

D.1.36 The bat activity recorded during the remote recording surveys triggered the need for an additional dawn survey (see Vol 2 for bat triggering survey criteria). Therefore, a second stage of bat surveying was undertaken, comprising one dawn survey visit by two ecologists to assess the usage of the site and immediate surrounds by bats.

Breeding birds

D.1.37 Breeding birds forage and nest within a range of habitat including grassland, scrub, trees and marginal aquatic habitats. Birds can also nest on and within buildings. The survey area, as shown in Vol 8 Figure 6.4.3 (see separate volume of figures) includes the site, and vegetation and buildings immediately adjacent to the site that may support nesting birds.

Wintering birds

D.1.38 Wintering birds are mainly associated with aquatic habitats such as intertidal mudflats and marshes, marginal vegetation and wetlands, which they use for resting and foraging. Some wintering bird species are also associated with terrestrial habitats such as scrub and grassland, which they use for roosting at high tide or foraging.

D.1.39 The survey area, as shown in Vol 8 Figure 6.4.4 (see separate volume of figures) comprises the foreshore within Bell Lane Creek on site and

extending northwards as far as the confluence with the River Thames. The foreshore comprises stones and silt, which are exposed at low tide.

D.1.40 The survey area also includes the River Wandle from the Armoury Way bridge, south of the site, to the confluence with the River Thames to the north of the site. There is no exposed intertidal foreshore within the section of the River Wandle to the east of the site. Therefore, this section of the river was surveyed for birds resting on the water's surface.

Black redstart

D.1.41 Black redstart nest on and within buildings and structures (mostly those that are derelict), and forage on sparsely-vegetated open areas. The survey area is shown in Vol 8 Figure 6.4.5 (see separate volume of figures), and includes buildings on and adjacent to the site, the railway arches to the north of the site, and other features such as ephemeral short perennial habitat in the northern half of the site.

Invertebrates

D.1.42 The river wall on site was identified by stakeholders as having potential for a notable assemblage of invertebrates. Therefore, an initial visit by an entomologist (invertebrate specialist) was undertaken to assess the river wall. The survey area is shown in Vol 8 Figure 6.4.6 (see separate volume of figures) and includes the river wall within and adjacent to the site.

Invasive plants

D.1.43 Invasive plants that are listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) occur in a wide range of habitats, although they are more often associated with watercourses or wet areas, or within areas of disturbed ground, where material contaminated with seeds and rhizomes (sections of root that can re-grow), may have been imported into the area.

D.1.44 The invasive plants survey area, as shown on Vol 8 Figure 6.4.7 (see separate volume of figures), comprises the proposed development site, and an area within 10m of the proposed development site boundary. The 10m zone beyond the site boundary was surveyed to record any invasive plants present adjacent to the site that could potentially spread onto the site, or that could have roots that extend into the site below ground (eg, Japanese knotweed (*Fallopia japonica*)).

Results

D.1.45 In this section, the results of the desk study, notable species surveys and the invasive plant survey are presented. The results are then interpreted in paras D.1.65 and D.1.75.

Desk Study

D.1.46 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 8 Table D.1.

Vol 8 Table D.1 Terrestrial ecology – species found within 500m of the site between 2011 and 2011

Common name	Latin name	Record count
Mammals		
West European hedgehog	*Erinaceus europaeus*	8
Bat	*Vespertilionidae*	6
Birds		
Northern pintail	*Anas acuta*	58
Little egret	*Egretta garzetta*	2
European honey-buzzard	*Pernis apivorus*	2
Peregrine falcon	*Falco peregrinus*	4
Little gull	*Larus minutus*	2
Caspian gull	*Larus cachinnans*	78
Herring gull	*Larus argentatus*	8
Mediterranean gull	*Larus melanocephalus*	4
Common tern	*Sterna hirundo*	6
Arctic tern	*Sterna paradisaea*	8
Common kingfisher	*Alcedo atthis*	18
Hedge accentor / Dunnock	*Prunella modularis*	2
Black-tailed godwit	*Limosa limosa*	2
Yellow wagtail	*Motacilla flava*	2
House sparrow	*Passer domesticus*	30
Common linnet	*Carduelis cannabina*	8
Common redpoll	*Carduelis flammea*	2
Reed bunting	*Emberiza schoeniclus*	6
Amphibians		
Common frog	*Rana temporaria*	6
Smooth newt	*Lissotriton vulgaris*	4
Invertebrates		
Cinnabar	*Tyria jacobaeae*	4
Stag beetle	*Lucanus cervus*	40
Plants		
Pasqueflower	*Pulsatilla vulgaris*	2

Bat surveys

Bat triggering (remote recording) surveys

D.1.47 The bat triggering (remote recording) surveys were undertaken on three nights between 7 July 2011 and 9 July 2011 in suitable weather conditions (Vol 8 Table D.2).

D.1.48 The remote recording surveys undertaken at this site recorded two species of bats using the site, common pipistrelle (*Pipistrellus pipistrellus)* and soprano pipistrelle (*Pipistrellus pygmaeus).*

D.1.49 During the remote recording surveys, common pipistrelle bat passes were only recorded on one night (7 July 2011) and at one location (location one) when five passes were recorded.

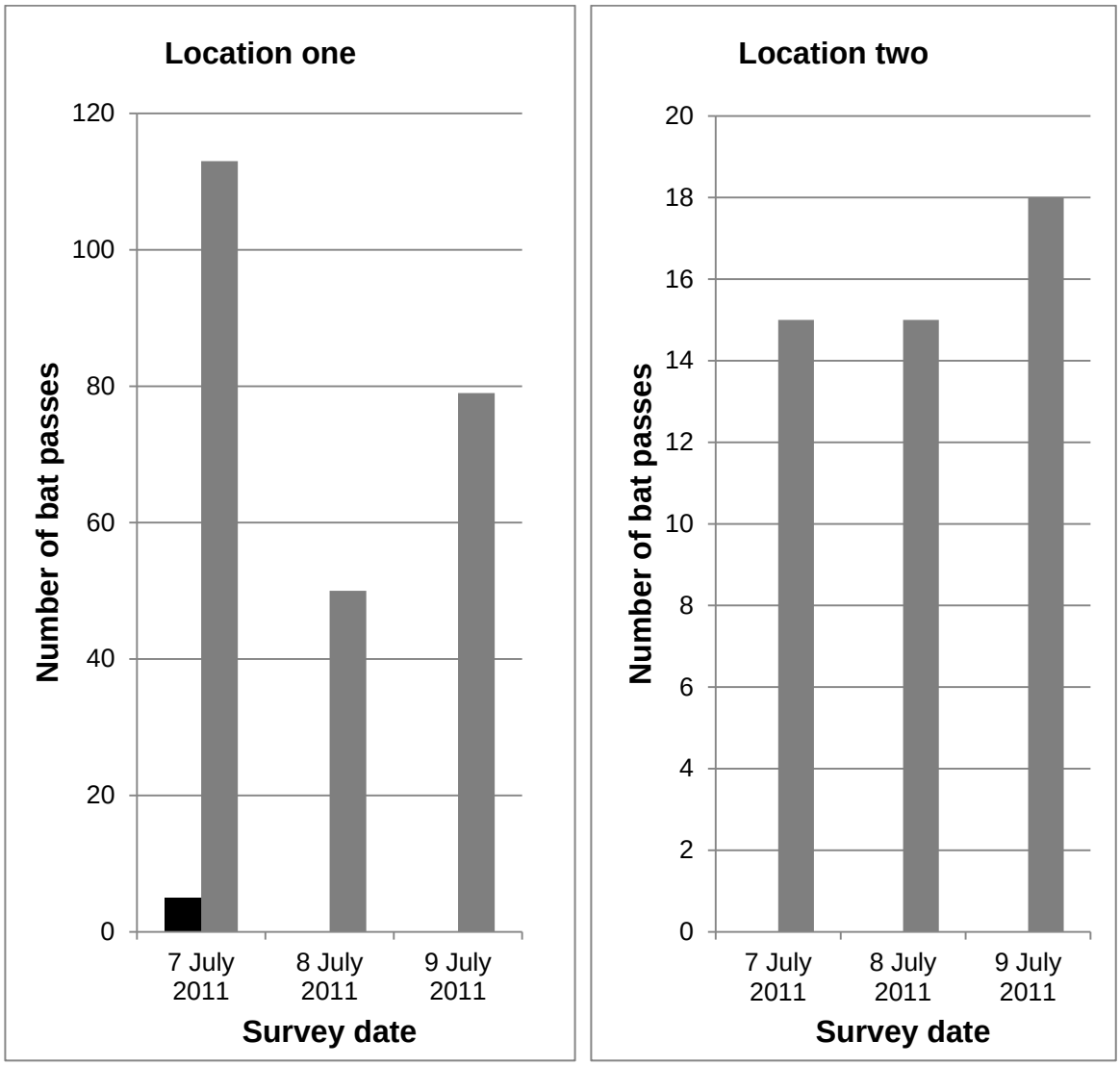
D.1.50 The maximum number of soprano pipistrelle bat passes recorded in any one night was 113, recorded at location one on the north side of Bell Lane Creek. A maximum of 18 soprano pipistrelle bat passes were recorded at location two adjacent to the buildings to the south of Bell Lane Creek, see Vol 8 Plate D.1.

D.1.51 No bat passes were recorded close to sunrise or sunset when bats generally leave and return to their roosts.

Vol 8 Table D.2 Terrestrial ecology – bat survey weather conditions

Survey visit	Weather conditions
7July 2011	15°C, moderate breeze, 100% cloud cover, dry
8 July 2011	13°C, gentle breeze, 40% cloud cover, dry
9 July 2011	14°C, gentle breeze, 70-80% cloud cover, dry

Vol 8 Plate D.1 Terrestrial ecology – bat passes recorded during remote recording surveys at two locations at Dormay Street



Bat activity (dawn) surveys

D.1.52 As there were high numbers of soprano pipistrelle recorded during the remote recording survey, this triggered the need for a bat activity (dawn) survey to be undertaken (based on bat triggering criteria in Vol 2 Section 5). The bat activity survey was undertaken on 15 July 2011 in suitable weather conditions (light breeze, dry, 100% cloud cover, 15°C). The bat activity survey results are shown on Vol 8 Figure 6.4.2 (see separate volume of figures).

D.1.53 During the activity survey at dawn, soprano pipistrelle bats were recorded continuously foraging up and down the River Wandle and along adjacent vegetation. A total of 258 passes were recorded, the majority likely to comprise multiple passes by the same individual bats. A small soprano pipistrelle roost was identified within the railway arches to the northeast of the site with one bat seen entering the structure.

D.1.54 No other bat species were recorded during the bat activity survey.

Breeding bird survey

D.1.55 A total of three survey visits were conducted at monthly intervals (27 May, 10 June and 8 July 2011) in suitable weather conditions (see Vol 8 Table D.3) by an experienced ornithologist (bird specialist). The results of the breeding bird survey are shown on Vol 8 Figure 6.4.3 (see separate volume of figures) and in Vol 8 Table D.4.

Vol 8 Table D.3 Terrestrial ecology – breeding bird survey weather conditions

Date	Weather conditions
27 May 2011	11°C, calm, overcast, dry.
10 June 2011	9°C, light southwesterly breeze, 25% cloud cover, dry.
8 July 2011	13°C, light southwesterly breeze, 75% cloud, dry.

D.1.56 A total of 17 bird species and 23 breeding territories (active nests and their surrounding territory) were recorded within the survey area. Species of conservation importance were recorded as follows:

a. One pair of mallards (*Anas platyrhynchos*) and two pairs of dunnock (*Prunella modularis*) were recorded nesting within the vegetation on the northern bank of Bell Lane Creek on site.

b. A pair of grey wagtail (*Motacilla cinerea*) was recorded nesting on one of the buildings on the southern bank of Bell Lane Creek on site as shown on Vol 8 Fig 6.4.3.

Vol 8 Table D.4 Terrestrial ecology – summary of breeding bird territories

Species name	Latin name	Conservation designation[i]	Estimated number of breeding territories
Mute swan	*Cygnus olor*	Green List	1
Mallard	*Anas platyrhynchos*	Amber list	1
Moorhen	*Gallinula chloropus*	Green List	1
Coot	*Fulica atra*	Green List	1

[i] 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[i]	Estimated number of breeding territories
Feral pigeon	*Columba livia*	Green List	1
Wood pigeon	*Columba palumbus*	Green List	1
Grey wagtail	*Motacilla cinerea*	Amber list	1
Wren	*Troglodytes troglodytes*	Green List	2
Dunnock	*Prunella modularis*	Amber list UK BAP priority list	2
Robin	*Erithacus rubecula*	Green List	2
Blackbird	*Turdus merula*	Green List	3
Blue tit	*Parus caeruleus*	Green List	1
Magpie	*Pica pica*	Green List	1
Carrion crow	*Corvus corone*	Green List	1
Chaffinch	*Fringilla coelebs*	Green List	1
Greenfinch	*Carduelis chloris*	Green List	2
Goldfinch	*Carduelis carduelis*	Green List	1

Wintering Birds

D.1.57 A total of six survey visits were undertaken at monthly intervals between October 2011 and March 2012. The survey visits were undertaken in suitable weather conditions (see Vol 8 Table D.5). The main foraging and resting areas for wintering birds are indicated on Vol 8 Figure 6.4.4 (see separate volume of figures). The numbers of individuals of each species recorded in each month are provided in Vol 8 Table D.6.

D.1.58 A total of 16 waterbird[ii] species have been recorded within the survey area. The following distribution of species was observed:

a. the majority of records were associated with the foreshore between the weir within the River Wandle and the confluence with the River Thames, to the north of the site

b. the majority of teal *(Anas cracca)* and moorhen *(Gallinula chloropus)* were recorded along Bell Lane Creek, within and adjacent to the site

c. gadwall *(Anas strepera*), black-headed gull *(Chroicocephalus ridibundus*), common gull *(Larus canus),* lesser black-backed gull *(Larus fuscus)* and herring gull *(Larus argentatus)* were distributed

[ii] 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.

across the survey area with no large aggregations of these birds recorded at any one location

d. a common kingfisher *(Alcedo atthis)* was recorded flying through the survey area off site to the north of the railway bridge

e. mallard *(Anas platyrhynchos*) and tufted duck *(Aythya fuligula)* were recorded on and adjacent to the site within Bell Lane Creek as well as within the wider survey area.

D.1.59 Grey wagtail *(Motacilla cinerea)* was also regularly present adjacent to the site.

Vol 8 Table D.5 Terrestrial ecology – wintering bird survey weather conditions

Date	Weather conditions
26 October 2011	7°C, gentle breeze**,** 50% cloud cover, dry
28 November 2011	0°C, light breeze, 100% cloud cover, dry
13 December 2011	11°C, light breeze, 50% cloud cover, dry
9 January 2012	1°C, gentle breeze, 25% cloud cover, dry
7 February 2012	2°C, light breeze, 75% cloud cover, dry
8 March 2012	4°C, gentle breeze, 100% cloud cover, dry

Vol 8 Table D.6 Terrestrial ecology – species and numbers of wintering waterbirds recorded during monthly wintering bird surveys

Species name	Latin name	Conservation designation[iii]	Maximum monthly wintering waterbird counts					
			26 October 2011	28 November 2011	13 December 2011	9 January 2012	7 February 2012	8 March 2012
Cormorant	*Phalacrocorax carbo*	Green List	-	3	1	-	1	-
Grey heron	*Ardea cinerea*	Green List	1	1	1	-	-	-
Mute swan	*Cygnus olor*	Green List	2	2	1	-	-	-
Egyptian goose	*Alopochen aegyptiacus*	Green List	3	3	3	1	-	-
Canada goose	*Branta canadensis*	Green List	5	-	-	-	-	-
Gadwall	*Anas strepera*	Amber List	-	-	7	2	-	2
Teal	*Anas crecca*	Amber List	3	6	1	10	16	17
Mallard	*Anas platyrhynchos*	Amber List	29	15	31	14	9	2
Tufted duck	*Aythya fuligula*	Amber List	5	3	8	-	1	1
Moorhen	*Gallinula chloropus*	Green List	4	9	10	4	9	9
Coot	*Fulica atra*	Green List	1	3	5	4	4	4

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

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

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

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

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

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

Species name	Latin name	Conservation designation[iii]	Maximum monthly wintering waterbird counts					
			26 October 2011	28 November 2011	13 December 2011	9 January 2012	7 February 2012	8 March 2012
Black-headed gull	*Chroicocephalus ridibundus*	Amber List	9	16	5	12	17	-
Common gull	*Larus canus*	Amber List	2	3	2	4	-	-
Lesser black-backed gull	*Larus fuscus*	Amber List	1	-	-	-	1	-
Herring gull	*Larus argentatus*	Red List UK BAP Priority List	-	-	-	1	-	-
Kingfisher	*Alcedo atthis*	Amber List	1	-	-	-		-

Black redstart survey

D.1.60 A total of five back redstart survey visits were undertaken between 27 May and 19 July 2011 by an experienced ornithologist in suitable weather conditions (see Vol 8 Table D.7). The three July visits are outside of the optimum survey period for black redstart. However, surveys can be undertaken during July as breeding usually continues into this month (Brown and Grice 2005)[1]. The other two visits were undertaken during the peak breeding period for black redstart in May and June. Therefore, if black redstart were breeding on or near the site, then this would have been recorded with the survey effort undertaken. Consequently, three survey visits in July are not considered to limit the results of the survey.

D.1.61 No black redstarts were recorded during the survey as shown on Vol 8 Figure 6.4.5(see separate volume of figures).

Vol 8 Table D.7 Terrestrial ecology – black redstart survey weather conditions

Date	Weather conditions
27 May 2011	11°C, calm, overcast, dry.
10 June 2011	9°C, light southwesterly breeze, 25% cloud cover, dry.
8 July 2011	13°C, light southwesterly breeze, 75% cloud, dry.
15 July 2011	15°C, calm, cloudless, dry.
19 July 2011	13°C, calm, 90% cloud cover, dry.

Invertebrate survey

D.1.62 No notable invertebrates associated with the river wall were recorded or considered likely to be present within sections of the wall that were not accessible. The results of the survey are shown on Vol 8 Figure 6.4.6(see separate volume of figures).

Invasive plants survey

D.1.63 An invasive plant survey was undertaken on 2 August 2011 by an experienced ecologist. The results of the survey are shown on Vol 8 Figure 6.4.7(see separate volume of figures).

D.1.64 One species of invasive plant, Japanese knotweed *(Fallopia japonica),* was recorded on site. There were two stands on the northern side of the Bell Lane Creek (Ordnance Survey grid reference TQ25548 75006 and TQ25514 75015). The stands appeared to have been recently treated.

Interpretation

Bats

D.1.65 It is considered that the survey area is used by a small population of common pipistrelle and a larger population of soprano pipistrelle, both for foraging and commuting.

D.1.66 During the remote recording surveys, common pipistrelle bat passes were only recorded on one night (7 July 2011) and at one location (location one) when five passes were recorded. No bat passes were recorded close to

sunrise or sunset when bats generally leave and return to their roosts. Therefore, no common pipistrelle roost is suspected in close proximity to the site. No common pipistrelle bats were recorded during the dawn activity survey (15 July 2011). The results are indicative of a small number of common pipistrelle bats occasionally visiting the vegetation and river corridors on and adjacent to the site for foraging and commuting.

D.1.67 Soprano pipistrelle bats were recorded in relatively high numbers during both remote recording surveys and during the activity survey undertaken at dawn. The maximum number of bat passes recorded in any one night was 113, recorded at location one on the north side of Bell Lane Creek, which is indicative of bats foraging along Bell Lane Creek and adjacent vegetation, and may also indicate activity associated with roosts within the railway arches to the north of the site. A maximum of 18 soprano pipistrelle bat passes were recorded at location two adjacent to the buildings to the south of Bell Lane Creek. As foraging habitat in this area is limited, this activity is likely to be associated with bats commuting this area of the site.

D.1.68 During the activity survey at dawn, soprano pipistrelle bats were recorded continuously foraging up and down the River Wandle and along adjacent vegetation. A total of 258 passes were recorded, the majority comprising multiple passes by the same individual bats.

D.1.69 A small soprano pipistrelle roost was identified within the railway arches to the northeast of the site with one bat seen entering the structure. It is likely that other soprano pipistrelle bat roosts are present within these arches.

Breeding birds

D.1.70 The trees and scrub on and adjacent to the site support breeding birds. Of the 17 bird species which occupied breeding territories within the survey area, four are of nature conservation importance and are included in the Birds of Conservation Concern Red or Amber List and/or are UK BAP Priority Species: mute swan (one breeding territory), mallard (one breeding territory), grey wagtail (one breeding territory) and dunnock (two breeding territories).

Wintering birds

D.1.71 Of the 16 waterbird species that were recorded within the survey area, nine are of nature conservation importance and are included in the Birds of Conservation Concern Red or Amber List and/or are UK BAP Priority Species: gadwall, teal, mallard, tufted duck, black-headed gull, common gull, lesser black-backed gull, herring gull and kingfisher. Kingfisher is afforded special protection because it is listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended).

D.1.72 The results indicate that the foreshore habitat on and adjacent to the site is generally used for foraging and resting by small numbers of wintering waterbirds, in particular mallard, tufted duck and teal. The remaining wintering bird species were distributed across the survey area, with the majority recorded off site to the north, close to the confluence with the River Thames.

Black redstart

D.1.73 The absence of black redstart observations indicates that this species does not currently use the site and the immediate surrounds for either foraging or breeding. While there are many opportunities for black redstart to nest and forage in London, not all these locations are occupied by this species. This is mainly due to the rarity of black redstart in the UK and in London[2].

Invertebrates

D.1.74 Sections of the river wall on and adjacent to the site had been highlighted by stakeholders as having potential for a notable invertebrate assemblage. Assessment of the river wall by an experienced entomologist (invertebrate survey specialist) deemed that the wall on site was not likely to support a notable assemblage of invertebrates. Following an initial visit, where no notable invertebrates were recorded, the entomologist confirmed that no further survey visits were considered necessary.

Invasive plants

D.1.75 The invasive plant species Japanese knotweed was recorded on site to the north of Bell Lane Creek. This species is listed on Schedule 9 of the Wildlife and Countryside Act 1981, which makes it illegal to cause these plants to spread or grow in the wild. Where works are to be undertaken within 10m of this species, control measures would be required to prevent its spread.

References

[1] Brown, A., Grice, P. *Birds in England*. T & A D Poyser Ltd (2005).

[2] Holling and Rare Breeding Birds Panel. *Rare breeding birds in the United Kingdom in 2008*. Mark Holling and the Rare Breeding Birds Panel (2008)

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.08**

Volume 8: Dormay Street appendices

Appendix E: Historic environment

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

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Environmental Statement

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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 8 Table E.1 below, with their location shown on the historic environment features map (Vol 8 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 8 Table E.1 Historic environment – gazetteer of known heritage assets within the site and assessment area

HEA Ref no.	Description	Site code/ HER ref/ List Entry Number
1A	Barge bed of probable 19th or 20th century date located on the south side of Bell Lane Creek. Identified by the Museum of London Archaeology (MOLA) site visit in 2011.	---
1B	Yellow stock brick wall around part of the site probably associated with the 19th century layout of the former industrial buildings. Identified by the Museum of London Archaeology (MOLA) site visit in 2011.	---
1C	A small patch of cobbled surface of granite sets, remains along the river pathway to the south of the site and east of Dormay Street. These are most likely remnants of the industrial area of the Wandle riverside and the industrial buildings once constructed along this area. They contribute to the industrial character of the area and probably date to around the mid 19th century.	---
1D	Existing riverwall on both sides of Bell Lane Creek. Multiphase canal wall of brick, stone and concrete, earliest phase possibly dating to the early 19th century, with additions to present.	---
1E	The location of the first factory of Burroughs Wellcome and Company (now GlaxoSmithKline), constructed in c. 1883 (burnt down in 1889).	---
1F	The chance find of a Neolithic to Bronze Age palstave from the Wandle River, recorded on the GLHER.	020830

HEA Ref no.	Description	Site code/ HER ref/ List Entry Number
2	Frogmore Depot, Dormay Street, SW18. An archaeological evaluation by Museum of London Archaeology Service (MoLAS; now named MOLA) in 2004. Samples were taken through the deposits and analysed. The stratigraphy consisted of three phases of organic silts overlaid by clays dating from 2300 BC - AD 1150 (Late Neolithic to medieval periods) and capped by disturbed ground. Evidence of grass and marsh, and cereal production that was likely to have taken place nearby. There were clear indications of the changing environment along the River Wandle, including the increasing influence of the Thames over time. Other deposits indicated sediments characterised by the bright colours of an 18th or 19th-century nearby dye factory.	FDD04
3	Wentworth House with forecourt wall, gate and gatepiers. Grade II listed. Early 18th century. Two storeys, 5 windows, with one window later extension. Brown brick. Red brick band first floor. New slate roof. Flat door hood on richly-carved brackets. Original wood eaves cornice (remodelled). Red gauged flat arches and dressings to flush framed windows. Staircase with thick turned balusters, wide handrail, square newels and panelling. Panelling and wood cornice in ground floor area. Later wrought iron gate and stone capped piers to ramped forecourt wall.	1183819
4	Findspot of Neolithic, scrapers and flakes (tools) found by chance. The exact location is uncertain; thought to be from Truckers Estate, close to the junction of West Hill Road and Santos Road. Recorded on the Greater London Historic Environment Record (GLHER).	031198
5	Stables of the former Ram (Youngs) Brewery Complex. Grade II listed. Constructed 1896 with minor 20th century alterations.	1391086
6	Former Ram Brewery, Wandsworth High Street, SW18. An archaeological watching brief by MoLAS in 2007. Demolition deposits of 18th-20th-century date were recorded above natural gravels.	RBY07
7	The chance find of an early Romano British coin and fragments of pottery. Recorded on the GLHER.	020761
8	The chance find of a Mesolithic flake/blade from the “Wandsworth waterside” in 1981. Recorded on the GLHER.	031187

HEA Ref no.	Description	Site code/ HER ref/ List Entry Number
9	Ferrier Industrial Estate, Morie Street, SW18. An archaeological evaluation by AOC Archaeology Ltd in 2000. Prehistoric features were found cut into the natural brickearth or gravels. Five pits were recorded in the north of the site, three of which may have been part of a fence line. In the middle of the site, a shallow ditch and a cluster of three pits were found, in the south of the site, a possible shallow ditch. Two fragments of Late Neolithic - Early Bronze Age pottery and struck flint fragments were recovered from these features. Above lay a ploughsoil containing struck flint, covered by a soil deposit of 18th - 19th-century date. A number of 19th and 20th-century walls, and surfaces were also exposed.	MOI00
10	5 Church Row, Wandsworth Plain, SW18. An archaeological evaluation by Pre-Construct Archaeology (PCA) in 2000. Natural was not observed. A series of dumped layers were recorded which made up the ground beside of the River Wandle, presumably behind a river revetment. These were cut by the foundations of two buildings, the first of which was a brick built wall dated to the 17th or 18th century, the second was probably a late 19th-century outbuilding or industrial unit within the Church Row property.	CWP00
11	7, 8 and 9 Church Row. Grade II listed. 18th Century townhouses.	1065559
12	1–6 Church Row. Grade II* listed. Townhouses c. 1723.	1183550
13	The chance find of an Iron Age blade, a possible Roman bronze knife, a Roman spud tool, a medieval dagger and a medieval snafflebit (part of a horse's bridle). Recorded on the GLHER.	031276 031312 031311 031370 031369
14	The Church of All Saints. Grade II* listed. Tower constructed in 1630 and refaced and raised 1841. Body of church largely rebuilt in 1779. Alteration and improvement works in the 19th century.	1357684
15	The Church of All Saints burial ground recorded by Mrs Basil Holmes in 1896.	Holmes ID: 168
16	52–58 Putney Bridge Road, SW15. An archaeological evaluation by Oxford Archaeological Unit (OAU) in 1997. No significant archaeological remains were revealed and no artefacts earlier than 19th century were recovered. The	PTB97

HEA Ref no.	Description	Site code/ HER ref/ List Entry Number
	only deposits exposed comprised a post-mediaeval garden soil, overlain by shallow brick foundations associated with Victorian houses demolished in recent times.	
17	66–84 Putney Bridge Road, SW18. An archaeological evaluation by MoLAS in 2001. Natural gravels were cut by two linear features containing struck flint tools, possibly of Mesolithic or Early Neolithic date, and a fragment of medieval pottery. There was also an undated posthole. It is likely that this represented a prehistoric scatter of flints that had been disturbed and redeposited by medieval agricultural activity. The features were sealed by medieval or later ploughsoils.	PBD01
18	Osiers Road (The Morganite Works), SW18. An archaeological watching brief and excavation by PCA in 2004 and 2005. An infilled water course was recorded. This feature is shown on maps of the 18th and early 19th century. A timber stake of unknown date was identified in association with the water course. Natural sand and terrace gravels were recorded between 101.1–103.0m Above Tunnel Datum (ATD). The second phase recorded the fill of the channel produced pottery from a range of periods from medieval to post medieval. An assessment of the sedimentary sequence of the channel was taken and indicates mineral rich deposition between 2020–1700 BC and peat formation from 1500 cal BC. Peat formation continued until 380-540 cal AD. The date of 1500 BC for the start of peat formation is comparable with other well-dated peat sequences in the lower reaches of the River Thames. After this period there is evidence of renewed fluvial sedimentation, possibly due to further migration of the main river channel, or increased flooding due to changes in the fluvial regime within the Wandle Valley river catchment. Insect remains, after peat formation, indicate that the local environment was damp. The presence of herbivores indicated possible anthropogenic activity, such as pastoral farming. Natural sandy gravel was recorded between 103.3m OD and 104.5m ATD.	98164
19	Former Ram (Youngs) Brewery Complex. Grade II* listed. Late-18th century, early to mid-19th century with late 19th and 20th century additions and alterations.	1065461
20	A ship wreck visible at low tide. Observed during the site visit and recorded by the UK Hydrographic Office.	---
21	14 Armoury Way: The Crane Public House (now The	---

HEA Ref no.	Description	Site code/ HER ref/ List Entry Number
	Armoury). A 19th century building of local interest. The building is not listed.	
22	Surrey Iron Railway (point indicates the approximate location of this north-south linear feature at its closest point to the site to the east). This railway opened in 1803, connected the Thames with Croydon and Merstham, and was the first public horse-drawn railway independent of a canal. The line ran to the east of the Wandle, crossing the north-east corner of the current site to serve the Wandle mills. The line closed in 1846.	---
23	Richmond and Windsor Branch Line. Brick built railway viaduct dating to the mid 19th century.	---
24	Bazalgette Southern Low Level Sewer. Mid/late 19th-century sewer.	---

E.2 Site location, topography and geology

Site location

E.2.1 The site straddles Bell Lane Creek, which runs through the middle of the site on an east-west alignment. The Causeway road is included within the site and forms its eastern boundary, beyond which is the current course of the River Wandle. To the north of the creek, the site is bounded by a vehicle storage area to the north, and 35m beyond this is a railway viaduct. On the southern side of the creek, the southern part of the site is bounded by low rise industrial buildings and the Borough of Wandsworth Depot to the south and west.

Topography

E.2.2 Bell Lane Creek runs east-west through the middle of the site. Ground levels are flat, at around 104.5m ATD (above Tunnel Datum) on the south side of the creek and at 105.0–105.5m ATD on the north side of the creek. There is a 4.0m drop down to the creek foreshore, which lies at 101.5m ATD beside the river walls and at 100.5m ATD at the low water mark.

Geology

E.2.3 The site is situated in an area of deep alluvium associated with the present and former courses of the River Wandle[1]. The Wandle is a major tributary of the Thames and flows south to north, with the confluence of the two rivers 340m to the north of the site. Originally the river would have comprised braided channels across undulating sands and gravels, and the site is situated slightly east of the centre of the floodplain. The Kempton Park gravel terrace forms the Wandle valley sides, 70m to the east and 140m to the west of the site[2].

E.2.4 British Geological Survey (BGS) boreholes are sparse in the area, with 11 boreholes within 300m of the site. The borehole logs are generally modern and detailed. There is one borehole record from recent geotechnical ground investigation in the northern part of the site[3]. This recorded the top of the underlying gravels at 100.5m ATD overlain by organic alluvial clays (with root traces) to 101.2m ATD sealed by peats to 101.8m ATD. Over these sediments there is 3.4m thickness of made ground, to 105.2m ATD. The borehole indicates the site is situated over an area that was once one of migrating channels of the Wandle, which became backwater and fringing fen as the river moved away.

E.2.5 A geoarchaeological investigation (**HEA 2**) on the floodplain 80m to the west of the site found similar alluvium, deposited by the river over the last 2,300 years, from the late Neolithic to post-medieval period. These deposits preserved rich assemblages of environmental remains, which have helped to reconstruct the past characteristics of the Wandle and its valley.

E.3 Past archaeological investigations within the assessment area

E.3.1 No archaeological investigations have been carried out in the site in the past. There have been seven archaeological investigations within the study area. These have revealed multi-period remains.

E.3.2 The nearest archaeological investigation to the site was in 2004 at the Frogmore Depot (**HEA 2**), 80m to the west of the site. This recorded organic silts overlaid by clays, dating from 2300 BC–AD 1150 (Late Neolithic to medieval periods). Investigations on the gravel terrace on both sides of the Wandle valley have revealed prehistoric activity. Neolithic or Bronze Age activity in the form of pits and ditches was recorded 190m to the east (**HEA 9**), whilst Mesolithic or Neolithic features with struck flint was recorded 195m to the west (**HEA 17**). Other investigations (including **HEA 2**, **9** and **17**) have revealed mostly post-medieval remains, including **HEA 16**, 110m to the south; **HEA 10**, 100m to the south; **HEA 16**, 210m to the southwest; and **HEA 18**, 235m to the northwest of the site.

E.4 Archaeological and historical background of the site

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

Prehistoric period (700,000 BC–AD 43)

E.4.2 During the early prehistoric, the River Wandle consisted of multiple migrating channels spanning the current floodplain. The site, located close to the modern confluence of the Thames and the Wandle, would have been within an area which may have comprised fresh and brackish water, marsh, dry land and river channel at different times. A BGS borehole in the northern part of the site[4] shows that organic sediments, which would preserve environmental remains and organic artefacts, accumulated on the site in backwaters and marsh adjacent to the river channels.

E.4.3 The Mesolithic hunter-gather communities of the postglacial period (10,000–4000 BC) inhabited a still largely wooded environment. The river Wandle would have provided a predictable source of food (from hunting and fishing) and water, as well as a means of transport and communication. Evidence of activity is characterised by flint tools rather than structural remains. A Mesolithic flake or blade was found by chance 200m to the north of the site (**HEA 8**).

E.4.4 Sea levels gradually rose and the area would have been increasingly subject to flooding and alluvial sedimentation. At Frogmore Depot (**HEA 2**), 80m to the west of the site, evidence indicated that the area around the site was marshy and prone to flooding by the Neolithic. Pollen recorded indirect evidence for nearby woodland disturbance and cereal cultivation. Diatom analysis provided clear indications of the changing environment along the River Wandle, including the increasing influence of the Thames, with a freshwater environment developing into a brackish water environment as rising sea levels brought the tidal head of the Thames further upriver.

E.4.5 Further evidence of a marshy environment was recorded at Osiers Road (**HEA 18**), 235m to the northwest of the site. The borehole data from the site itself suggests that the site was partially or wholly within one of the channels of the Wandle during at least part of prehistory, but the course of the channel would have changed through time and may not have included the whole site.

E.4.6 Although parts of the site would have been dry ground in prehistory, prehistoric settlement would have been on the higher, drier gravel terraces on either side of the valley. The Greater London Historic Environment Record (GLHER) notes the chance find of a Neolithic or Bronze Age palstave (bronze axe) from the River Wandle within the western part of the site (**HEA 1A**). At the Ferrier Industrial Estate (**HEA 9**), 190m to the east of the site, prehistoric features in the form of at least five pits and several ditches were found to cut into the natural geology. These features included fragments of Neolithic to Bronze Age pottery as well as struck flint fragments. An archaeological evaluation at 66–84 Putney Bridge Road (**HEA 17**), 195m to the west of the site and on the other side of the valley, unearthed a disturbed prehistoric flint scatter.

E.4.7 Although settlement within the site is unlikely, due to the marshy environment, the natural resources of the marshes would have been

exploited, as a source of food, transport and raw materials. In wetland areas wooden trackways were sometimes constructed to provide access to gravel islands on the floodplain, and/or areas of activity. Water was associated with certain religious or votive practices and trackways and wooden structures can also be associated with ritual deposits of metals and other objects. The GLHER notes the chance find of a group of Neolithic flint tools (**HEA 4**), found approximately 30m to the west, and an Iron Age blade 150m to the south of the site (**HEA 13**).

Roman period (AD 43–410)

E.4.8 The site lay c. 8.8km to the southwest of the Roman town of *Londinium*, which grew up in the mid 1st century AD in the area of the City of London. Small, nucleated settlements, typically located along the major roads leading to the capital, acted both as markets and as producers to the capital (MoLAS, 2000)[5].

E.4.9 Although no evidence of Roman settlement has been found at Wandsworth, it has been suggested that the High Street, 240m to the south of the site, originally followed the line of an east-west Roman road that branched off Stane Street Roman road in the area of Clapham (Farrant, 1975)[6], and there is evidence for an east-west road through Mortlake and Putney to the west, which may have formed part of the same road(Gerhold, 1998)[7]. The road, and its crossing of the Wandle, is likely to have attracted settlement and other activity. Despite the presence of the possible road and suitable topographical and geological conditions, evidence of Roman activity in Wandsworth has been elusive to date and is limited to a small number of isolated findspots of Roman objects largely found by chance. Evidence of Roman activity in the study area around the site comprises only isolated chance finds recorded on the GLHER, in the form of an early Romano British coin and fragments of pottery (**HEA 7**), found 110m to the south of the site; and a possible Roman bronze knife and a Roman hoe found 150m to the south (**HEA 13**).

E.4.10 The position of the site within the Wandle floodplain suggests that it was still marsh and prone to flooding, and evidence of the wetland environment was found during archaeological investigations at Osiers Road (**HEA 18**), 235m to the northwest of the site. By this time, the Wandle had probably largely developed into a single channel river. Parts of the marshes were possibly exploited for a number of resources, and the periphery of the floodplain may have been cleared and used as grazing particularly during the summer months.

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

E.4.11 Wandsworth (*Wendleswurthe* - 'Wendel's farm') is first mentioned in AD 693 when it is referred to as a single large estate, granted to the nuns of Barking Abbey, and covering much of the area of modern Battersea and Wandsworth (Gerhold,1998)[8] (Victoria County History, 1967)[9]. It reverted back to the Crown following the destruction of the Abbey by the Danes (Victoria County History, 1967)[10]. Domesday Book (1086) records that the manor (estate) of Wandsworth was held by Edward the Confessor prior to the Conquest (1066). At that time it was occupied by six freemen tenants

farming land with a considerable amount of meadowland (Williams and Martin, 2003)[11].

E.4.12 The exact location of settlement within the manor of Wandsworth is uncertain, but it is possible that the main focus developed in the vicinity of a bridge over the Wandle, approximately 300m to the south of the site. It is believed that the mid-16th century bridge, at this location, was built on the site of an earlier bridge.

E.4.13 No evidence of early medieval activity or occupation has been recorded within the study area. In all likelihood the site was located in marshland outside the main settlement, and was possibly used for rough pasture.

Later medieval period (AD 1066–1485)

E.4.14 Although Wandsworth was included in the entry for Battersea manor within Domesday Book, the reference to the 'berewick' (outlying part of an estate) of Wandsworth in a grant to Barking Abbey suggests that at this time it was a distinct place. The Wandsworth berewick was administered from Savage Farm, which stood just north of Wandsworth's medieval church (Gerhold, 1998)[12]. This church stood on the site of the current 17th/18th-century All Saints Church (**HEA 14**), 130m to the south of the site (Cherry and Pevsner, 1983)[13]. Wandsworth grew up as a roadside settlement along the east-west road from South London into Surrey, beside the church and bridge crossing of the River Wandle, approximately 300m to the south of the site. Until the 19th century the High Street bridge, which is known to have existed before 1539, was the only bridge across the river. Land to the north, beside the Wandle's mouth, and including the site, would have been a marshy area (Gerhold, 1998)[14]. The archaeological evaluation at the Frogmore Depot (**HEA 2**), 80m to the west of the site confirms that the area around the site was still prone to flooding during this period.

E.4.15 Domesday Book records 13 mills along the River Wandle, seven of which fell within the manor of Wandsworth, indicating the economic importance of the river. The fast flow and the reported cleanness of the River Wandle was exploited for a number of industries including fishing, bleaching and hat making, known to have been carried out in the area as early as the 13th century (Weinreb and Hibbert, 1983)[15].

E.4.16 An archaeological evaluation at 66–84 Putney Bridge Road (**HEA 17**), 195m to the west of the site, recorded fragments of medieval pottery and evidence of agricultural activity. Medieval pottery within a channel was uncovered during an archaeological watching brief and excavation at Osiers Road (**HEA 18**), 235m to the northwest of the site. The GLHER records the chance find of a medieval dagger and medieval part of a horse's bridle, 150m to the south of the site (**HEA 13**).

E.4.17 Parts of the floodplain were probably drained and reclaimed piecemeal during this period. The lack of finds and the distance from the High Street and the bridge crossing, suggests that the site lay some distance outside the village, and was probably meadow or pasture.

Post-medieval period (AD 1485–present)

E.4.18 Documentary evidence suggests that a stone bridge across the River Wandle existed on the site of the present bridge, prior to 1569 (Gerhold, 1998)[16], and this was confirmed when remains of a 16th-century bridge abutment were recorded during an archaeological watching brief by MoLAS in 1993[17]. Savage Farm, the bridge and the church formed the focus of the settlement, approximately 300m to the south of the site.

E.4.19 The site lay outside the settlement, probably on reclaimed land beside the River Wandle, the course of which was altered throughout this, and earlier, periods. The main channel effectively became a succession of level pools between mills, and originally occupied more of central Wandsworth than the present channel (Gerhold, 1998)[18]. A number of industries were located along the river to exploit the fast flow. The geoarchaeological investigation 80m to the west of the site (**HEA 2**) revealed evidence of industrial dyeing with brightly coloured sediments relating to a time when the Wandle supported textile industries. The BGS borehole in the northern part of the site[19] indicates that similar evidence might be preserved in the alluvial deposits here.

E.4.20 Rocque's map of 1746 (Vol 8 Plate E.1) is small scale but shows the general topography and the location of the main settlement and roads. It is difficult to locate the site accurately as the area has subsequently changed considerably. The site appears to lie in pasture west of the River Wandle, possibly with one or more industrial buildings within the site. The map shows the main settlement of Wandsworth to the south, stretched out along the High Street. The River Wandle comprises several main channels.

E.4.21 Stanford's map of 1862 (Vol 8 Plate E.2) shows the increasing urbanisation of the area, with further development extending out from the town centre along both banks of the Wandle, and further industrial activity north-south along the sides of the river, eg mills and breweries. Much of the growth would have been brought about by the coming of the railways. The Richmond and Windsor branch of the London and South Western Railway, built in c. 1846, is shown c. 35m to the north of the site (**HEA 22**) and is still extant. It comprises a brick viaduct with arches, although some of the arches have been replaced by modern decks across modern roads. This map shows extensive osier beds (for growing a kind of willow used in basket making) in the northern part of the site, north of Bell Lane Creek. The southern part of the site has several buildings and yards, probably of an industrial nature, along the south side of the creek.

E.4.22 The Ordnance Survey (OS) 1st edition 25":mile map of 1862–95 (Vol 8 Plate E.3) is a detailed map that shows the buildings in the southern half of the site. These comprised three large industrial warehouses, open yards, and two circular 'Maltkilns' and 'Pumps' adjoining the south side of the central building. The business would have made use of the water from the creek in industrial processes and also for transportation. Two small docks/wharfs off the main Bell Lane Creek are also shown within the site, as well as further larger docks and wharves formerly part of the creek but

now infilled. The map shows the northern part of the site as undeveloped land.

E.4.23 The western part of the site appears to have been the location of the first factory of Burroughs Wellcome and Company (**HEA 1E**), which is now GlaxoSmithKline, one of the largest pharmaceutical companies in the world. In 1883, Borroughs Wellcome and Company constructed a factory which partially occupied the western part of the site, on the south side of the creek. The OS 1st edition map shows two linear warehouses within the westernmost extent of the site. The factory comprised a three-storey warehouse/manufactory and at least two engine rooms and a number of other associated warehouses and offices. It was one of the few pharmaceutical manufacturing sites in Britain at that time. In 1888, the company moved to Dartford, and in 1889 the factory burnt down.

E.4.24 The Ordnance Survey 2nd edition 25":mile map of 1896–8 (Vol 8 Plate E.4) shows little change within the site and the immediate vicinity, although the former maltings are labelled 'Wandsworth Royal Laundry' indicating a change in use, and a small annex has been added at the eastern end of the building in the eastern part of the site. The Ordnance Survey 3rd edition 25":mile map of 1909–20 (not reproduced) shows no change other than the demolition of the building(s) in the western part of the site.

E.4.25 The Ordnance Survey 1:10,000 scale map of 1962–8 (Vol 8 Plate E.5) show that the earlier buildings which lay in the southern part of the site had been demolished and replaced with three buildings. The western building lies in the vicinity of the western branch of the Bell Lane Creek, which had now been filled in. This building is probably that which currently still exists within the site. The northern part of the site is shown as open land and is unchanged.

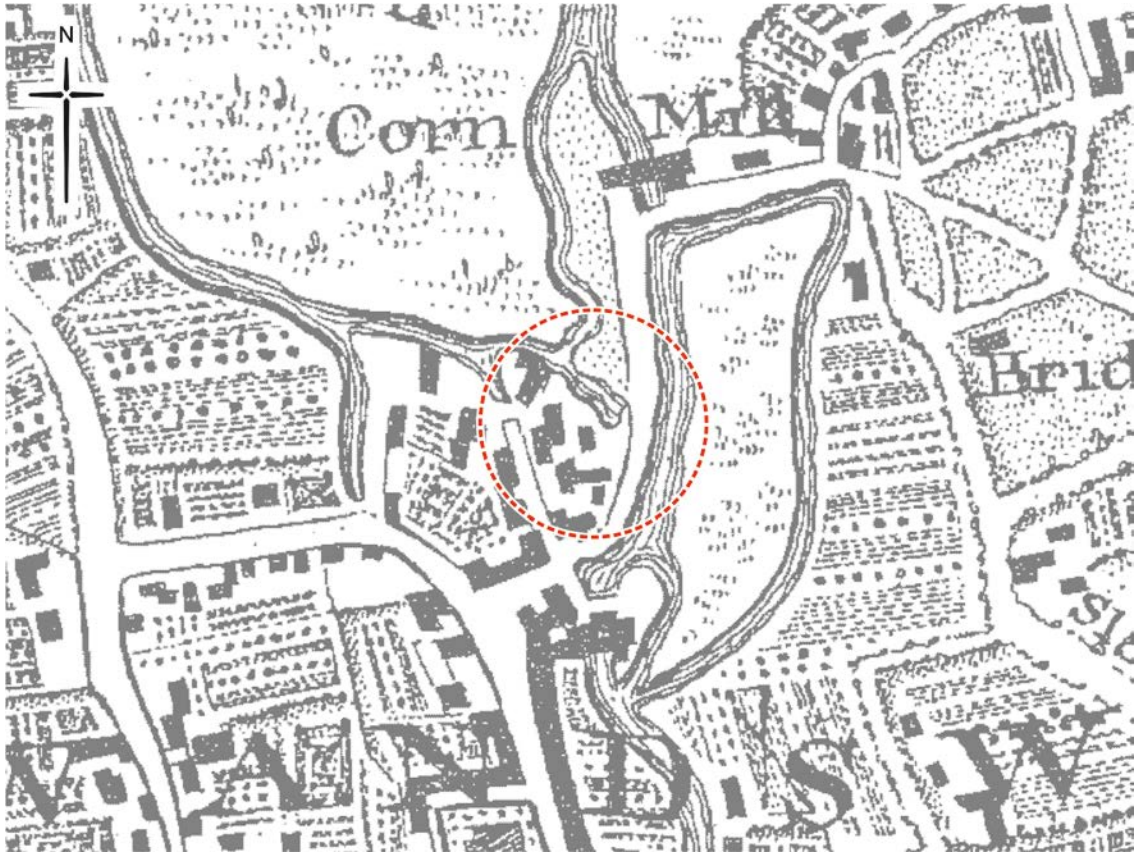
The current site

E.4.26 The northern part of the site is an area of hardstanding surrounded by security fencing and is currently used as storage for recycling vehicles (Vol 8 Plate E.6). The western half of the southern part of the site comprises the Borough of Wandsworth Depot which is used for car parking and as a coach depot (Vol 8 Plate E.7). In the western part of the site is a vehicle shed, constructed simply from steel 'I' section columns and sloping roof (material unknown) which first appears on the Ordnance Survey map of 1962–68. East of this are two modern brick and concrete buildings which post-date the 1962–68 survey. Where the site boundary stretches south down The Causeway, it includes an area of cobbled road of probable 19th century origin (**HEA 1C;** Vol 8 Plate E.10). The existing riverwall on both sides of Bell Lane Creek in the middle of the site comprises a multiphase canal wall of brick, stone and concrete, the earliest phase possibly dating to the early 19th century, with additions to present (**HEA 1D**; Vol 8 Plate E.11). Within the site, on the south side of the creek, are the remnants of a 19th or early 20th century barge bed, comprising a levelled area of foreshore with a timber brace (**HEA 1A**; Vol 8 Plate E.8). A brick boundary wall along the eastern boundary of the southern half of the site (**HEA 1B**; Vol 8 Plate E.9) probably dates to the 19th century.

E.4.27 On the east side of Dormay Street, 25m west of the site, is the Grade II listed 18th-century Wentworth House (**HEA 3**; Vol 8 Plate E.12).

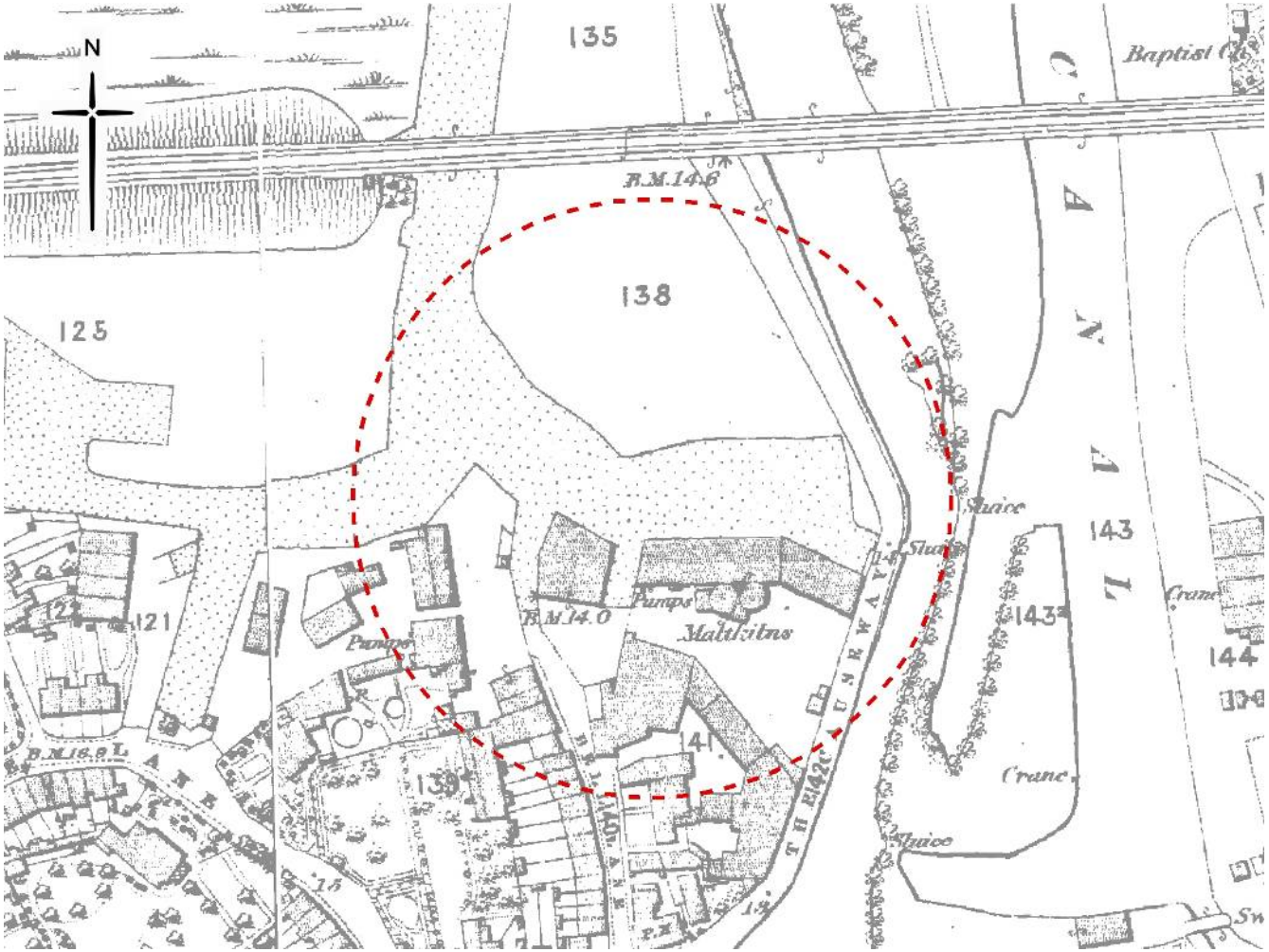
E.5 Plates

Vol 8 Plate E.1 Historic environment – Rocque's map of 1746

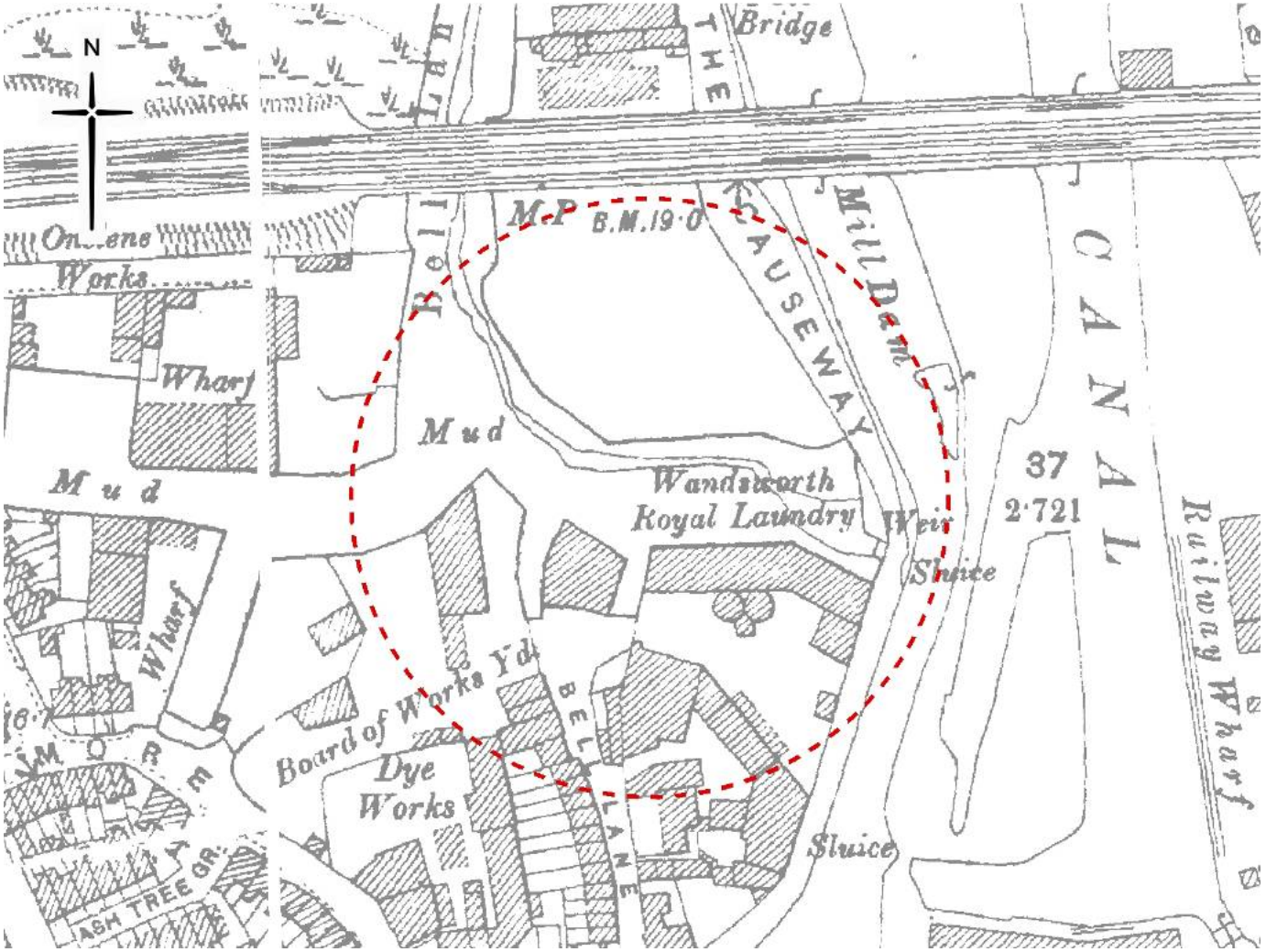


Vol 8 Plate E.2 Historic environment – Stanford's map of 1862

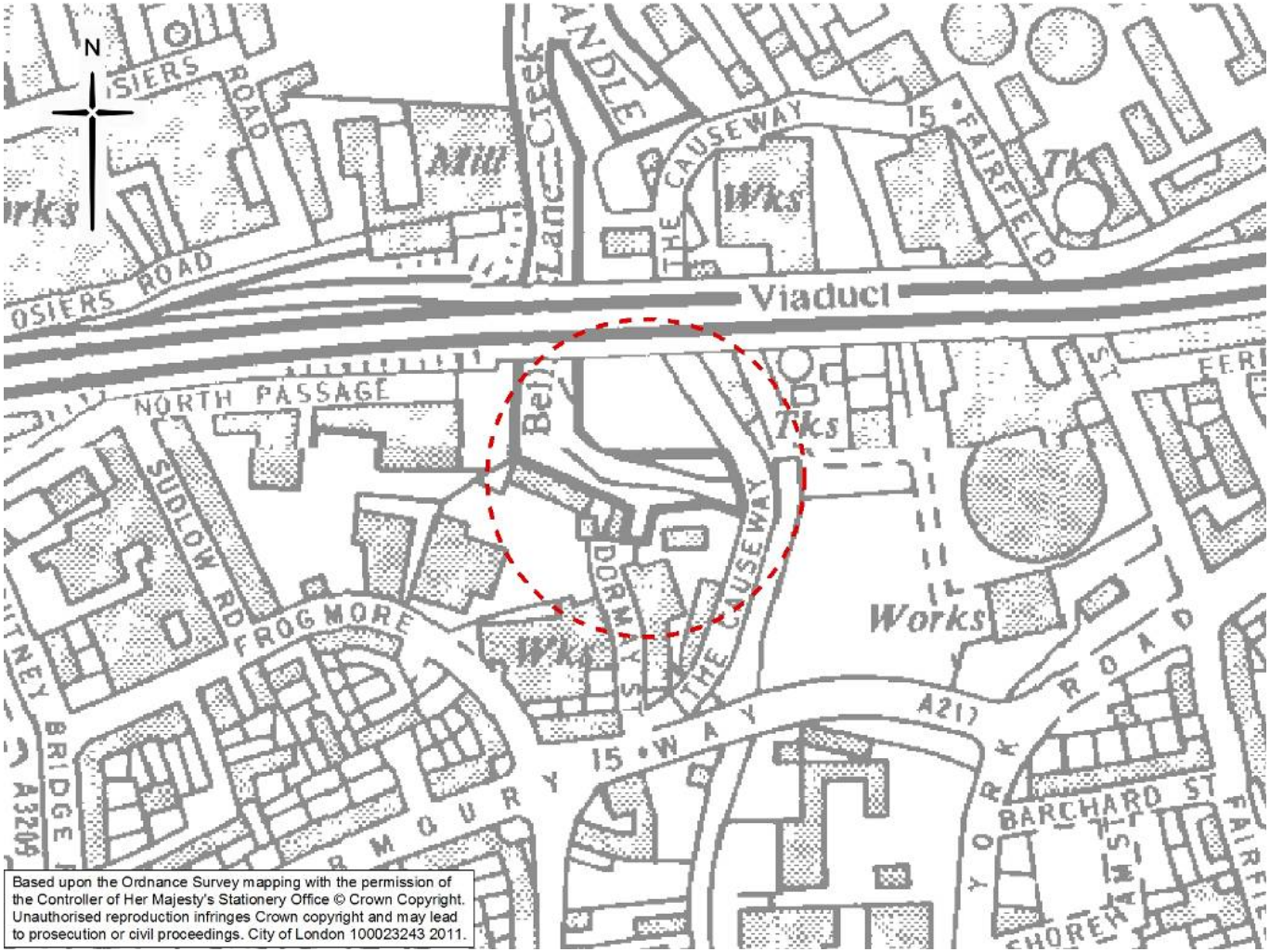
Vol 8 Plate E.3 Historic environment – Ordnance Survey 1st edition 25” scale map of 1862–95 (not to scale)



Vol 8 Plate E.4 Historic environment – Ordnance Survey 2nd edition 25" scale map of 1896–8 (not to scale)



Vol 8 Plate E.5 Historic environment – Ordnance Survey 1:10,000 scale map of 1962–8 (not to scale)



Vol 8 Plate E.6 Historic environment – overview of the northern part of the site

Looking west, standard lens; MOLA; 19th August 2011

Vol 8 Plate E.7 Historic environment – overview of the southern part of the site

From a warehouse to the west of the site boundary; looking east; standard lens; MOLA; 19th August 2011

Vol 8 Plate E.8 Historic environment – barge bed within the site

From the southern side of the creek; looking north; standard lens; MOLA; 19th August 2011

Vol 8 Plate E.9 Historic environment – brick boundary wall along the eastern boundary of the site

From the river pathway; looking southwest; standard lens; MOLA; 19th August 2011

Vol 8 Plate E.10 Historic environment – cobbled surface to the east of Dormay Street towards Armoury Way

From the river pathway; looking southwest; standard lens; MOLA; 19th August 2011

Vol 8 Plate E.11 Historic environment – Bell Lane Creek to the north of the site

From the river pathway showing the canal wall; looking west; standard lens; MOLA; 19th

August 2011

Vol 8 Plate E.12 Historic environment – Grade II listed Wentworth House

To the west of the site; looking northeast; standard lens; MOLA; 19th August 2011

References

[1] British Geological Survey. *Digital solid and drift geology data*.

[2] British Geological Survey. *Solid and Drift Geology, map sheet 270*.

[3] British Geological Survey. *Borehole no. SA1105, at National Grid Reference 525551 175016*.

[4] British Geological Survey. See citation above.

[5] Museum of London Archaeology Service, *The Archaeology of Greater London*. MoLAS and English Heritage, 150, (2000).

[6] Farrant N. '*Roman roads in Wandsworth'* in The Wandsworth Historian Vol 13 Dec 1975. Wandsworth Historical Society, fig 4 (1975).

[7] Gerhold D, *Wandsworth Past.* Historical Publications 13 (1998).

[8] Gerhold D, *Wandsworth Past.* Historical Publications, 13, (1998).

[9] Victoria County History, *A History of the County of Surrey* Vol IV. London 108, (1967).

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[11] Williams A and Martin GH, *The Domesday Book, a complete translation.* Penguin, 84, (2003).

[12] Gerhold D, *Wandsworth Past*. *Historical Publications* (1998), 14.

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[15] Weinreb B and Hibbert C, *The London Encyclopaedia.* Macmillan, 947, (1983).

[16] Gerhold D, *Wandsworth Past.* See citation above. p7.

[17] London Archaeological Archive and Research Centre site code WWD93.

[18] Gerhold D, *Wandsworth Past.* See citation above. p11.

[19] British Geological Survey borehole no. SA1105, at National Grid Reference 525551 175016.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.08**

Volume 8: Dormay Street appendices

Appendix F: Land quality

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

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Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 8 Dormay Street appendices

Appendix F: Land quality

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Appendix F: Land quality

F.1 Baseline report

F.1.1 Baseline data is sourced from:

a. walkover survey

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

c. stakeholder consultation

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

Site walkover

F.1.2 A site walkover survey of Dormay Street was undertaken on 9th November 2010.

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

F.1.4 The proposed development site is split over two areas separated by Bell Lane Creek. The southern part of the site is the location for the proposed combined sewer overflow (CSO) drop shaft and currently comprises the London Borough (LB) of Wandsworth Maintenance Depot (which includes underground fuel storage and distribution, via an above ground pump island).

F.1.5 A Hazchem sign (indicating chemical storage) was noted at the site entrance and construction plant equipment could be viewed from the site perimeter. An above ground tank (probable diesel) is present within the eastern part of the Wandsworth Maintenance Depot area.

F.1.6 The northern site area (which would form part of the construction compound) is currently covered with hardstanding and is used for storage of vehicles and skips by Wandsworth Council.

F.1.7 The surrounding area is predominantly industrial/commercial.

F.1.8 Detailed site walkover notes are provided in Vol 8 Table F.1 below.

Vol 8 Table F.1 Land quality – site walkover report

Item Site Ref (PWH7X, Dormay Street)	Details
Date of walkover	9th November 2010
Site location and access	The site comprises part of the Frogmore Industrial Complex and Causeway Island, including parts of the LB Wandsworth Maintenance Depot (formerly warehousing associated with Keltbray Limited a specialist Demolition and Civil Engineering contractor) Site observed through security fencing/gates.

Item Site Ref (PWH7X, Dormay Street)		Details
Size and topography of site and surroundings	Record elevation in relation to surroundings, any hummocks, breaks of slope etc.	The site is relatively flat and mostly hard surfaced.
Neighbouring site use (in particular note any potentially contaminative activities or sensitive receptors)	North	The site is bordered by the vehicle storage area in Causeway island and the railway land further north.
	South	Adjacent to the south of the site are offices of an aerial supply company (Panorama Antennas). To the south of Panorama Antennas, at the entrance to Dormay Road, is a ceramics/tile workshop called 'Prestige Tiling' and bordering this road is a row of refurbished Victorian Warehouses. A Public House 'The Armoury' is also located at the entrance of Dormay Road and adjacent to this a sink and tap studio called Sinksation. A plumbers merchant is also located here.
	East	The River Wandle borders the eastern section of the site. Wandsworth Holder Station is located further east.
	West	LB of Wandsworth depot occupies the land west of the site.
Site buildings	Record extent, size, type and usage. Any boiler rooms, electrical switchgear?	Warehousing and office/depot buildings. The eastern section of the site is occupied by an industrial area. At the entrance to this area, a Hazchem sign was noted and construction plant equipment could be viewed.
Surfacing	Record type and condition	Hard surfacing.
Vegetation	Any evidence of distress, unusual growth or invasive species such as Japanese Knotweed?	None observed
Services	Evidence of buried services?	None observed

Item Site Ref (PWH7X, Dormay Street)		Details
Fuels or chemicals on-site	Types/ quantities?	Probable diesel
	Tanks (above ground or below ground)	Pump island within council depot indicates below ground fuel tanks.
	Containment systems (eg, bund, drainage interceptors). Record condition and standing liquids	None observed
	Refill points located inside bunds or on impermeable surfaces etc?	None observed
Vehicle servicing or refuelling on-site	Record locations, tanks and inspection pits etc.	See above
Waste generated/stored on-site	Adequate storage and security? Fly tipping?	None observed
Surface water	Record on-site or nearby standing water	Bell Lane Creek dissects the site. River Wandle to the east of the site. River Thames, approximately 250m to the north of the site.
Site drainage	Is the site drained, if so to where? Evidence of flooding?	None observed
Evidence of previous site investigations	eg trial pits, borehole covers.	None observed
Evidence of land contamination	Evidence of discoloured ground, seepage of liquids, strong odours?	None observed
Summary of potential contamination sources		Industrial or commercial areas on all site boundaries. Depots on southern part of site. Northern part of site used for vehicle and container storage.
Any other comments	Eg access restrictions/ limitations	Site is mostly developed. The site was observed from outside security fencing/gates.

Review of historical contamination sources

F.1.9 Historical mapping (dated between 1868 and the present day) has been reviewed in order to identify potentially contaminating land-uses at the site and within the 250m assessment area.

F.1.10 Vol 8 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.1.11 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.1.12 Items listed in Vol 8 Table F.2 below are also shown in Vol 8 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 8 Appendix E.

Vol 8 Table F.2 Land quality – potentially contaminating land-uses

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
On-site			
1	Corporation Works/Yard	c1898-c1980	Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, poly aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), chlorinated aliphatic hydrocarbons
2	Bell Lane Creek (infilled land/wharf)	c1869-c1964	Various depending upon source of infill – organic materials will degrade to produce landfill gases (eg methane, carbon dioxide)
3	Depot	c1988-present	Heavy metals, asbestos, total petroleum hydrocarbons (TPH), aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
4	Electricity works includes switch house	c1951-c1968	Hydrocarbons, PAHs, heavy oils, PCBs, asbestos
5	Depot	c1985-present	Heavy metals, asbestos, TPH, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
6	(a) Royal Wandsworth	c1896-c1916	Heavy metals, arsenic, selenium, free cyanide, nitrates, sulphates ,

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
	Laundry		asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs
	(b) Various works	c1976-present	Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
Off-site			
7	Water works (150m north)	c1896-c1949	Chlorine, oils, greases, PCBs (possibly associated with backup power)
8	Railway (30m north)	c1868-present	Hydrocarbons (diesel and lubricating oils), ash and fill with heavy metals, sulphates, PAHs, asbestos, herbicides, semi volatile organic compounds (SVOCs)
9	Firework factory (150m northwest)	c1896	Sulphur, metal oxides, explosives
10	Food works (195m northwest)	c1916-c1920	Hydrocarbons, heavy metals
11	Ram Brewery (45m south)	c1868-recent	Volatile organic compounds, total petroleum hydrocarbons, heavy metals, ethanol/methanol, ammonia, chlorinated alkalis, benzene, toluene, ethylbenzene and xylenes
12	Wharves (adjacent west)	c1951-c1988	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphides, sulphates, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
13	Warehouse (20m west)	c1951-recent	Use unknown
14	Dye works (60m west)	c1951-c1952	Heavy metals, sodium dichromate, chlorinated organic solvents, chlorinated hydrocarbons, organic solvents
15	Electrical substation (85m west)	c1951	Oils, PCBs
16	Laundry (formed of two buildings	c1951-c1988	Heavy metals, arsenic, selinium, free cyanide, nitrates, sulphates ,

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
	170m west)		asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs
17	(a) Engineering works (195m southwest)	c1951	Heavy metals, arsenic, boron, free cyanide, nitrate, sulphate, sulphide, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
	(b) Garage (195m southwest)	c1980-recent	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compound, heavy metals and asbestos
18	Wandsworth Tar Works and associated tanks (10m east)	c1951-c1967	Phenolics, PAH, ammoniacal liquors, cyanides, tar
19	(a) Timber yard (10m south)	c1951-c1964	Heavy metals, arsenic, boron, sulphates, phenols, acetone, aromatic hydrocarbons, PAHs, cresols
	(b) Depot (10m south)	c1964-c1976	Heavy metals, asbestos, TPH, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
	(c) Laundry (20m south)	c1916	Heavy metals, arsenic, selenium, free cyanide, nitrates, sulphates , asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs
20	(a) Laundry (85m south)	c1951	Heavy metals, arsenic, selenium, free cyanide, nitrates, sulphates, asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs
	(b)Works (85m south)	c1964	Heavy metals, arsenic, boron, free cyanide, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
21	Coal hopper (120m north)	c1951-c1986	Hydrocarbons, heavy metals, arsenic, PAHs, PCBs, sulphide, sulphate
22	Coal bunker (155m northeast)	c1951	

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
23	Works (190m northwest)	c1951	Heavy metals, arsenic, boron, free cyanide, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
24	Engineering works (160m northwest)	c1951-c1959	Heavy metals, arsenic, boron, free cyanide, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
25	(a) Engineering works (230m northwest)	c1951-c1971	
	(b) Electrical works (230m northwest)	c1985	
26	Gas works and holder (65m east)	c1868-c1920	Volatile aromatics, phenolics (phenol and creosol), PAH in coal tar and ash, hydrocarbons, heavy metals, free cyanide, ammoniacal liquors, sulphate
27	Electrical substations (closest 140m west)	c1951-present	Oils, PCBs
28	Works (10m west)	c1968-present	Heavy metals, arsenic, boron, free cyanide, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
29	Refuse disposal solid waste transfer station (130m north)	c1986	Heavy metals, arsenic, free cyanide, sulphate, sulphide, asbestos, oil/ fuel hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs
30	Cement works (70m northeast)	c1986	Slag, pulverised fuel ash (PFA), asbestos, lignosulphonate (plasticiser), carboxylic acids, sulphates
31	Garage (120m east)	c1988-present	Hydrocarbons, methyl tert-butyl ether (MTBE), chlorinated hydrocarbons, chlorinated solvents, heavy metals, asbestos
32	(a) Engineering works (20m south)	c1976-c1988	Heavy metals, arsenic, boron, free cyanide, nitrates, sulphates, sulphides, asbestos, aromatic

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
	(b) Works (20m south)	c1988-present	hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
33	Works (adjacent north)	c1988-present	
34	Works (25m west)	c1988-present	
35	Works (adjacent west)	c1988	
36	Sugar packing station (96m west)	c1971-c1980	Hydrocarbons, heavy oils, solvents
37	Flavour essences factory (130m southwest)	c1964-c1988	
38	Garage (95m south)	c1964-present	Hydrocarbons, MTBE, chlorinated hydrocarbons, chlorinated solvents, heavy metals, asbestos

On-site

F.1.13 The Dormay Street site has been developed with a number of previous uses that could be regarded as potentially contaminating, notably a corporation works located at the site between c1898 and c1980, electricity works between c1951 and c1968 and infilled land along Bell Lane Creek, as well as the more recent works and depots located largely within and bordering the southern section of the site.

Off-site

F.1.14 Within the 250m assessment area, the historical mapping shows that the area surrounding the Dormay Street site was heavily industrialised from the late 19th Century onwards. Historical land-uses include a gas works, tar works, wharves and unspecified works, which surround the site on all boundaries.

Geology

F.1.15 Data from the Thames Tideway Tunnel project ground investigation indicates the anticipated geological succession, as summarised in Vol 8 Table F.3.

Vol 8 Table F.3 Land quality – anticipated site geology

Geological unit / strata	Description	Approximate depth below ground level (m)
Made Ground	Largely comprises sandy gravelly silt with local gravels of brick, concrete and flint.	0.0 – 2.5
Alluvium	Soft and firm sandy slightly gravelly clay with occasional shell fragments.	2.5 – 3.17
River Terrace Deposits	Medium dense to dense to dense sand and gravel (predominantly quartz sand and flint gravel).	3.17 – 5.62
London Clay	Slightly sandy and silty fissured clay.	5.62 – 49.5

Unexploded ordnance

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

F.1.17 A desk based assessment for UXO threat was undertaken by 6 Alpha Associates Limited at the Dormay Street site (see Vol 8 Appendix F.3)[3]. The assessment covered three areas within the Dormay Street site (Area A – terrestrial work area to the north of Bell Lane Creek, Area B – river work area and Area C – terrestrial work area to the south of Bell Lane Creek). The report reviews information sources such as the Ministry of Defence (MoD), Public Records Office and the Port of London Authority (PLA).

F.1.18 The report establishes that there were no high explosive strikes within Area A, B or C, however one strike occurred within the buffered site boundary and a further three were recorded within 100m of the buffered site boundary. In addition, the site has not been noticeably developed since WWII and as such buried UXO items are unlikely to have been removed.

F.1.19 Taking into account the findings of this study and the known extent of the proposed works, it is considered that there is an overall low/medium threat from UXO within Area A, and a low threat from UXO within both Area B and C.

Thames Tideway Tunnel ground investigation data

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

F.1.21 Boreholes were drilled in the immediate vicinity of the Dormay Street site as part of the project-wide ground investigation, as shown on Vol 8 Figure F.1.2 (see separate volume of figures).

F.1.22 Vol 8 Figure F.1.2 (see separate volume of figures) also identifies a number of other boreholes excavated in the vicinity of the site; these are not considered relevant to the contamination status of the site due to their distance from the proposed shaft location or because certain boreholes were excavated purely for geotechnical purposes.

2009 investigation

F.1.23 Three boreholes (SA1105 (on-site), SA1106 and PR1107 (both to the west)) were drilled as part of the Thames Tideway Tunnel project ground investigation for the Dormay Street site. Although the investigation was primarily for geotechnical purposes, samples from the boreholes were tested for the presence of common contaminants to obtain preliminary information on the contamination status of soils and groundwater in the area.

Soil contamination testing

F.1.24 Eight soil samples comprising four samples of Made Ground, one sample of Alluvium, and three samples of London Clay encountered in the boreholes were sent for laboratory analysis.

F.1.25 The Made Ground in borehole SA1106 was recorded to have a slight hydrocarbon odour. Additionally ash and clinker were also noted in the Made Ground in all boreholes: this is commonly a source of PAHs.

F.1.26 The laboratory analysis comprised a suite of common contaminants that may be associated with the current and former industrial setting of the site and surrounding area.

F.1.27 The testing suite included the following contaminants: heavy metals and metalloids, PAHs, TPH, VOCs, Phenols, Cyanide, ammoniacal nitrogen, pH, soil organic matter content.

F.1.28 The testing record concentrations of the potential contaminants that are typical of soils in an older urban setting (eg some detectable PAHs and TPH). The testing did not; however, record contaminants above generic human health screening values[4,5] for light industrial land-use. These values consider risks to workers in the long term assuming that some open amenity space is provided.

F.1.29 Refer to Volume 2 Environmental assessment methodology for full guidance on the criteria used.

Groundwater contamination data

F.1.30 Refer to Section 13 Water resources – groundwater of this volume for information on groundwater quality.

Sediment quality analysis

F.1.31 No sediment quality testing has been undertaken in the Bell Lane Creek or River Wandle at the Dormay Street site.

2011 ground investigation data

F.1.32 A site investigation of the Wandsworth Depot area to the east of Dormay Street, was undertaken on behalf of Thames Tideway Tunnel project by Structural Soils Limited in May 2011[6].

F.1.33 The investigation comprised excavation of six cable percussive boreholes extending to depths of between 5.2m and 8.1m below ground level. The boreholes were all located south of the Bell Lane Creek (but are not shown on the accompanying drawing).

Soil contamination testing

F.1.34 16 soil samples (from various strata) were tested for a range of common metal , PAHs, TPH, phenols, cyanide, pH and soil organic matter.

F.1.35 Elevated concentrations of lead above the light industrial/commercial human health screening values that were used were found in three samples of Made Ground with a maximum of 11980mg/kg being recorded.

F.1.36 The Structural Soils Limited interpretative report concluded that some elevated TPH concentrations were recorded exceeding water pipeline guidance, but not human health screening values.

F.1.37 No substantial elevated concentrations of any other contaminants tested for were found in the soils tested.

Soil gas testing

F.1.38 Gas monitoring showed elevated methane (2.9%) and carbon dioxide (3.3%).

Third party ground investigation data

F.1.1 No third party ground investigation was available for review at the Dormay Street site.

Other environmental records

F.1.39 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 8 Table F.4. Pertinent records are discussed in further detail below.

F.1.40 The location of these records is shown on Vol 8 Figure F.1.3 (see separate volume of figures).

Vol 8 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	2
Historical landfill site	0	1
LA pollution prevention and control	1	4
Licensed waste management facility	0	5
Notification of installations handling hazardous substances	0	2
Past potential contaminated industrial	Areas of past potential contaminated	

Item	On-site	Within 250m of site boundary
uses	industrial uses are just present on-site and within 250m.	
Pollution incident to controlled water*	0	2
Registered waste transfer site	0	5
Registered waste treatment or disposal site	0	1

**Does not include regular CSO discharges*

F.1.41 Inspection of the data has identified an on-site local authority pollution prevention and control entry related to mobile screening and crushing process operations within the council depot.

F.1.42 There are a number of areas located within the 250m radius that are identified as having past potential contaminated industrial uses. It can be inferred that the past potential contaminating industrial uses can be attributed to various industries highlighted in the historical map review, which include former tar works, gas works, various unspecified works and depots as highlighted on Vol 8 Figure F.1.1 (see separate volume of figures). Contaminants associated with these types of previous land-use are identified in Vol 8 Table F.2.

F.1.43 Within 250m of the Dormay Street site, inspection of the data has identified two Controls of Major Accident Hazards site (COMAH) records and at the same site, two notifications of installations handling hazardous substances. These relate to the nearby former gas works and current gas holder station.

F.1.44 In addition, a historical landfill is located approximately 150m to the north and five waste transfer sites and one waste treatment and disposal sites are all located within the 250m of the Dormay Street site.

F.1.45 Two pollution incidents to controlled water are located within the 250m assessment area, the first located directly south of the site within the River Wandle and the second further south on Wandsworth High Street).

Land quality data from local authority

F.1.46 The LB of Wandsworth was consulted with respect to land quality information for this area. The full response is presented in Section F.2.

F.1.47 The council confirmed that the site is located in an industrial / commercial area and that the land-use within the surrounding area is as described above.

F.1.48 The response from the council describes that there may be minor localised areas of contamination in the area of the proposed development as a result of the historical industrial land-uses.

F.1.49 In addition to the information taken from the historical mapping, the council identified that a workshop located approximately 25m to the east of the site was used from 1956 to the early 1990s for small scale smelting of lead and is now used for stone cutting.

F.1.50 The council also noted that during the construction of an office block on the council depot, very high concentrations of arsenic (over 10,000mg/kg) were discovered in close association with intact timber members thought to have originally been used to protect the wharf walls.

Summary of contamination sources

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

a. ongoing contamination of underlying soil and groundwater from current industrial land uses and the council depot including above and below ground fuel tanks. Contaminants may include fuels, oils, and heavy metals.

b. soil and groundwater contamination associated with historical land-use, for example electricity works, corporation yard, laundry, lead smelting and Made Ground fill (Bell Lane Creek). Elevated lead and arsenic has been recorded locally and contaminants may also include other metals, hydrocarbons, VOCs, PAHs, PCBs and phenols.

c. sediment contamination in Bell Lane Creek and River Wandle, associated with historical industrial activities in the area. Contaminants may include PAHs, metals and pathogens.

d. potentially elevated ground gases or vapours from past development, fill material in the Bell Lane Creek or alluvial deposits.

e. potential UXO.

F.1.52 Off-site sources include historical and existing industries particularly the gas and tar works. Typical contaminants associated with these industries include hydrocarbons, phenolics, ammoniacal liquors, PAHs, cyanide and tar.

F.2 Local authority consultation

WANDSWORTH COUNCIL
Technical Services Department
Environmental Services & Community Safe
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: SR155941
Your ref:
Date: 11 May 2011

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

Dear Ms Brooks

Re: Dormay Street site, London, SW18

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

- The 1869 OS mapping shows the area to comprise terraced housing with gardens together with small scale industrial/commercial uses on adjacent land to the north and east. A malting plant was located 60m northeast and a brewery 150m southeast. A canal runs from the River Thames 120m east to the brewery site. Flour mills are located at 90m southeast and 140m north east on the River Wandle. A tidal inlet from the Thames comes to approximately 50m to the north of the site.
- The 1896 OS mapping shows the tidal inlet to be serving wharves. A Council Depot is in place on adjacent land to the north. A laundry is sited 70m northeast. A dyeworks operates from adjoining land to the west of the preferred site.
- The 1916 mapping shows few changes to the 1896 epoch other than the mill 90m southeast has become a laundry.
- By the 1930s the laundry had become a timer yard and the canal infilled. On the other side other the River Wandle, 120 northeast is a tar distillery that uses byproducts/waste from a gasworks further to the northeast. This arrangement is continued on the 1947 mapping. Note that at this time there is still the old terraced housing along the west side of Dormay Street.
- In the 1950s the area was developed to the current layout including demolition of the housing. The inlet/creek serving the wharves to the north was infilled to become part of the council depot (largely the parking area). A large electrical substation has been sited 100m to the north.

  In 1954 the site of preference was used for the manufacture and storage of waterproofing finishing materials. A change of use to the manufacture of metal

bearings occurred in 1974, becoming a refrigeration works in 1984. In 1991 the current use as an aerial manufacturer commenced. The land further north east off Dormay Street became used for a construction vehicle depot. A small workshop 25m to the east was used from 1956 to the early 1990s for the sorting and storage of scrap metals. For a short period this including small scale smelting of lead (in a crucible). It is now used for stone cutting.

During the construction of an office block on the council depot to the north very high concentrations of arsenic (over 10,000mg/kg) were discovered in the soil. Investigations revealed that this was associated with large intact timber members probably originally used to protect the wharf walls and left on the site. The surrounding soils were not affected other than where pieces of timber were present.

- The land in the area has alluvium as superficial deposits overlying a London Clay solid geology. The alluvium is classified as a minor aquifer but no abstractions are taken from it.
- A number of high explosive bombs are recorded to have fallen around but not on the area during the Second World War.

Based on the information within our possession we conclude that there may be minor localized areas impacted by contaminants in the area of interest, resulting from the variety of historical industrial uses, but this is unlikely to be widespread.

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

Yours sincerely,

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

F.3 Detailed Unexploded Ordnance (UXO) risk assessment

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 at: http://www.environment-agency.gov.uk/research/planning/33708.aspx. Accessed 25th March 2011.

[3] 6 Alpha Associates Limited. Detailed Unexploded Ordnance Risk Assessment. Study site: Work area PWH7X Dormay Street

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

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

[6] Structural Soils Limited *Dormay Street Intrusive Geoenvironmental Investigation* (May 2011)

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Detailed Unexploded Ordnance (UXO) Risk Assessment

Study Site: Work Area PWH7X – Dormay Street
Document Number: 336-RG-TPI-PWH7X-000001
Client Name: Thames Water
6 Alpha Project Number: P2853_R4_V2.0
Date: 17th May 2012

Originator: Max Chainey (14th May 2012)
Quality Review: Lisa Askham (16th May 2012)
Released by: Lee Gooderham (17th May 2012)

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Figures

EXECUTIVE SUMMARY

Study Site	The Client has specified the Study Site as Work Area PWH7X, located at National Grid Reference "525547, 174971". For the purposes of this report, the Site has been divided into **AREA A** (Land aspect of main Work Area), **AREA B** (River of main Work Area), and **AREA C** (Land aspect of main Work Area).		
Key Findings	In light of the research for this report, 6 Alpha has assessed the threat on this Site based on these pertinent facts: • **AREA A** is situated on what was predominantly developed land during World War Two (WWII). **AREA B** overlaps the *River Wandle*. **AREA C** is situated on what was undeveloped land during WWII. • Whilst no WWII bombing targets have been identified within **AREA A, B or C**, the *Wandsworth, Wimbledon and Epsom Gas Works* located approximately 100m to the northeast of the buffered Site boundary were a primary bombing target. • *Wandsworth Metropolitan Borough*, where the Site is located, experienced a bombing density of 160 High Explosive (HE) bombs per 1,000 acres. This is a relatively low to medium bombing density for *London*. • No HE bomb strikes occurred within **AREAS A, B or C**, however one strike occurred within the buffered Site boundary. A further three HE bomb strikes were recorded within 100m of the buffered Site boundary. • No bomb damage was recorded within **AREAS A, B or C**, however within the buffered Site boundary a structure was identified "seriously damaged; doubtful if repairable". • The Site has not been noticeably developed since WWII and thus is unlikely to have removed buried UXO items. 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** **LOW/MEDIUM**	**AREA B** **LOW**	**AREA C** **LOW**
Recommended Risk Mitigation	**The following actions are recommended before undertaking any activity on the Study Site:** **ALL AREAS** **1. Operational UXO Risk Management Plan;** appropriate site management documentation should be held on site in the event of a suspected or real UXO discovery. **2. UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of explosive ordnance encounter and are a vital part of the general safety requirement. **AREA A** **3. On-Site Banksman;** all open excavation works should be accompanied by an UXO Specialist to monitor works down to the maximum bomb penetration depth.		

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 PWH7X. The Site is located at National Grid Reference 525547, 174971. 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, B, and C** 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 within *Wandsworth*. It is located to the north of *Armoury Way* and immediately to the west of the *River Wandle*. *Bell Lane Creek* runs through the centre of the Site, from east to west. Current aerial photography has identified the following within each area: **AREA A:** Industrial structural developments. **AREA B:** *Bell Lane Creek.* **AREA C:** A car park and work area, with no major structural developments.
Proposed Engineering Works	*Thames Water* have specified a summary of the proposed engineering works, including working draft plans with drawing no. 100-DA-CVL-PWH7X-346020_AH, 100-DA-CNS-PWH7X-246105_AI and 100-DA-CNS-PWH7X-246106_AI. These works have been divided between **AREAS A, B, and C**, however where not explicitly stated, 6 Alpha has made an assumption of which area the work will be carried out. **Area A** • Demolition of some existing buildings on the construction site occupied by Keltbray Limited and Wandsworth Borough Council. • Construction of a 12m internal diameter shaft, approximately 35m deep. It is anticipated the shaft will be constructed using a sprayed concrete primary lining with a cast in-situ concrete lining. A pre-cast segmental lining could also be used as an alternative to the sprayed concrete. • Construction of 2.6m internal diameter connection tunnels, to King Georges Park (approximately 500m long), and to a main tunnel (approximately 550m long) connection near Hurlingham Wharf (within **AREA B and C** also). • An interception chamber upon the Frogmore-Storm relief sewer to intercept flows and enable the transfer of these to the main tunnel. • Construction of valve and passive filter chambers. • A length of connection culvert between the interception chamber and the shaft, including a valve chamber. • Installation, maintenance and removal of two, temporary construction working areas separated by Bell Lane Creek to facilitate the construction of the above. The shaft construction area (approximately 1120 m^2) will be located in an area currently occupied by commercial premises located between Dormay Street and Causeway carriageways A second additional construction area (approximately 1525 m^2) on the opposite bank of Bell Lane Creek will be provided.
Ground Conditions	Thames Water have indicated the following ground conditions for the Work Areas as:

Site Geology	Depth Below Ground Level (m)	Thickness (m)
Made Ground	0.00	3.00
Alluvium	3.00	0.50
River Terrace Deposits	3.50	3.00
London Clay	6.50	45.50
Lambeth Group	52.00	20.00
Thanet Sand	72.00	8.00
Seaford Chalk	80.00	Proven to 5.00

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

STAGE TWO – REVIEW OF HISTORICAL DATASETS	
Sources of Information Consulted	The following primary information sources have been used in order to establish the background UXO threat: 1. Home Office WWII Bomb Census Maps; 2. WWII & post-WWII Aerial Photography; 3. Official Abandoned Bomb Register; 4. National Archives in Kew; 5. Internet based research; 6. Historic UXO information provided by 33 Engineer Regiment (Explosive Ordnance Disposal) at Carver Barracks, Wimbish.
Site History and Use	According to the County Series (CS) & Ordnance Survey (OS) historical mapping, the following site history can be recorded immediately prior to and post-WWII: **1938 CS mapping – AREA A** is located on predominantly developed land consisting of unidentified structures. **AREA B** contains no development. **AREA C** is located on undeveloped land. **1949 OS mapping** – There are no significant or noticeable changes to the areas.
1945 Aerial Photography ***(Figure 4)***	The 1945 aerial photography confirms the following: **AREA A:** There is structural development within **AREA A** that is concomitant with mapping from 1938. Therefore we can infer that structures within this area are largely intact.
WWII Luftwaffe Bombing Targets ***(Figure 5)***	**ALL AREAS**: Primary targets have been identified as the *Wandsworth, Wimbledon and Epsom Gas Works* located approximately 100m to the northeast of the buffered Site boundary, and a "generating station" located on the boundary of the buffered Site boundary to the north. "Opportunistic" targets include railway stations and railway infrastructure, "depots", "engineering works", "chemical works" and "warehouses" all located within 1km of the Site.
WWII HE Bomb Strikes ***(Figure 6)***	Air Raid Precaution (ARP) reports indicate the following: **AREA A:** No bomb strikes. **AREA B:** No bomb strikes. **AREA C:** No bomb strikes. One bomb strike occurred within the buffered Site boundary and three 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. **AREA C:** No bomb damage. Within the buffered Site boundary to the southwest, a structure was labelled as "seriously damaged; doubtful if repairable".
WWII HE Bomb Density ***(Figure 8)***	The Study Site is located within the *Wandsworth Metropolitan Borough,* which recorded 160 HE bombs per 1,000 acres. This figure does not include incendiary devices, as they were often released in such large numbers that they were seldom recorded.
Abandoned Bombs	The Official Abandoned Bomb Register recorded one 250kg incendiary bomb approximately 1.7km to the northwest.

STAGE THREE – DATA ANALYSIS	
Was the ground undeveloped during WWII?	**AREA A:** No; the ground was predominantly developed. **AREA B:** Yes; this area overlaps the *River Wandle* and was undeveloped. **AREA C:** Yes; the land was undeveloped.
Is there a reason to suspect that the immediate area was a bombing target during WWII?	**ALL AREAS:** Yes; the Site is located only 100m from *Wandsworth, Wimbledon and Epsom Gas Works*, which was a primary target, and additionally is surrounded by numerous "opportunistic" targets.
Is there firm evidence that ordnance landed on Site?	**AREA A:** No. **AREA B:** No; but unlikely to have been recorded given the environment. **AREA C:** No. However, there is evidence of one bomb strike within the buffered Site boundary.
Is there evidence of damage sustained on Site?	**AREA A:** No. **AREA B:** No; but unlikely to have been recorded given the environment. **AREA C:** No. Within the buffered Site boundary, a structure was "seriously damaged" due to a bomb.
Is there any reason to suspect that military training may have occurred at this location?	**ALL AREAS:** No; there is no reason to suspect that the military has ever used this Site for training.
Would an UXB entry hole have been observed and reported during WWII?	**AREA A:** Likely; the land was industrially developed and no bomb damage occurred within this area that may have created debris. Therefore an UXB entry hole is likely to have been witnessed. **AREA B:** Unlikely; UXBs falling in the *River Wandle* are unlikely to have been observed and reported. **AREA C:** Likely; the land was undeveloped during WWII, with a high footfall and public highway around the periphery of this area. Therefore an UXB entry hole would have been witnessed and recorded.
What is the expected UXO contamination?	**ALL AREAS:** The most likely source of UXO contamination is from *German* aerial delivered ordnance, which ranges from small incendiary bombs through to large HE bombs (of which the latter forms the principal threat).
Would previous earthworks have removed the potential for UXO to be present?	**AREA A:** Unlikely; the changes to the area have not been significant as many of the buildings present during WWII are still present today. **AREA B:** No; no significant earthworks have occurred. **AREA C:** No; no significant earthworks have occurred.

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

STAGE FOUR – RISK ASSESSMENT (…continued)

UXO RISK CALCULATION TABLE

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

Activity	AREA A		
	Probability (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Enabling Works	1x1=1	3x2=6	1x6=6
Tunnelling	1x2=2	1x1=1	2x1=2
Shaft Installation	1x2=2	1x2=2	2x2=4
Open Excavations	1x2=2	2x2=4	2x4=8

Activity	AREA B		
	Probability (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Tunnelling	1x2=2	1x1=1	2x1=2

Activity	AREA C		
	Probability (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Tunnelling	1x2=2	1x1=1	2x1=2

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

STAGE FIVE – RECOMMENDED RISK MITIGATION MEASURES WITH RESULTING RISK RATING	
If a geophysical survey is required are the ground conditions an issue?	**Non-Intrusive Methods of Mitigation** – The suitability for an effective non-intrusive method of mitigation is largely dependent on the depth (3.0m for this Site) and composition of made ground, as any magnetometer results are highly likely to be affected by ferro-magnetic contamination due to previous construction activities within the Study Site location. **Intrusive Methods of Mitigation** – Intrusive magnetometry is expected to be possible on this Site, however deep excavation of made ground is required prior to the use of this methodology. It should be noted that ferro-contamination of any made ground/fill material, particularly at the fill layer, is likely to adversely affect detection capability of the equipment.

MITIGATION MEASURES TO REDUCE RISK TO 'ALARP'		
Activity	**Risk Mitigation Measures**	**Final Risk Rating**
ALL AREAS	**The following actions are recommended before undertaking any activity on the Study Site:** 1. **Operational UXO Risk Management Plan;** appropriate site management documentation should be held on site to plan for and guide upon the actions to be carried out in the event of a suspected or real UXO discovery. 2. **UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of explosive ordnance encounter and are a vital part of the general safety requirement. All personnel working on the site should receive a general briefing on the identification of UXB, what actions they should take to keep people and equipment away from the hazard and to alert site management. Posters and information of the general nature of the UXB threat should be held in the site office for reference and as a reminder.	ALARP
AREA A	3. **On-Site Banksman;** all open excavation works should be accompanied by an UXO Specialist to monitor works down to the maximum bomb penetration depth.	
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

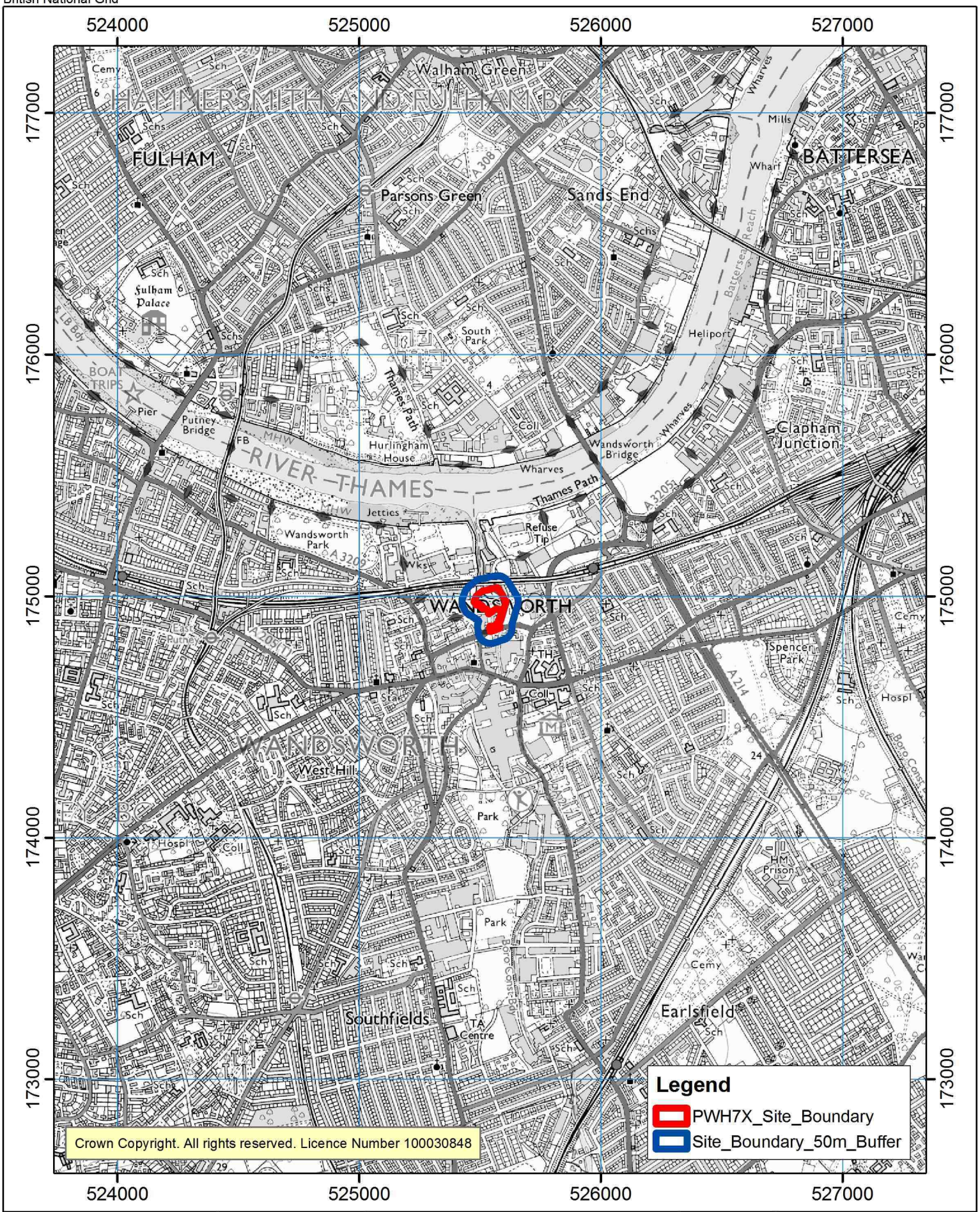
Figure One

Site Location

Thames Tideway Tunnel - Work Area PWH7X
Site Location

Figure 1

British National Grid



BOMB SEARCH

6 Alpha Associates Ltd.
Quatro House
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Surrey GU16 7ER
United Kingdom
www.6alpha.com
0203 371 3900

0 100 200 400 600 800 1,000 Meters

N

Project Number: P2853_PWH7X
Drawn By: Dominique René
Checked by: Lee Gooderham
Date: 14th May 2012

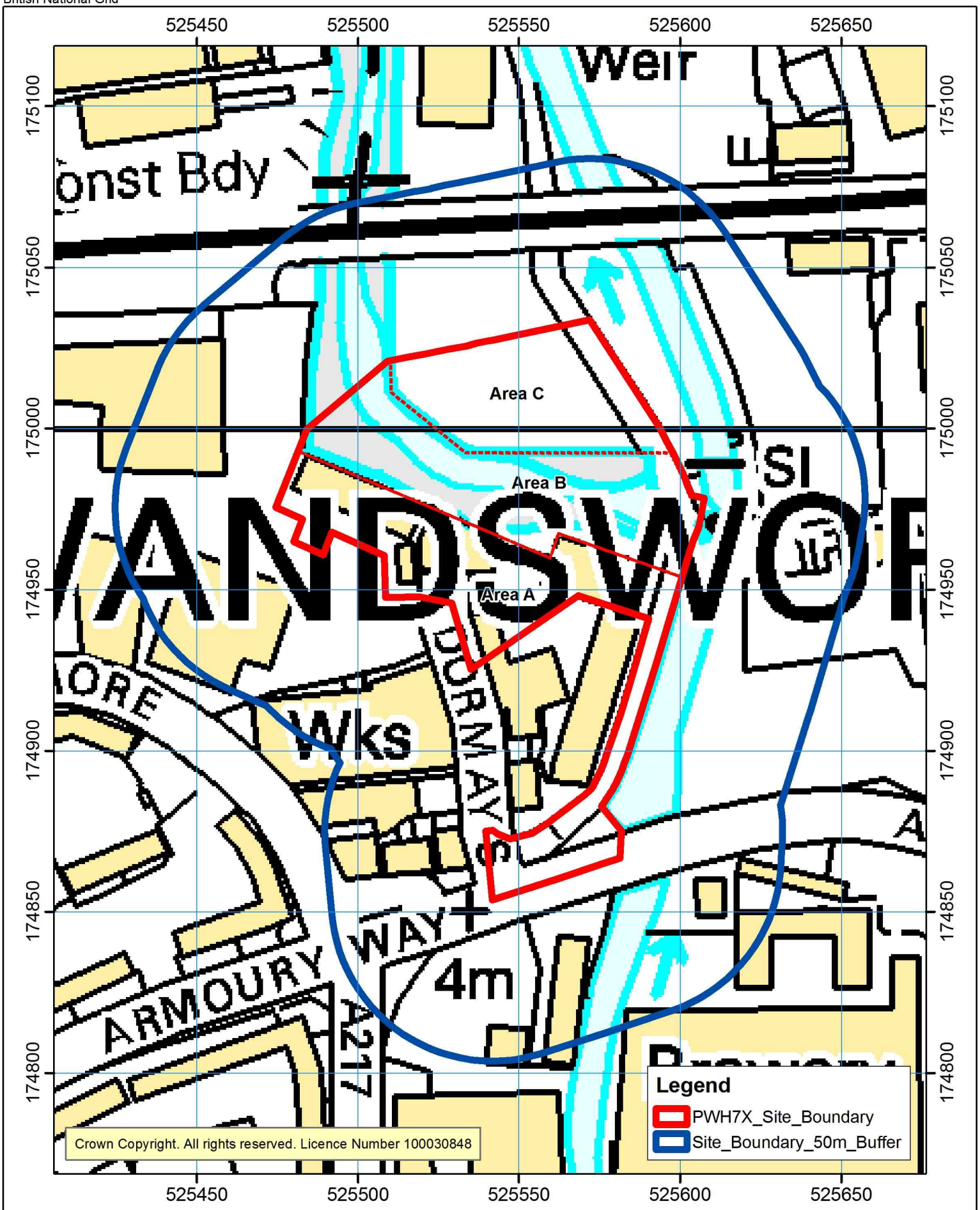
Figure Two

Site Plan

Thames Tideway Tunnel - Work Area PWH7X Site Boundary

Figure 2

British National Grid



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0 5 10 20 30 40 50 Meters

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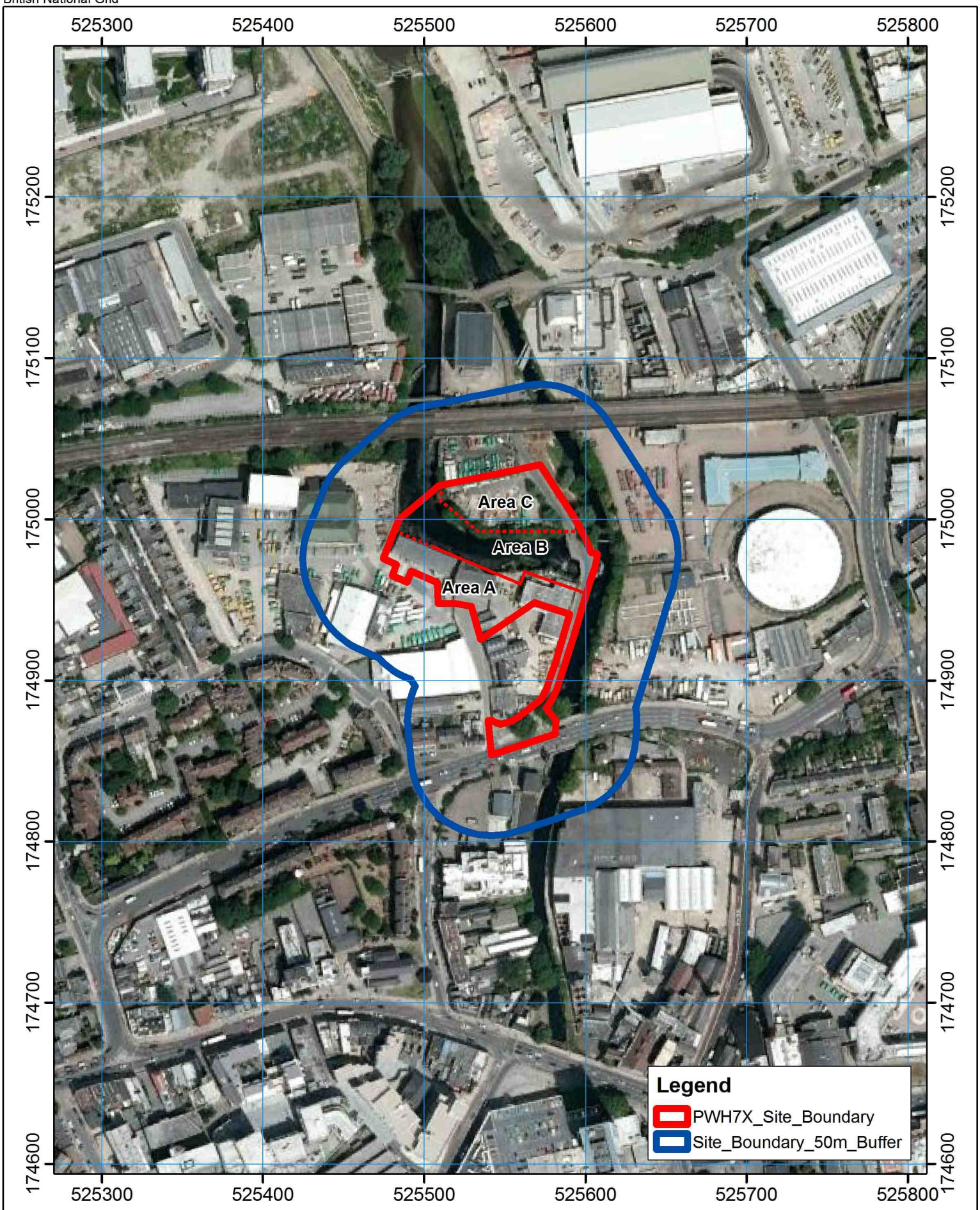
Figure Three

Current Aerial Photography

Thames Tideway Tunnel - Work Area PWH7X
Current Aerial Photography

Figure 3

British National Grid



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0 25 50 100 150 Meters

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Figure Four

1945 Aerial Photography

Thames Tideway Tunnel - Work Area PWH7X
1945 Aerial Photography

Figure 4

British National Grid

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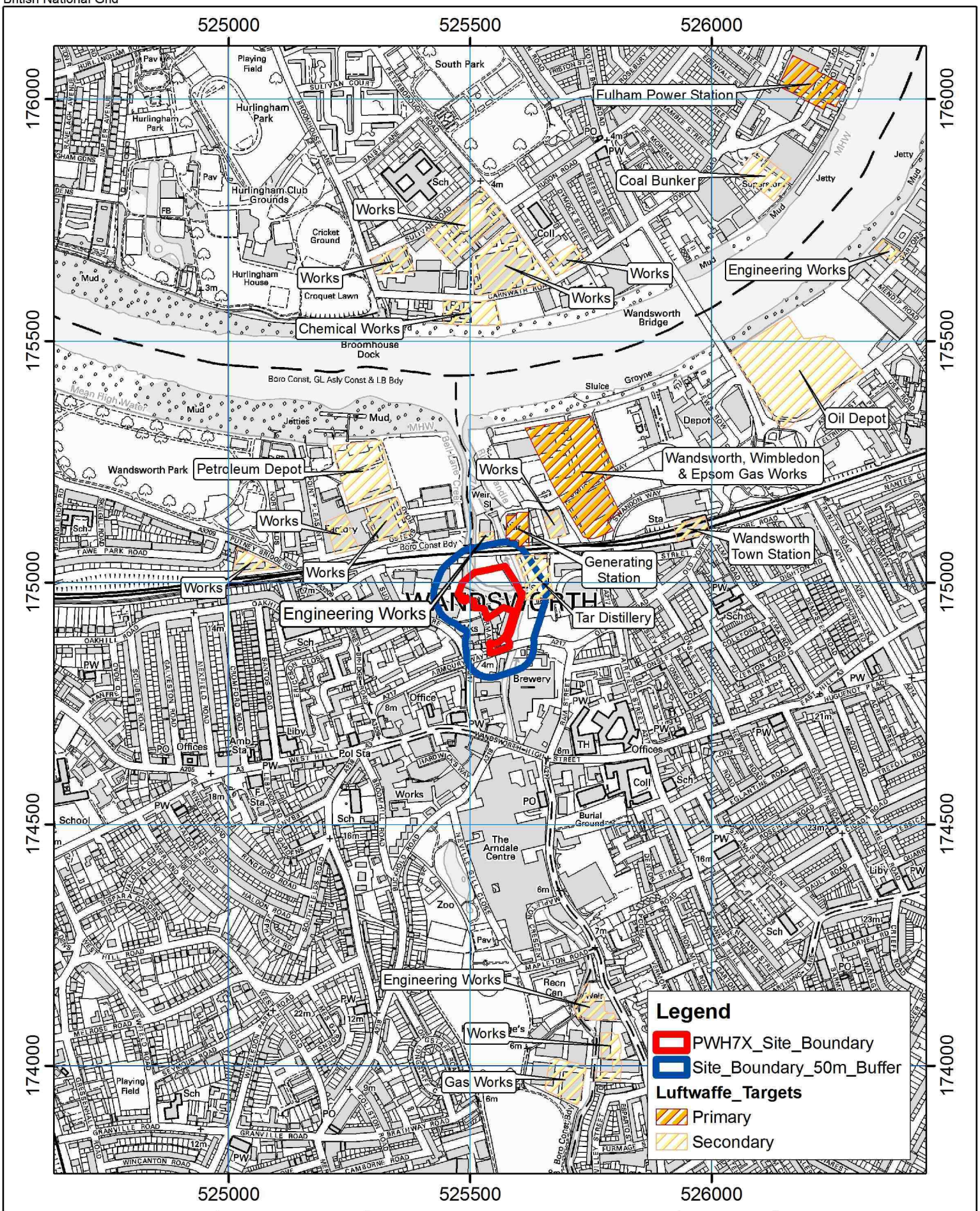
Figure Five

WWII Luftwaffe Bombing Targets

Thames Tideway Tunnel - Work Area PWH7X
WWII Luftwaffe Bombing Targets

Figure 5

British National Grid



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0 50 100 200 300 400 500 Meters

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Figure Six

WWII High Explosive Bomb Strikes

Thames Tideway Tunnel - Work Area PWH7X
WWII High Explosive Bomb Strikes

Figure 6

British National Grid

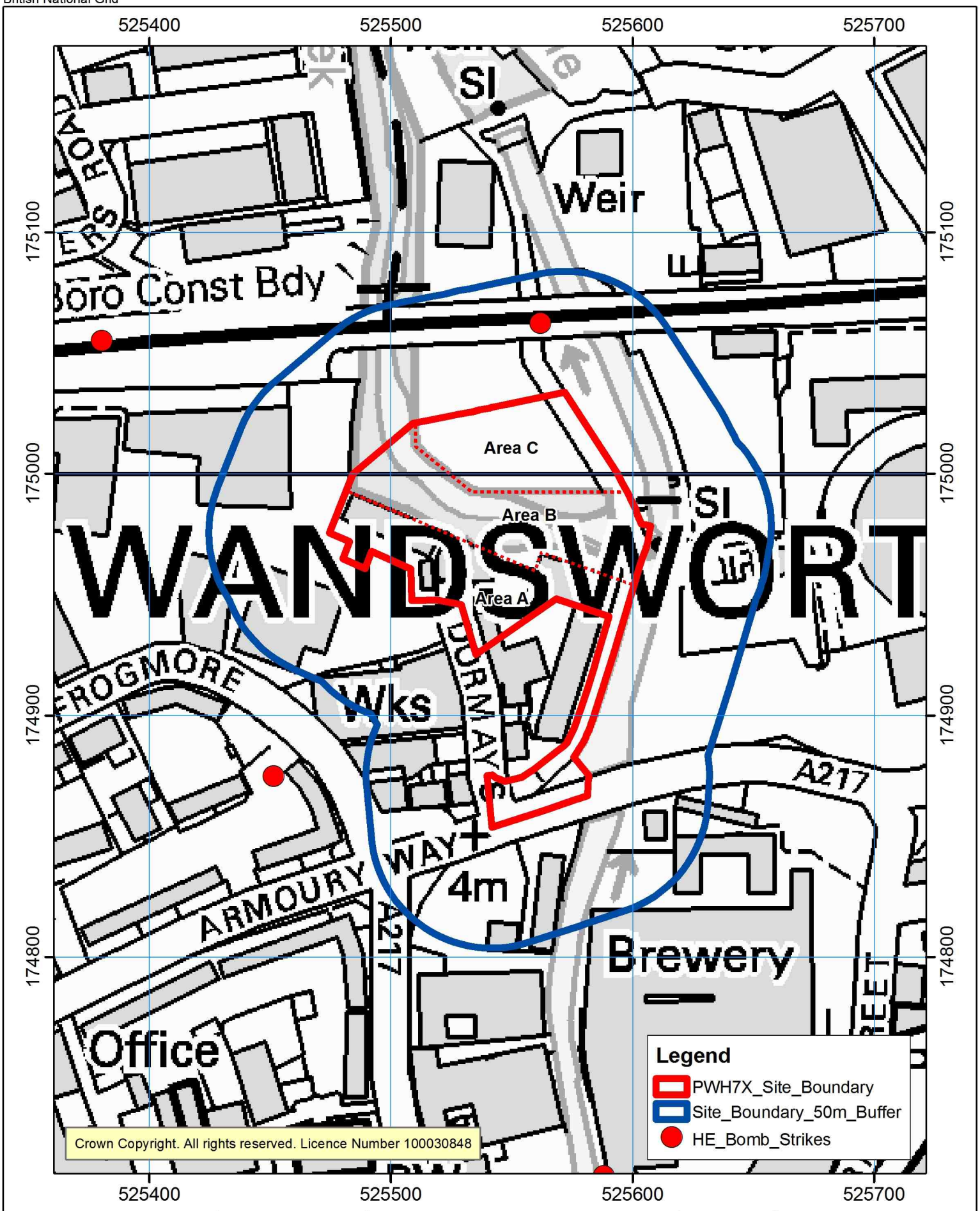

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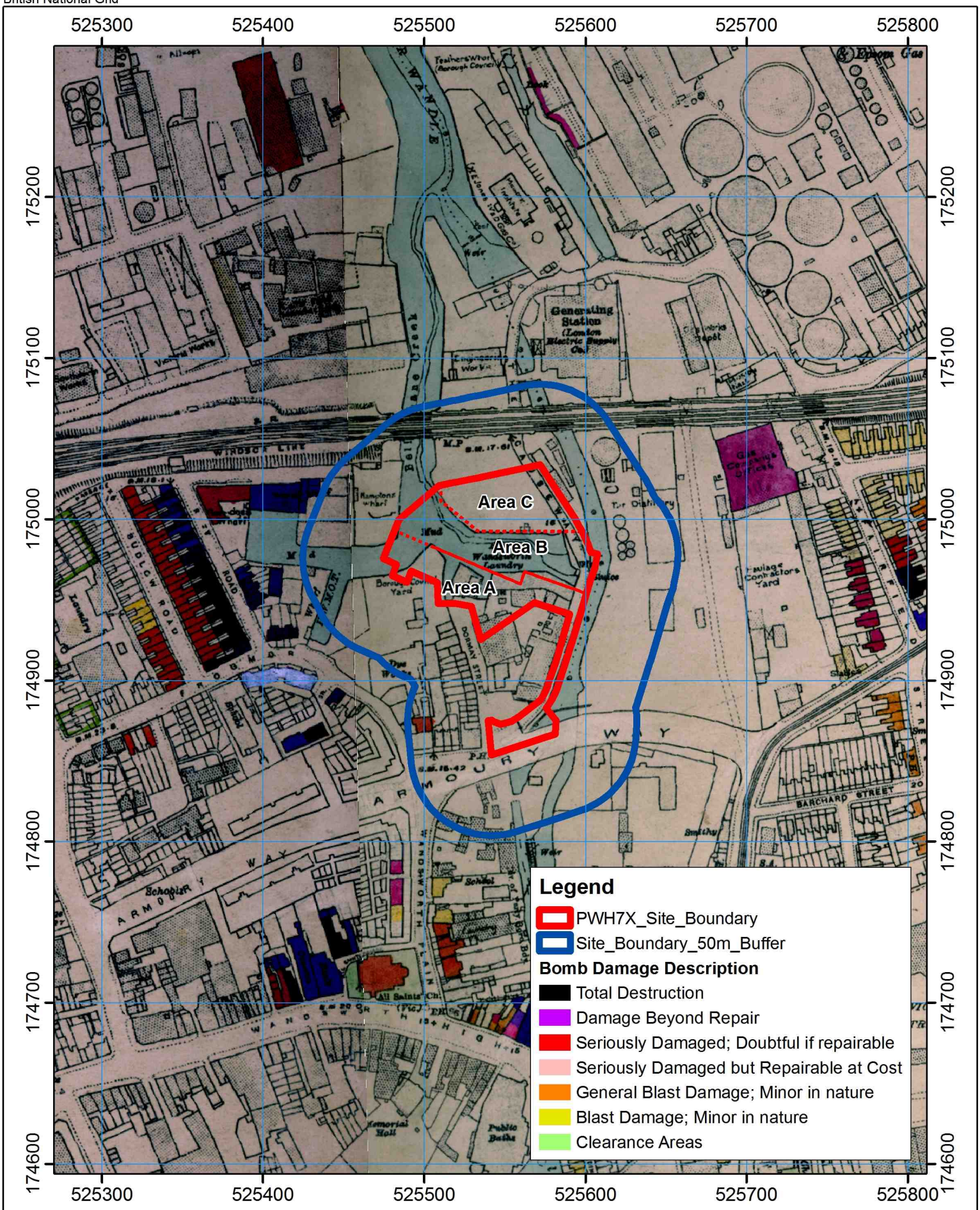
Figure Seven

London County Council Bomb Damage Mapping

Thames Tideway Tunnel - Work Area PWH7X
London County Council Bomb Damage Map

Figure 7

British National Grid



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0 25 50 100 150 Meters

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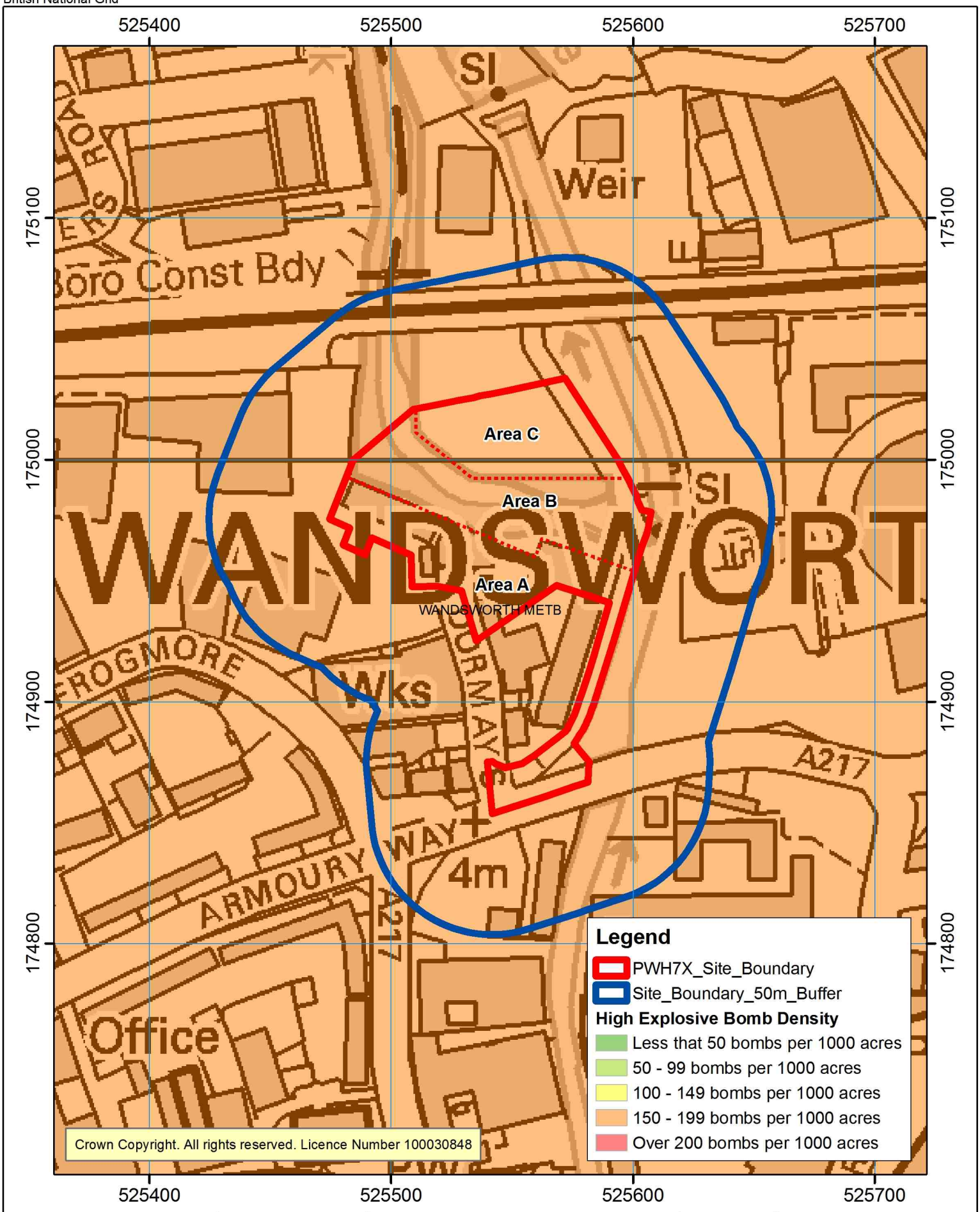
Figure Eight

WWII High Explosive Bomb Density

Thames Tideway Tunnel - Work Area PWH7X
WWII High Explosive Bomb Density

Figure 8

British National Grid



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Checked by: Lee Gooderham
Date: 14th May 2012

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.08**

Volume 8: Dormay Street 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 8 Appendices: Dormay Street site assessment

Appendix G: Noise and vibration

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Appendix G Noise and vibration

G.1 Baseline noise survey

Introduction

G.1.1 As described in Volume 2 Environmental assessment methodology Section 9, 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 Dormay Street are a mixture of two and three storey town houses located south of the proposed development along Armoury way (between Frogmore and Dormay Street) as well as properties within London Court along Frogmore. To the west are more residential properties along Sudlow Road as well as Wandsworth maintenance depot and other industrial buildings.

Survey methodology

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

G.1.4 An initial baseline noise survey was completed on 15th-16th June 2011 and additional data was collected on 3rd July 2011 and 10th October 2011. The baseline surveys comprised short term attended measurements taken during the daytime, evening and night-time, as well as completing continuous unattended monitoring.

G.1.5 Short term attended noise monitoring was completed at two 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 Continuous unattended noise monitoring was completed at one location within the private grounds of Wandsworth Council offices. Data was collected over a three day period (3rd to 5th July) in accordance with the survey methodology agreed with the Borough.

G.1.7 Vol 8 Table G.1 describes the survey equipment that was used to collect the baseline data at the site.

Vol 8 Table G.1 Noise – survey equipment

Item	Type	Manufacturer	Serial number(s)	Laboratory calibration date
Initial baseline survey: 15th-16th June, 2011				
Hand-held analyser(s)	2250	Brüel & Kjær	2626232	15/02/2010*
½ " microphone(s)	4189	Brüel & Kjær	2621211	15/02/2010*
B&K sound calibrator(s)	4231	Brüel & Kjær	2619375	12/01/2011*
Additional baseline survey: 3rd - 5th July, 2011				
Hand-held analyser(s)	2250	Brüel & Kjær	2626232 2435919	15/02/2010* 25/05/2011**
½ " microphone(s)	4189	Brüel & Kjær	2621211 2519772	15/02/2010* 12/05/2011**
B&K sound calibrator(s)	4231	Brüel & Kjær	2619375 2445811	12/01/2011* 14/10/2010**
Additional baseline survey: 10th October, 2011				
Hand-held analyser(s)	2250	Brüel & Kjær	2626231	20/01/2010*
½ " microphone(s)	4189	Brüel & Kjær	2621208	19/01/2010*
B&K sound calibrator(s)	4231	Brüel & Kjær	2619375	12/01/2011*

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

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

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

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

G.1.11 The prevailing weather conditions observed the attended baseline surveys are described in Vol 8 Table G.2.

G.1.12 Contemporary weather data recorded at Heathrow Airport (EGLL) has been summarised in Vol 8 Table G.3. This is deemed to be representative of the prevailing weather conditions for the continuous unattended monitoring kit.

Vol 8 Table G.2 Noise – weather conditions during baseline noise surveys

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation	Description
Initial baseline survey – 15th June, 2011 (daytime, 10:00-12:00)				
Maximum: 1.9-2.9 Average: 0.5-0.9	WSW; SW	20-21	No	Overcast, dry and breezy
Initial baseline survey – 15th June, 2011 (daytime, 14:00-16:00)				
Maximum: 2.3-4.3 Average: 0.6-1.0	SW	18-21	Yes - brief light rain observed)	Overcast and breezy
Initial baseline survey – 15th June, 2011 (evening, 20:00-22:00)				
Maximum: 1.7-4.4 Average: 0.5-1.0	SW	17-19	Yes - brief light rain observed)	Overcast and breezy
Initial baseline survey – 16th June, 2011 (night-time, 00:00-04:00)				
Maximum: 1.5-2.4 Average: 0.4-0.6	Variable, predominantly SW	15	No	Overcast, dry and calm
Additional baseline survey – 3rd July, 2011 (daytime, 14:00-18:00)				
Maximum: 1.2-2.7 Average: 0.4-1.0	Variable	23-25	No	Overcast and dry with occasional breeze

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation	Description
Additional baseline survey – 10th October, 2011 (night-time, 00:00-04:00)				
Maximum: 1.9-3.2 Average: 0.5-0.9	Westerly	17	No	Scattered cloud, dry and breezy

Vol 8 Table G.3 Noise – contemporary weather data for Heathrow Airport

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation	Description
Sunday 3rd July, 2011 (15:00 onwards)*				
1.6-3.6	Variable	19-23	No	Clear, dry and breezy
Monday 4th July, 2011**				
1.6-5.1	Variable	14-25	No	Clear, dry and breezy
Tuesday 5th July, 2011 (until 15:00)***				
1.6-5.7	Variable	13-25	No	Clear, dry and breezy

**http://www.wunderground.com/history/airport/EGLL/2011/7/3/DailyHistory.html*
***http://www.wunderground.com/history/airport/EGLL/2011/7/4/DailyHistory.html*
****http://www.wunderground.com/history/airport/EGLL/2011/7/5/DailyHistory.html*

Measurement locations

G.1.13 Vol 8 Table G.4 details the measurement locations which are also presented in Vol 8 Figure G.1 (see separate volume of figures), and shown in Vol 8 Plate G.1 to Vol 8 Plate G.3.

Vol 8 Table G.4 Noise – measurement locations

Measurement location number	Description	Co-ordinates	
		X	Y
DST01	On public footpath adjacent to Frogmore, beside London Court residential dwellings	525435	174906
DST02	On public footpath adjacent to Dormay Street, beside public house	525532	174872

Measurement location number	Description	Co-ordinates	
		X	Y
DST03	Within private grounds of Wandsworth Council offices, opposite back gardens of residential dwellings along Sudlow Road	525352	174969

Results

G.1.14 The range of values for each of the parameters collected during the baseline surveys are summarised in Vol 8 Table G.5 to Vol 8 Table G.7.

Vol 8 Table G.5 Noise – sampled noise survey results DST01

Location Detail: DST01, on public footpath adjacent to Frogmore, beside London Court residential dwellings						
Measurement period	**Noise level (dB(A) free-field)**			**Averaged ambient noise level, $dBL_{Aeq,15min}$**		**$dBL_{Aeq,15min}$ (rounded to nearest 5dB)**
	L_{AFmax}	**$L_{A90,15min}$**	**$L_{Aeq,15min}$**	**Free field**	**Façade**	**Façade**
Daytime (10.00-12.00, 14.00-16.00)	86	50	57-60	59	62*	60
Evening (20.00-22.00)	72	46	52-54	53	56*	55
Night (00.00-04.00)	70	37	41-49	45	48*	50
Weekend day (14.00-18.00)	78	45	53-61	57	60*	60
Weekend night (00.00-04.00)	64	39	43-47	45	48*	50

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

Vol 8 Table G.6 Noise – sampled noise survey results DST02

Location Detail: DST02, on public footpath adjacent to Dormay Street, beside public house						
Measurement period	**Noise level (dB(A) free-field)**			**Averaged ambient noise level, $dBL_{Aeq,15min}$**		**$dBL_{Aeq,15min}$ (rounded to nearest 5dB)**
	L_{AFmax}	**$L_{A90,15min}$**	**$L_{Aeq,15min}$**	**Free field**	**Façade**	**Façade**
Daytime (10.00-12.00, 14.00-16.00)	90	60	69-71	67*	70	70
Evening (20.00-22.00)	80	54	67-68	64*	67	65
Night (00.00-04.00)	70	37	41-49	45*	48	50
Weekend day (14.00-18.00)	87	55	67-69	65*	68	70
Weekend night (00.00-04.00)	64	39	43-47	45*	48	50

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

Vol 8 Table G.7 Noise – continuous noise survey results DST03

Location Detail: DST03, within private grounds of Wandsworth Council offices, opposite back gardens of residential dwellings along Sudlow Road							
Day	**Period**	**Period noise level (dB(A) free-field)**			**Period noise level (dB(A) façade)**		
		L_{AFmax}	**L_{A90}**	**L_{Aeq}**	**L_{AFmax}**	**L_{A90}**	**L_{Aeq}**
Weekday	07.00-08.00	86	43	55	89	46	58
	08.00-18.00	89	44	56	92	47	59
	18.00-19.00	79	44	55	82	47	58
	19.00-22.00	81	42	53	84	45	56
	22.00-07.00	76	35	48	79	38	51

Location Detail: DST03, within private grounds of Wandsworth Council offices, opposite back gardens of residential dwellings along Sudlow Road							
Day	**Period**	**Period noise level (dB(A) free-field)**			**Period noise level (dB(A) façade)**		
		L_{AFmax}	**L_{A90}**	**L_{Aeq}**	**L_{AFmax}**	**L_{A90}**	**L_{Aeq}**
Sunday	07.00-21.00*	88	35	55	91	38	58
	21.00-07.00	81	39	55	84	42	58

**The data presented in this row is deemed to be representative of the reference period. The continuous monitor collected data from 15:00 onwards. Baseline condition photographs specific to topics.*

Vol 8 Plate G.1 Noise measurement location DST01

Note: On public footpath adjacent to Frogmore, looking southwest towards London Court

Vol 8 Plate G.2 Noise measurement location DST02

Note: On public footpath adjacent to Dormay Street, looking north

Vol 8 Plate G.3 Noise measurement location DST03

Note: Within private grounds of Wandsworth Council offices, looking west towards back gardens of residential dwellings along Sudlow Road

G.2 Construction noise prediction results

G.2.1 The construction noise prediction methodology follows the methodology provided in Vol 2 Section 9.

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 Vol 8 Table G.8.

G.2.4 Time histories of the predicted daytime construction noise levels across the programme of construction works are shown in Vol 8 Plate G.4 to Vol 8 Plate G.8.

Vol 8 Table G.8 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	BS5228-11: 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	5	BS5228-1: Table C.4, Item 71	Circular bench saw,
	Cutting equipment (diamond saw)	1	108	5	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 C.5, Item 5	Compressor for hand-held pneumatic breaker, 1 t
	Hand-held percussive breaker	1	111	30	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker
	Waste collection via skip or tipper lorry	1	106	10	BS5228-1: Table C.8, Item 21	Skip wagon
	Oxyaceteline cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
Site set up and general site	Oxyaceteline cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
	JCB with hydraulic breaker	1	116	10	BS5228-1: Table C.5,	Backhoe mounted

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
					Item 1	hydraulic breaker
	Cutting equipment (diamond saw)	1	108	10	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	Compressor 250cfm	1	93	50	BS5228-1: Table C.5, Item 5	Compressor for hand-held pneumatic breaker, 1 t
	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
	Water settling/treatment	1	104	100	Measured	Dirty water plant
	Hiab lorry/crane	1	105	5	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Wheel wash	1	91	20	BS5228-1: Table C.3, Item 13	Water Jet Pump
	Generator - 200 kVA	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator
	Well drilling Rig	1	107	50	Manufacturer	BauerBBA well drilling rig
Demolition General site equipment also	Service Crane 25T mobile Crane	1	98	30	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	22T Excavator c/w hydraulic hammer	1	116	30	BS5228-1: Table C.5, Item 1	Backhoe mounted hydraulic breaker

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
applicable during this phase	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
Piling for shaft/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 General site equipment also applicable during this phase	Concrete deliveries (aggitating)	1	99	80	BS5228-1: Table C.4, Item 19	Cement mixer truck (idling)
	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging)
	25t excavator	1	97	80	BS5228-1: Table C.2, Item 25	Tracked excavator, 15 t
	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	Vent fans	1	90	100	Estimated	Ventilation plant
	25t mobile crane	1	98	20	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
	Sump pump	4	95	100	BS5228-1: Table D.7, Item 65	Draining trench water pump
	Pneumatic breakers	4	111	20	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
Long connection tunnel construction, (TBM assembly)	500t mobile (TBM assembly only)	1	106	25	BS5228 Table C 4, Item 38	Wheeled mobile telescopic crane, 400 t
	100t mobile (TBM assembly only)	1	106	25	BS5228 Table C 4, Item 38	Wheeled mobile telescopic crane, 400 t
Long connection tunnel drive General site equipment also applicable during this phase	100t crawler crane	1	106	50	BS5228 Table C 4, Item 38	Wheeled mobile telescopic crane, 400 t
	Mains substation	1	100	100	Measured	Diesel generator, 800kVA
	Air compressor 600cfm	1	98	50	BS5228-1: Table D.6, Item 41	Compressor
	Grout mixer including silos and feeders	1	95	50	Measured	Batching
	Loading shovel	1	116	30	BS5228-1: Table C.9,	Wheeled loader

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
					Item 10	
	Flatbed trucks for materials haulage	1	105	20	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Flatbed trucks for segment haulage	1	105	20	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Dumper	2	104	30	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Telehandler 5t	2	99	80	BS5228-1: Table C.2, Item 35	Telescopic handler, 10 t
	Dewatering pumps 150mm submersible	3	104	100	BS5228-1: Table C.4, Item 88	Water pump
	Ventilation fans - set	1	100	100	Measured	Ventilation fans
	Waste water treatment plant	1	104	100	Measured	Dirty water plant
Long connection tunnel secondary lining General site equipment also applicable during this phase	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging)
	Air compressor 600cfm	1	93	100	BS5228-1: Table C.5, Item 5	Compressor for hand-held pneumatic breaker, 1 t
	Mains substation	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator
	Sump pumps 150mm	2	96	100	BS5228-1: Table C.4, Item 88	Water pump (diesel), 100 kg
	Waste water treatment plant	1	104	100	Measured	Dirty water plant

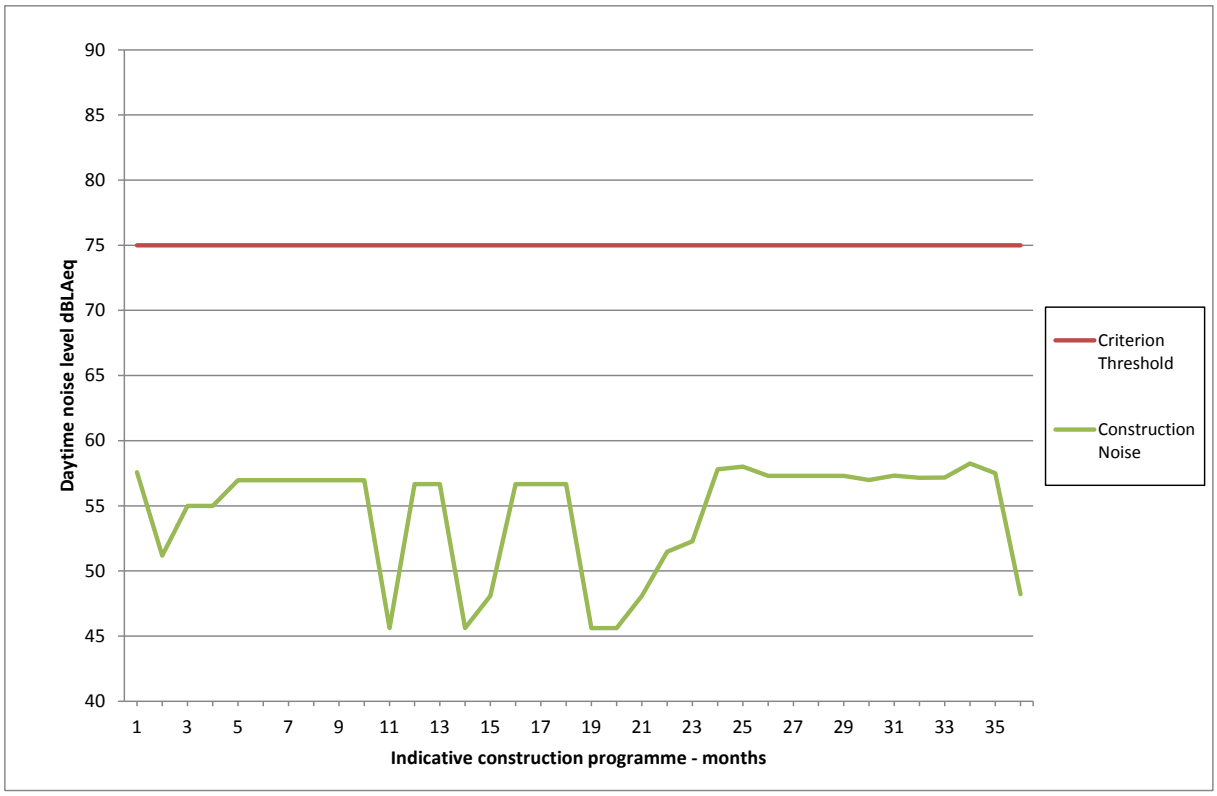
Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
Shaft secondary lining	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	Service Crane 40T mobile Crane	1	98	25	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	Hand tools (e.g. drills and wrenches)	4	95	80	Estimated	Impact wrench and compressor
	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging)
	Concrete pump	2	95	20	BS5228-1: Table C.4, Item 24	Concrete pump + cement mixer truck (discharging), 8 t / 350 bar
	Fixed and portable concrete vibrators	4	95	20	BS5228-1: Table C.4, Item 33	Poker vibrator
Culvert and chamber works General site equipment also applicable during this phase	Service crane - 100T mobile crane	1	99	50	BS5228-1: Table C.4, Item 41	Mobile telescopic crane, 100 t
	25t excavator	1	97	50	BS5228-1: Table C.2, Item 25	Tracked excavator, 15 t
	Dumper	1	104	50	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging)
	Concrete boom pump	1	108	20	BS5228-1: Table C.4, Item 29	Truck mounted concrete pump + boom arm, 26 t

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
	Fixed and portable concrete vibrators	4	102	20	BS5228-1: Table D.6, Item 20	Poker vibrator
	Hand tools (e.g. drills and wrenches)	4	95	80	Estimated	Impact wrench and compressor
Landscaping General site equipment NOT applicable during this phase	25t excavator	1	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
	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

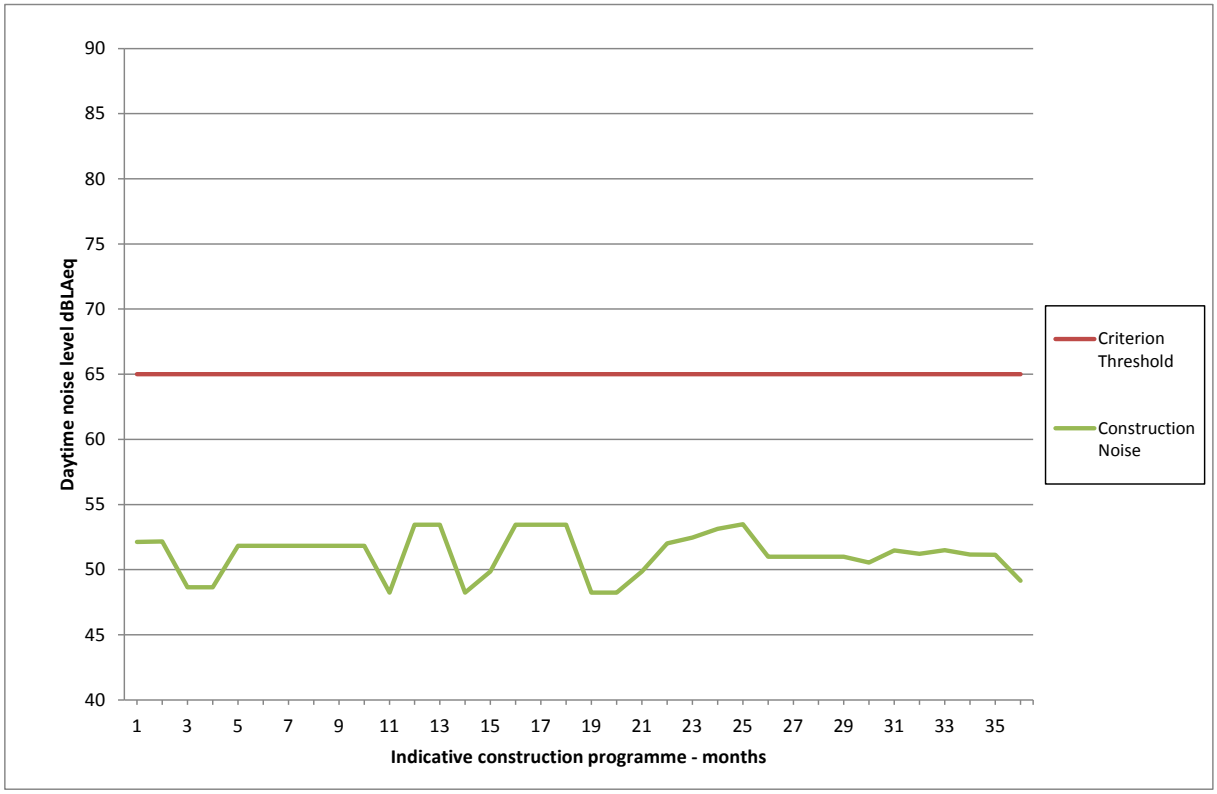
Note: This schedule provides an illustration of typical plant that could be used in the construction of the Thames Tideway Tunnel at this site. The appointed Contractor must comply with section 6 of the CoCP but may vary the method and plant to be used. This schedule therefore represents the most reasonable 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 plates 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 but not presented here.

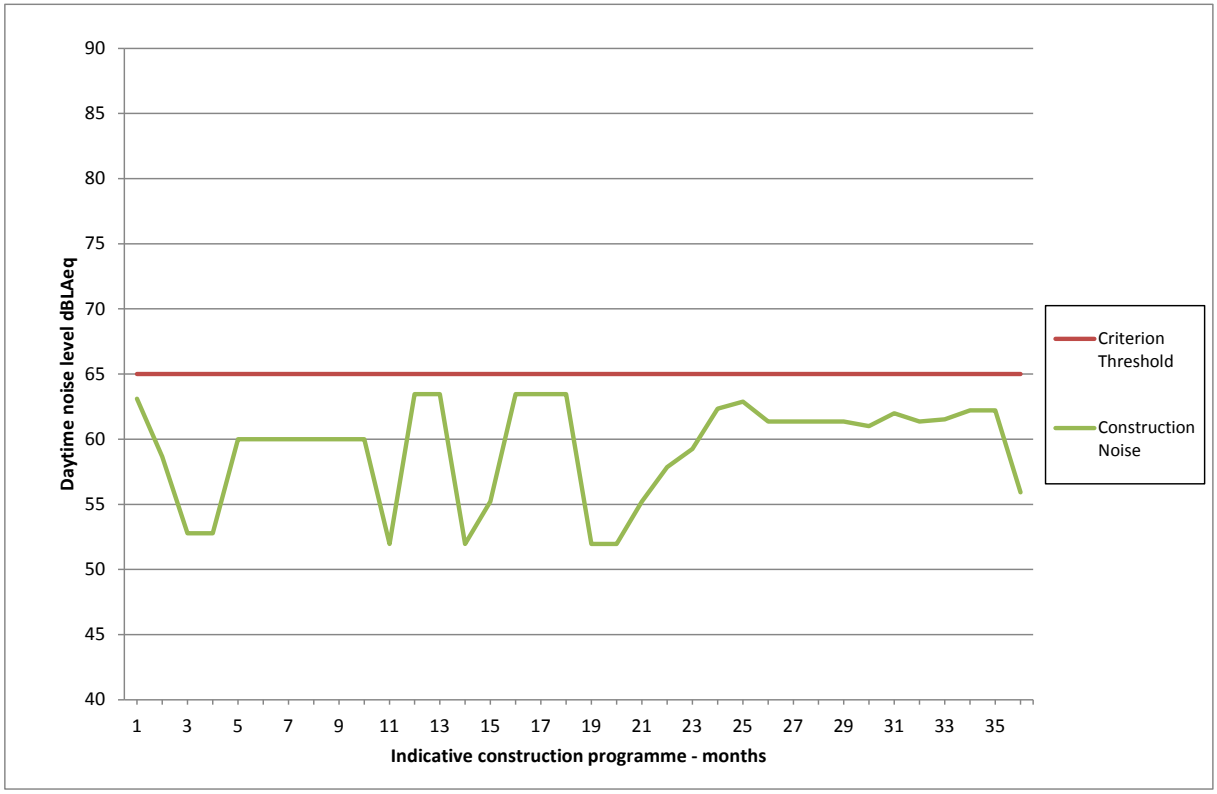
Vol 8 Plate G.4 Average monthly daytime noise level over duration of construction – 16-22 Armoury Way (DS1)



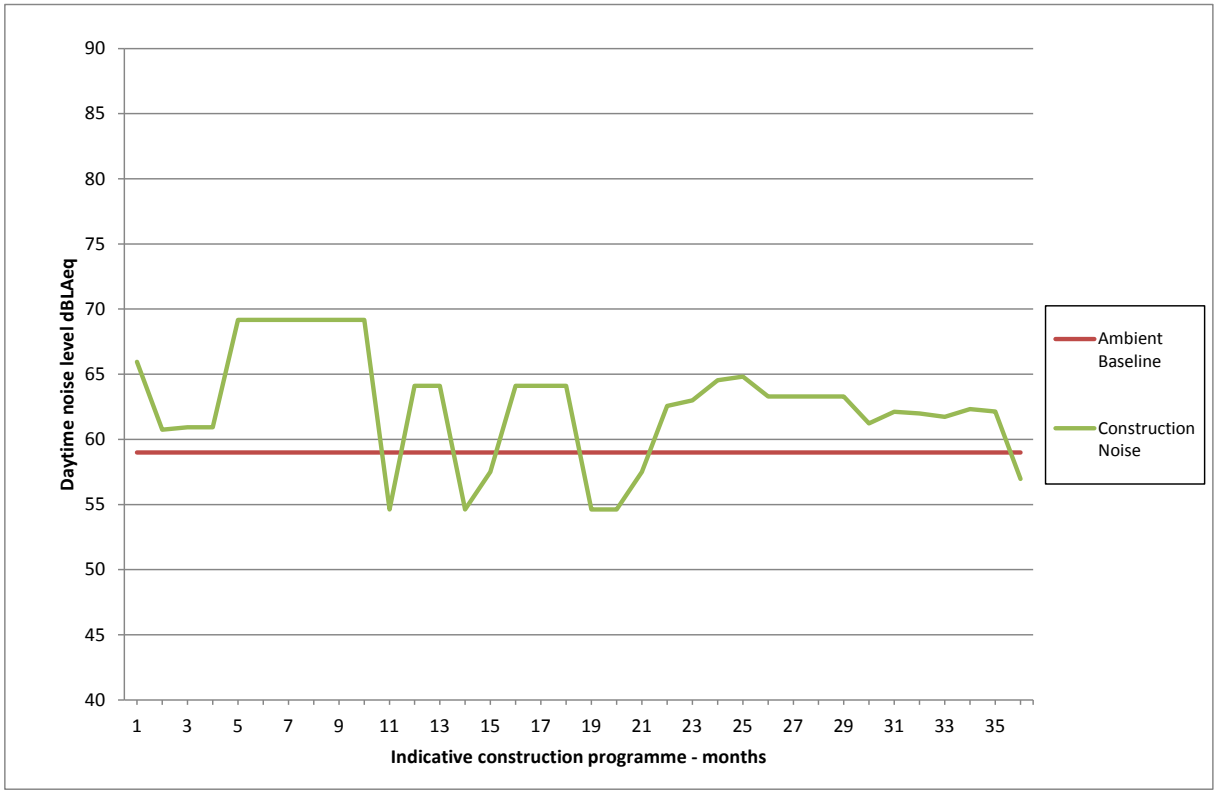
Vol 8 Plate G.5 Average monthly daytime noise level over duration of construction – 8-13 London Court (DS2)



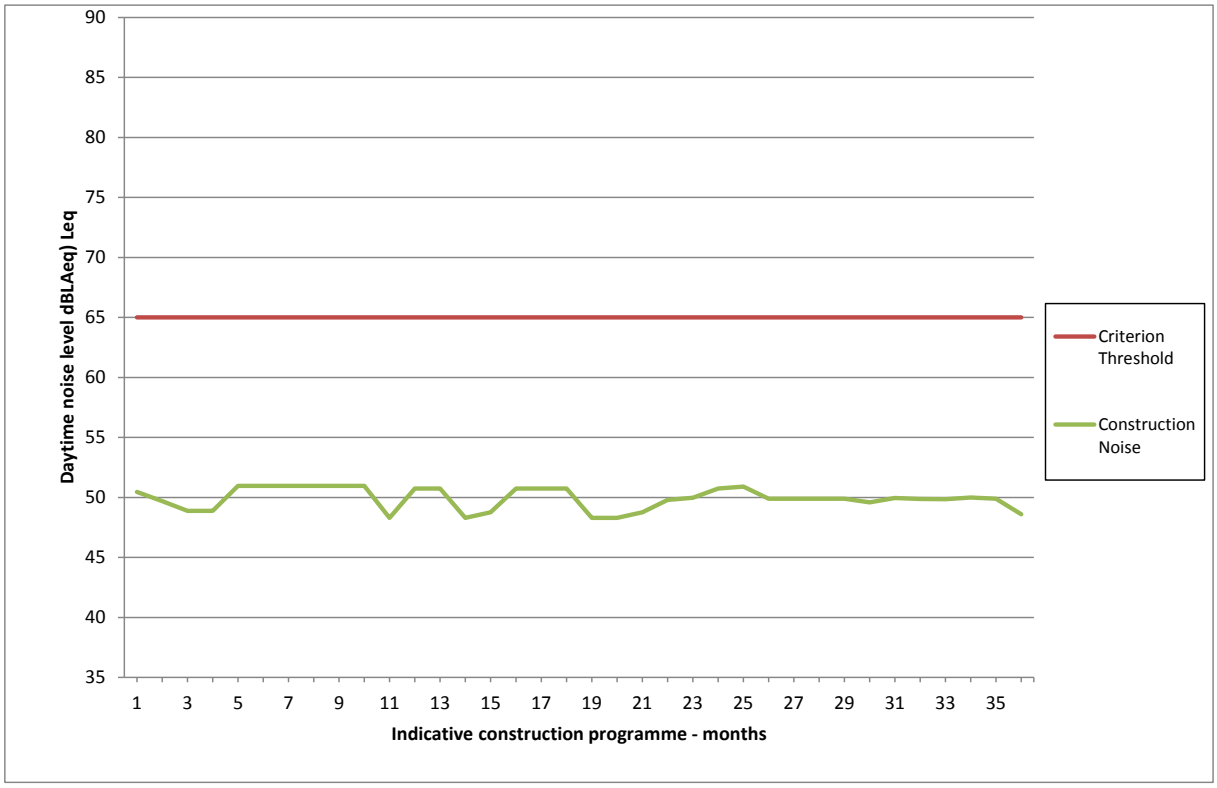
Vol 8 Plate G.6 Average monthly daytime noise level over duration of construction – 28-51 Sudlow Road (DS3)



Vol 8 Plate G.7 Average monthly daytime noise level over duration of construction – Frogmore Complex (DS4)



Vol 8 Plate G.8 Average monthly daytime noise level over duration of construction – 1-20 Enterprise Way (DS5)



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[1] 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: **6.2.08**

Volume 8: Dormay Street appendices

Appendix H: Socio-economics

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Appendix H: Socio-economics

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Appendix H: Socio-economics

H.1 Baseline community profile

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

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

H.1.3 The main protected characteristic group concentrated within the wider local area surrounding the proposed construction site is persons suffering from income deprivation and overall deprivation.

Resident population

H.1.4 The resident population was approximately 875 people within 250m of the site and approximately 22,800 within 1km of the site at the time of the last census.

Gender and age

H.1.5 Of the total population within 250m, female residents account for 51.9% of the population. Within 1km (52.2%) and within the LB of Wandsworth (52.5%) females are also predominant.

H.1.6 Vol 8 Table H.1 outlines age breakdown by assessment area, it illustrates that within 250m, the proportion of under 16 year olds (13.0%) is slightly lower than within 1km (16.3%) and the LB of Wandsworth (16.3%) level and moderately lower than the Greater London average (20.2%).

H.1.7 The proportion of 65 year olds within 250m (5.3%) is moderately lower than within 1km (9.0%) and the LB of Wandsworth (10.4%), and considerably lower than the Greater London average (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 8 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	13.0%	16.3%	16.3%	20.2%
Over 65 years old	5.3%	9.0%	10.4%	12.4%

Ethnicity

H.1.8 Vol 8 Table H.2 outlines ethnicity by assessment area, showing that within the proportion of White residents within 1km of the site (81.0%) and within the LB of Wandsworth (78.0%) is slightly higher than the proportion within 250m (73.0%) which in turn is comparable to Greater London (71.2%).

H.1.9 The proportion of Asian residents within 250m (5.5%) is similar to that within 1km (4.9%), somewhat lower than within the LB of Wandsworth (7.0%) and considerably lower than within Greater London (12.1%).

H.1.10 The proportion of Black residents within 250m (16.2%) is considerably higher than within 1km (8.7%), within the LB of Wandsworth (9.6%) and across Greater London (10.9%).

Vol 8 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	73.0%	81.0%	78.0%	71.2%
BME	27.0%	19.0%	22.1%	28.8%
Asian	5.5%	4.9%	7.0%	12.1%
Black	16.2%	8.7%	9.6%	10.9%
Other	1.3%	2.1%	2.1%	2.7%
Mixed	3.9%	3.3%	3.4%	3.2%

The figure for BME data presented in Vol 8 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, Christians are the predominant religious group at 57.4%, 63.9% and 61.8% respectively. Muslims are the second most predominant religious group accounting for 7.1% of residents within 250m of the site, slightly higher than the proportion within 1km (5.0%) and the borough overall (5.2%).

H.1.12 Within 250m, the proportion of residents who do not follow a religion (32.4%) is slightly higher than within 1km (28.9%) and somewhat higher than the proportion across Greater London (24.4%).

Health indicators

H.1.13 Vol 8 Table H.3 outlines health indicators by assessment area, noting that within 250m of the site, the proportion of residents who suffer from a long term or limiting illness (9.9%) is somewhat lower than within 1km (11.4%) and within the LB of Wandsworth (13.4%). The proportion within Greater London (15.5%) is higher than all of the above areas.

H.1.14 The proportion of residents who claim disability living allowance within 250m (4.3%) is broadly in line with claimant levels within the LB of Wandsworth (3.9%) and Greater London (4.5%). The proportion of claimants within 1km (3.5%) is somewhat lower than within Greater London.

Vol 8 Table H.3 Socio-economics – health indicators by assessment area

Health indicator	Assessment area			
	Immediate area (250m)	Wider local are (1km)	Borough wide (LB of Wandsworth)	Greater London
Long term limiting sick	9.9%	11.4%	13.4%	15.5%
Disability living allowance	4.3%	3.5%	3.9%	4.5%

H.1.15 For the Middle Layer Super Output Area (MSOA)[iii] in which the construction site falls, levels of adult obesity are in the lowest quintile (ie, the lowest being the best) relative to Greater London. Child obesity falls within the middle quintile compared with other Greater London boroughs.

H.1.16 Adults in LB of Wandsworth rank amongst the most physically active in comparison with other Greater London boroughs. By contrast, children are amongst the least physically active relative to Greater London.

H.1.17 For death rates by circulatory disease, respiratory disease, heart disease and stroke, the local MSOA ranks in the lowest or second lowest (ie, the best) quintile relative to Greater London. Death rates by cancer are slightly more prevalent and the local MSOA falls within the middle quintile.

H.1.18 For male and female life expectancy, the MSOA (Office of National Statistics , 2012)[5] ranks within the second highest quintile relative to Greater London (ie, the highest being the best). Life expectancy for both males and females averages 83.2 to 84.9 years.

[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.

Lifestyle and deprivation indicators

H.1.19 Vol 8 Table H.4 outlines lifestyle and income deprivation indicators by assessment area, showing that the proportion of households without cars within 250m of the site (47.0%) is somewhat higher than the proportions within 1km (39.1%) and the LB of Wandsworth. The proportion of households without cars in the above areas is slightly higher than the Greater London average (37.5%).

H.1.20 The incidence of income deprivation[iv] within 250m is 38.7%, moderately higher than within 1km (18.6%) and slightly higher than within Greater London (30.8%).

H.1.21 The incidence of overall deprivation within 1km (12.7%) is broadly in line with the borough wide level (10.1%) and considerably lower than within Greater London (24.5%). The incidence of overall deprivation within 250m is higher still (38.7%).

Vol 8 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	47.0%	39.1%	40.7%	37.5%
Income	38.7%	18.6%	15.4%	30.8%
Overall	38.7%	11.6%	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 Dormay Street.

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

H.2.3 Data 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 3,000 jobs.[vi] Vol 8 Table H.5[vii] illustrates the breakdown of employment by sector based on the UK Standard Industrial Classification (SIC) 2007[7]. It presents data for those sectors which account for more than 5% of total employment within 250m. It can be seen that:

a. Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles accounts for 28% of employment within 250m, double that within the LB of Wandsworth (14%) and considerably more than within Greater London (16%).

b. Accommodation and Food Service Activities account for 14% of employment within 250m, considerably more than within both the LB of Wandsworth (9%) and Greater London (8%).

c. Administrative and Support Service Activities account for 8% of employment across all three geographical areas.

d. Manufacturing accounts for 7% of employment within 250m, more than double that within the LB of Wandsworth and Greater London (both 3%).

e. Information and Communication accounts for 5% to 7% of employment across all three geographical scales.

f. Transportation and Storage accounts for 6% of employment within 250m, double that within the LB of Wandsworth (3%) and considerably more than within Greater London (4%).

[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.

g. Arts, Entertainment and Recreation accounts for 5% of employment within 250m, considerably more than within both the LB of Wandsworth and Greater London (both 3%).

h. Financial and Insurance Activities account for 5% of employment within 250m, more than double that within the LB of Wandsworth (2%) and slightly more than within Greater London (4%).

Vol 8 Table H.5 : Socio-economics – employment by top eight sectors (2012)

	Assessment area		
Sector (Standard Industrial Code 2007)	**Immediate area (250m)**	**Borough wide (LB of Wandsworth)**	**Greater London**
Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles	28%	14%	16%
Accommodation and Food Service Activities	14%	9%	8%
Administrative and Support Service Activities	8%	8%	8%
Manufacturing	7%	3%	3%
Information and Communication	7%	5%	7%
Transportation and Storage	6%	3%	4%
Arts, Entertainment and Recreation	5%	3%	3%
Financial and Insurance Activities	5%	2%	4%
Other (including unclassified)	20%	54%	48%

H.2.5 Within approximately 250m of the site there are approximately 350 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 in Vol 8 Table H.5, with a relatively high proportion of businesses engaged in Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles (17%), Information and Communication (11%), Accommodation and Food Service Activities (10%), Administrative and Support Service Activities (8%) and Manufacturing (6%).

[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.

H.2.6 Vol 8 Table H.6 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 greatest proportion. However, within approximately 250m of the site there are a greater proportion of business units of greater size than in the wider geographical area. Within 250m, 79% of businesses have one to nine employees, compared to 90% within the LB of Wandsworth and 88% within Greater London. Businesses with ten or more employees account for 21% of all businesses within 250m of the site, more than double that within the LB of Wandsworth (10%) and considerably more than within Greater London as a whole (12%).

H.2.7 For the sectors accounting for the greatest proportion of jobs and businesses within approximately 250m, the size banding of businesses varies. Within the Information and Communication sector, 89% of businesses have one to nine employees, compared to an average across all sectors of 79%; whereas 62% of both the Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles and Accommodation and Food Service Activities businesses are of this size.

H.2.8 Reflective of the industrial and warehousing character of the surrounding area, both the Accommodation and Food Service Activities sector and the Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles sector have above average proportions of large businesses within approximately 250m of the site. Overall 32% and 24% of business units respectively employ ten to 24 employees compared to the average across all sectors (14%). Both sectors also have higher proportions of business units employing 50 to 99 employees (3% and 2% respectively) and 100 to 249 employees (both 3%) compared to the averages across all sectors for these size bands.

Vol 8 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)	79%	14%	5%	1%	1%	0%
Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles	62%	24%	9%	2%	3%	0%
Information and Communication	89%	8%	3%	0%	0%	0%
Accommodation and Food Services Activities	62%	32%	0%	3%	3%	0%
Borough wide (LB of Wandsworth)	90%	7%	2%	1%	0%	0%
Greater London	88%	8%	2%	1%	1%	0%

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

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

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

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

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

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

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

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.08**

Volume 8: Dormay Street appendices

Appendix I: Townscape and visual

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Appendix I: Townscape and visual

I.1 Introduction

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

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Thames Tideway Tunnel
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Appendix J: Transport

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Appendix J: Transport

J.1 Introduction

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

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.08**

Volume 8: Dormay Street appendices

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 Dormay Street site is shown in Vol 8 Table K.1 below.

Vol 8 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 Formation

K.1.2 The superficial and solid geology in the vicinity of the site, as published by the British Geological Survey (BGS) (British Geological Survey, 2009)[1], is shown in Vol 8 Figure 13.4.1 and Vol 8 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 in the vicinity of the site; these are boreholes SA1105, SA1106 and PR1107. The locations of boreholes around the site are shown in Vol 8 Figure 13.4.3 (see separate volume of figures). The depths and thicknesses of geological layers encountered at the site is summarised in Vol 8 Table K.2 below.

Vol 8 Table K.2 Groundwater – anticipated ground conditions

Formation	Top elevation* mATD**	Depth below ground level (m)	Thickness (m)
Made ground	103.18	0.00	2.50
Alluvium	100.68	2.50	0.67
River Terrace Deposits	100.01	3.17	2.45
London Clay			
B	97.56	5.62	19.10
A3ii	78.46	24.72	12.30
A3i	66.16	37.02	2.50

Formation	Top elevation* mATD**	Depth below ground level (m)	Thickness (m)
A2	63.66	39.52	10.60

** Based on an assumed ground level of 104.00mATD*
*** mATD = metres above tunnel datum. A commonly used term for sub-surface construction projects, which defines height above a temporary datum set at -100mAOD (above Ordnance Datum).*

K.1.4 The CSO drop shaft and base slab at the Dormay Street site would extend down to approximately 80.87mATD and 78.87mATD respectively and would pass through the Made Ground, Alluvium, River Terrace Deposits and into the London Clay Formation, unit B.

K.1.5 The connection culvert from interception chamber to drop shaft would extend down to approximately 97.6mATD, close to the top of the London Clay Formation.

K.1.6 The Made Ground, containing sandy gravely clay with brick and occasional clinker, is expected to be 2.5m thick at the site.

K.1.7 The Alluvium comprised silty clay and clayey silt, with occasional scattered pebbles and granules. Within the Alluvium, local beds of fine to coarse-grained sand may be present, as laminar, lenticular or channel deposits, generally less than 1m thick but may reach up to 4m in thickness. The Alluvium is expected to be about 0.67m at the Dormay Street site.

K.1.8 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 width, in river terraces since the Anglian glaciation. The River Terrace Deposits at Dormay Street are expected to be 2.45m thick.

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 44.5m thick at the site.

K.2 Hydrogeology

K.2.1 A summary of the anticipated hydrogeological conditions at the Dormay Street site is shown in Vol 8 Table K.3 below.

Vol 8 Table K.3 Groundwater – anticipated hydrogeological units

Group	Formation	Hydrogeology
Superficial deposits	Made ground Alluvium	Confining layer[i]
	River Terrace Deposits	Upper aquifer
Thames	London Clay	Aquiclude[ii]

K.2.2 The Made Ground and Alluvium overlie the River Terrace Deposits or upper aquifer. The ground investigation boreholes drilled on site indicate that these superficial deposits were drilled dry and comprise of low permeability material. These superficial deposits act to confine the underlying River Terrace Deposits at this location.

K.2.3 The upper aquifer (River Terrace Deposits) is defined by the Environment Agency (EA) as a secondary A aquifer. These deposits are described as "permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers"[2].

K.2.4 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 Hammersmith Pumping Station site.

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

K.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.

[i] Confining layer – units of low permeability that bound an aquifer (Schwartz & Zhang, 2003).

[ii] Aquiclude – a geological formation through which virtually no water moves (EA website, 2012).

K.3.2 Information on groundwater levels for this assessment was collected from two off site boreholes (PR1107 and SR1108). These boreholes have response zones[iii] (EA, 2006)[3] and monitor groundwater levels in the River Terrace Deposits. The response zone depths, the monitored strata and the frequency of monitoring are detailed in Vol 8 Table K.4 below. The manual dip data collected from these monitoring boreholes is shown in Vol 8 Table K.5.

Vol 8 Table K.4 Groundwater – monitoring boreholes

Borehole	Response zone depths mATD	Strata	Monitoring type and frequency
PR1107	100.95-98.95	River Terrace Deposits	Fortnightly manual dips
SR1108	102.68-100.68	River Terrace Deposits	Monthly dips

Vol 8 Table K.5 Groundwater – summary level data

Borehole	Period of record	Maximum		Minimum		Average over period of record	
		mbgl	mATD	mbgl	mATD	mbgl	mATD
PR1107	20/10/2009 – 02/08/2012	2.13 (Aug. 2011)	102.32 (Aug. 2011)	3.03 (Dec. 2009)	101.42 (Dec. 2009)	2.56	101.89
SR1108	28/05/2009 – 12/07/2012	2.35 (May 2012)	102.33 (May 2012)	2.79 (August 2010)	101.89 (August 2010)	2.59	102.09

K.3.3 The recorded water levels in the River Terrace Deposits at PR1107 and SR1108 range between 101.42mATD and 102.33mATD. There is a 0.6m differential between the two borehole groundwater levels; as PR1107 is located closer to site it is considered to be more representative of site conditions. The water levels consistently remain above the top of the River Terrace Deposits, which is at 100.01mATD. This suggests that these deposits are fully saturated here and are confined by the overlying Made Ground and Alluvium at this location.

K.3.4 A plot of the groundwater levels within the River Terrace Deposits in the vicinity of the Dormay Street site is shown in Vol 8 Figure 13.4.3 (see separate volume of figures). There are two boreholes in the upper aquifer here (SR1108 and PR1107) and the recorded groundwater levels in these boreholes suggests a direction of groundwater flow from south to north at this location, as expected towards the River Thames.

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

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)[4] does not identify a condition status for the upper aquifer.

K.4.2 The status of the lower aquifer is not relevant to this assessment as the construction would not reach to this depth at the Dormay Street site.

K.4.3 No dewatering of the upper or lower aquifers is anticipated at the Dormay Street 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 sewer 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 around the site have been identified.

K.4.5 The nearest licensed abstraction from the River Terrace Deposits or upper aquifer is located at approximately 1km to the northwest of the site, close to the River Thames (28/39/39/0177). This source is held by the Trustees of the Hurlingham Club and is used for industrial, commercial and public service purposes. A capture zone for this source, estimated using licence information and appropriate aquifer properties, the boundaries of which remain approximately 1.4km from the Dormay Street site.

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 from the upper or lower aquifers located within a 1km radius of the site.

Vol 8 Table K.6 Groundwater – licensed abstractions

Licence number*	Licence holder	Purpose	Aquifer	Licensed volume [m^3/annum]
28/39/39/0177	Trustees of the Hurlingham Club	Industrial, commercial and public services	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 There are no SPZ's delineated within the vicinity of site. The nearest of these lies about 3.5km to the south. This source abstracts from the Chalk (lower aquifer) and would be unaffected due to construction taking place entirely within the upper aquifer and the London Clay.

K.6 Environmental designations

K.6.1 The site is bound by Bell Lane Creek, tributary of the River Thames to north. Groundwater in upper aquifer may be in hydraulic conductivity with Bell Lane Creek.

K.6.2 The flood risk assessment states that there are no groundwater flooding incidents within the vicinity of the Dormay Street site, based on information from the London Borough (LB) of Wandsworth SFRA.

K.6.3 There are no other environmental designations relevant to groundwater such as SSSI, SAC or SNCIs within 1km of the Dormay Street site.

K.7 Groundwater quality and land quality assessment

K.7.1 Historical mapping at the Dormay Street site indicates the presence of Corporation/Works Yard (c1898-1988) and Bell Lane Creek (c1869-1964) (Vol 8 Section 8). In addition, the Dormay Street site is located within former industrial area close to Gas and Tar Works with nearby sites known to be impacted with hydrocarbons. 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 8 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 monitoring boreholes located offsite (PR1107, SR1108, SA1110, SR1102A and SA1101) these locations are listed in Vol 8 Figure 13.4.1 (see separate volume of figures). The origin of these boreholes and groundwater quality data is detailed in Vol 8 Table K.7. Any exceedances of the UK drinking water standards *(The Water Supply Regulations,* 2000)[5] or relevant Environmental Quality Standards (EQS) (*River Basin Districts Typology Standards and Groundwater Threshold Values*, 2010)[6] are shaded in blue in this table.

K.7.3 The data shows exceedances of the relevant standards for polycyclic aromatic hydrocarbons (PAH's) and sodium at PR1107 (located 82m from the site) and for heavy metals, pesticides and hydrocarbons (including PAH's) at SR1102A (located at 559m from the site). PAH's may be formed during a range of human activities, including incomplete combustion of carbon-based fuels and other industrial processes (EA, 2010)[7]. In addition, PAH's are considered to be Priority Hazardous Substances under the Water Framework Directive (Commission of the European Communities, 2009)[8].

K.7.4 The EA monitors groundwater quality at a number of points across London, mainly the Chalk and Lower London Tertiaries (Lambeth Group). Although part of this network lies less than 0.5km away within King George's Park (PGWU1514), this borehole monitors groundwater quality in the lower aquifer only and is therefore not relevant as construction would take place entirely with the superficial deposits and the London Clay.

K.7.5 The land quality data from the ground investigation boreholes used in the groundwater quality assessment show several exceedances of the human health screening values (EA, 2009)[9] (soil guideline values designed to be protective of human health) within the Made Ground only. Further detail is provided in the land quality assessment (see Vol 8 Appendix F).

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Vol 8 Table K.7 Groundwater – groundwater quality results

Source of data*				SI	SI	TT	TT	TT	TT	TT	TT	SI	SI	TT	TT	TT	TT	TT	SI
Name				PR1107	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	SA1110	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A	SA1101
Hydrogeological unit**				RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	MG	RTD	RTD	RTD	RTD	RTD	RTD	RTD
Distance from site	EQS Criteria			82m	156m	156m	156m	156m	156m	156m	156m	554m	559m	559m	559m	559m	559m	559m	620m
Chemical	Value	Units	Source	2009	2009	15/8/2011	4/11/2011	16/1/2012	22/3/2012	3/5/2012	14/8/2012	2009	2009	15/8/2011	16/1/2012	16/4/2012	18/5/2012	3/11/2011	2009
1,1,1 - Trichloroethane	100	ug/l	SW Regs 98	-	-	<0.08	<0.08	<0.08	-	< 0.08	<0.08	-	-	<0.08	<0.08	-	< 0.08	<0.08	-
1,1,2 - Trichloroethane	400	ug/l	SW Regs 98	-	-	<0.2	<0.2	<0.2	-	< 0.2	<0.2	-	-	<0.2	<0.2	-	< 0.2	<0.2	-
1,2 - Dichloroethane {Ethylene Dichloride}	3	ug/l	WS Regs 20	-	-	<0.12	<0.12	<0.12	-	< 0.12	<0.12	-	-	<0.12	<0.12	-	< 0.12	<0.12	-
2,3 - Dimethylphenol {2,3-Xylenol}	-	ug/l	None	-	-	-	-	-	<0.0500	-	<0.05	-	-	-	-	<0.0500	-	-	-
2,3,5,6 - Tetrachloroaminobenzene {2,...Aniline}	-	ug/l	None	-	-	-	-	-	<0.00500	-	-	-	-	-	-	<0.00500	-	-	-
2,4 - Dichlorophenol	20	ug/l	WFD 2010	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1
2,4 - Dimethylphenol {2,4-Xylenol}	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1
2,4,6 - Trichlorophenol	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1
2,6 - Dichlorophenol	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1
2,6 - Dimethylphenol {2,6 Xylenol}	-	ug/l	None	-	-	-	-	-	<0.0500	-	<0.05	-	-	-	-	<0.0500	-	-	-
3,4 - Dimethylphenol {3,4 Xylenol}	-	ug/l	None	-	-	-	-	-	<0.0500	-	<0.05	-	-	-	-	<0.0500	-	-	-
4 - Chloro - 3- Methylphenol {P-Chloro-M-Cresol}	40	ug/l	WFD 2010	<0.1	<0.1	-	-	-	-	-	-	0.2	<0.1	-	-	-	-	-	<0.1
4-Methylphenol {para-Cresol}	-	ug/l	None	-	-	-	-	-	<0.0500	-	<0.05	-	-	-	-	<0.0500	-	-	-
Acenaphthene	-	ug/l	None	<0.01	<0.01	-	-	-	-	-	-	<0.01	170	-	-	-	-	-	<0.01
Acenaphthylene	-	ug/l	None	<0.01	<0.01	-	-	-	-	-	-	<0.01	6.9	-	-	-	-	-	<0.01
Acenapthene	-	ug/l	None	-	-	-	-	-	<0.01	-	<0.01	-	-	-	-	16	-	-	-
Acenapthylene	-	ug/l	None	-	-	-	-	-	<0.01	-	<0.01	-	-	-	-	0.53	-	-	-
Aliphatics >C10-C12	-	ug/l	None	2	<1	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	<1
Aliphatics >C12-C16 (Aqueous)	-	ug/l	None	4	8	-	-	-	-	-	-	-	<1	-	-	-	-	-	3
Aliphatics >C16-C21 (Aqueous)	-	ug/l	None	5	15	-	-	-	-	-	-	-	4	-	-	-	-	-	9
Aliphatics >C21-C35 (Aqueous)	-	ug/l	None	14	14	-	-	-	-	-	-	-	16	-	-	-	-	-	9
Aliphatics >C6-C8	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1
Aliphatics >C8-C10	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1
Aliphatics C5-C6	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	7.4	-	-	-	-	-	<0.1
Alkalinity (Carbonate)	-	mg/l as CaCO3	None	-	-	-	<4	-	-	-	-	-	-	-	-	-	-	<4	-
Alkalinity Ph 4.5 - As CaCO3	-	mg/l as CaCO3	None	200	300	234	212	224	-	218	231	1900	490	472	473	-	461	490	220
Aluminium Dissolved	200	ug/l as Al	DWS 2010	-	-	-	-	-	0.039	-	0.019	-	-	-	-	0.013	-	-	-
Aluminium Total	200	ug/l as Al	DWS 2010	-	-	46	26	0.025	-	0.038	0.042	-	-	<5	0.028	-	0.016	28	-
Ammonia - As N	0.39	mg/l as N	WS Regs 20	-	-	0.08	0.25	0.25	-	0.06	0.08	-	-	<0.05	4.3	-	4.34	4.2	-
Ammoniacal nitrogen	-	mg/l	None	0.76	0.42	-	-	-	-	-	-	2.4	7.9	-	-	-	-	-	0.14
Anthracene	0.1	ug/l	SW WFD	0.03	<0.01	-	-	-	<0.01	-	<0.01	<0.01	<0.01	-	-	0.1	-	-	<0.01
Antimony Total	5	ug/l	DWS 2010	-	-	-	-	-	2.9	-	3.9	-	-	-	-	0.4	-	-	-
Aromatics >C7-C8	50	ug/l	WFD 2010	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1
Aromatics >EC10-EC12	-	ug/l	None	4	4	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	4
Aromatics >EC12-EC16 (Aqueous)	-	ug/l	None	5	7	-	-	-	-	-	-	-	2	-	-	-	-	-	7
Aromatics >EC16-EC21 (Aqueous)	-	ug/l	None	8	15	-	-	-	-	-	-	-	34	-	-	-	-	-	12
Aromatics >EC21-EC35 (Aqueous)	-	ug/l	None	14	40	-	-	-	-	-	-	-	64	-	-	-	-	-	19
Aromatics >EC8-EC10	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1
Aromatics C6-C7	1	ug/l	DWS 2010	<0.1	<0.1	-	-	-	-	-	-	<0.1	19	-	-	-	-	-	<0.1
Arsenic Total	10	ug/l as As	DWS 2010	<1	2	4.1	3	3.7	-	3.8	3.7	<1	11	41.2	38	-	31	36	<1
Atrazine { }	0.1	ug/l	DWS 2010	-	-	<0.00300	<0.00300	<0.00300	-	<0.00800	<0.00800	-	-	<0.00300	<0.04000	-	<0.00800	<0.00300	-
Barium Dissolved	100	ug/l as Ba	SW Regs 96	-	-	-	-	-	16	-	12	-	-	-	-	160	-	-	-

Source of data*				SI	SI	TT	TT	TT	TT	TT	TT	SI	SI	TT	TT	TT	TT	TT	SI
Name				PR1107	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	SA1110	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A	SA1101
Hydrogeological unit**				RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	MG	RTD	RTD	RTD	RTD	RTD	RTD	RTD
Distance from site	EQS Criteria			82m	156m	156m	156m	156m	156m	156m	156m	554m	559m	559m	559m	559m	559m	559m	620m
Chemical	Value	Units	Source	2009	2009	15/8/2011	4/11/2011	16/1/2012	22/3/2012	3/5/2012	14/8/2012	2009	2009	15/8/2011	16/1/2012	16/4/2012	18/5/2012	3/11/2011	2009
Barium Total	100	ug/l as Ba	SW Regs 96	-	-	-	-	-	16	-	56	-	-	-	-	160	-	-	-
Bentazone	0.1	ug/l	DWS 2010	-	-	<0.00800	<0.00800	<0.00800	-	<0.00800	<0.00800	-	-	<0.08000	<0.00800	-	-	<0.03200	-
Benz[a]-Anthracene	-	ug/l	None	-	-	-	-	-	<0.01	-	<0.01	-	-	-	-	0.04	-	-	-
Benzene	1	ug/l	DWS 2010	<1	<1	<0.07	0.08	<0.07	<0.07	< 0.07	0.07	<1	110	0.31	0.6	1.81	0.95	<0.07	<1
Benzene (Ethylbenzene)	20	ug/l	FW List II	-	-	-	-	-	<0.06	-	<0.06	-	-	-	-	<0.06	-	-	-
Benzo (a) anthracene	-	ug/l	None	<0.01	<0.01	-	-	-	-	-	-	<0.01	1.2	-	-	-	-	-	<0.01
Benzo[a]Pyrene	0.01	ug/l	DWS 2010	<0.01	<0.01	<0.00500	<0.00500	<0.00500	<0.01	<0.00500	<0.01	<0.01	0.05	0.00730	<0.02500	<0.01	<0.00500	<0.00500	<0.01
Benzo[b]Fluoranthene	0.03	ug/l	WFD D 10	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	0.12	-	-	<0.01	-	-	<0.01
Benzo[g,h,i]Perylene	0.002	ug/l	WFD D 10	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	0.01	-	-	<0.01	-	-	<0.01
Benzo[k]Fluoranthene	0.03	ug/l	WFD D 10	<0.01	<0.01	-	-	-	<0.01	-	<0.01	0.01	0.06	-	-	<0.01	-	-	<0.01
Bifenthrin	-	ug/l	None	-	-	-	-	-	<0.00500	-	-	-	-	-	-	<0.00500	-	-	-
Boron Dissolved	1000	ug/l as B	DWS 2010	-	-	-	-	-	170	-	150	-	-	-	-	420	-	-	-
Boron Total	1000	ug/l as B	DWS 2010	350	370	220	160	170	-	0.15	0.17	250	410	340	330	-	0.37	360	310
Bromate	10	ug/l as BrO3	DWS 2010	-	-	<0.5	<0.5	0.6	-	< 0.5	<0.5	-	-	<0.5	<0.5	-	< 0.5	<0.5	-
Cadmium Total	5	ug/l as Cd	DWS 2010	<2	<2	<1.5	<1.5	<1.5	<1.5	< 1.5	<1.5	<2	<2	<1.5	<1.5	<1.5	< 1.5	<1.5	<2
Calcium Total	250	mg/l as Ca	DWS 2010	-	-	130	100	330	-	< 7.4	110	-	-	180	180	-	200	190	-
Carbendazim / Benomyl	0.1	ug/l	FW List II	-	-	<0.00300	<0.00300	<0.00300	-	<0.00500	<0.00500	-	-	<0.00300	-	-	<0.00500	<0.00300	-
Carbetamide	-	ug/l	None	-	-	<0.00600	<0.00600	<0.00600	-	<0.01000	<0.01000	-	-	<0.00600	-	-	<0.01000	<0.00600	-
Carbon Dioxide	-	ug/l	None	-	-	-	-	-	22400	-	16500	-	-	-	-	3500	-	-	-
Carbon Organic Dissolved	-	mg/l as C	None	-	-	-	-	-	3.3	-	3.2	-	-	-	-	4.9	-	-	-
Carbon tetrachloride	3	ug/l	DWS 2010	-	-	<0.07	<0.07	<0.07	-	< 0.070	<0.070	-	-	<0.07	<0.07	-	< 0.070	<0.07	-
Chlorfenvinphos	0.1	ug/l	DWS 2010	-	-	<0.00900	<0.00900	<0.00900	-	<0.00900	<0.00900	-	-	<0.00900	<0.00900	-	<0.00900	<0.00900	-
Chloride	250	mg/l as Cl	DWS 2010	130	200	80.2	69.2	88.5	-	72.8	60	-	55	153	123	-	160	184	450
Chloroform	100	ug/l	WS Regs 20	-	-	<0.6	<0.6	<0.6	-	1.41	1.25	-	-	<0.6	<0.6	-	< 0.600	<0.6	-
Chlortoluron	2	ug/l	FW List II	-	-	<0.00400	<0.00400	<0.00400	-	<0.01000	<0.01000	-	-	<0.00400	<0.50000	-	<0.01000	<0.00400	-
Chromium Dissolved	50	ug/l as Cr	DWS 2010	-	-	-	-	-	13	-	13	-	-	-	-	15	-	-	-
Chromium Total	50	ug/l as Cr	DWS 2010	<5	<5	15	9	13	-	12	-	<5	<5	18	14	-	16	7	<5
Chrysene	-	ug/l	None	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	0.03	-	-	0.03	-	-	<0.01
Clopyralid	-	ug/l	None	-	-	<0.01900	0.04000	<0.01900	-	<0.01900	<0.01900	-	-	<0.19000	<0.01900	-	-	<0.07600	-
Conductivity @ 20°C	2500	uS/cm	WS Regs 20	613	800	-	-	-	-	-	-	1880	1080	-	-	-	-	-	1880
Copper Total	2000	ug/l as Cu	DWS 2010	<2	3	<5.5	<5.5	<5.5	-	< 5.5	<5.5	7	<2	<5.5	<5.5	-	< 5.5	<5.5	7
Coumaphos	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.00500	-	-	-	-	-	-	<0.00500	-	-	-
Cresols	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-	<0.1
Cyanazine	0.1	ug/l	DWS 2010	-	-	<0.00700	<0.00700	<0.00700	-	<0.00800	<0.00800	-	-	<0.00700	<0.06000	-	<0.00800	<0.00700	-
Cyanide (Free)	50	ug/l as CN	DWS 2010	<20	<20	-	-	-	-	-	-	<20	48	-	-	-	-	-	<20
Cyanide (Total)	50	ug/l as CN	DWS 2010	<40	<40	-	-	-	-	-	-	<40	<40	-	-	-	-	-	<40
Cypermethrin	0.0001	ug/l	WFD 2010	-	-	<0.1	<10	<0.1	-	< 0.100	<0.100	-	-	0.13	<0.1	-	< 0.100	<0.1	-
Cypermethrin ID	-	Code	None	-	-	-	-	-	12	-	-	-	-	-	-	<5	-	-	-
Dalapon	-	ug/l	None	-	-	<0.05000	<0.05000	<0.05000	-	<0.05000	-	-	-	<0.05000	<0.05000	-	<0.05000	<0.05000	-
Diazinon	0.1	ug/l	DWS 2010	-	-	<0.00900	<0.00900	<0.00900	-	<0.00900	<0.00900	-	-	<0.00900	<0.00900	-	<0.00900	<0.00900	-
Dibenz-[A,H]-Anthracene	-	ug/l	None	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	0.3	-	-	<0.01	-	-	<0.01
Dichloromethane	20	ug/l	WFD 2010	-	-	<3	<3	<3	-	< 3.0	<3.0	-	-	<3	<3	-	< 3.0	<3	-
Dichlorprop	0.1	ug/l	DWS 2010	-	-	<0.01100	<0.01100	<0.01100	-	<0.01100	<0.01100	-	-	<0.11000	<0.01100	-	-	<0.04400	-
Diuron	0.1	ug/l	DWS 2010	-	-	<0.00500	<0.00500	<0.00500	-	<0.01000	<0.01000	-	-	<0.00500	<0.15000	-	<0.01000	<0.00500	-
Enterococci (Species)	-	Nr/100ml	None	-	-	-	-	-	0	-	0	-	-	-	-	0	-	-	-
Escherichia coli (Confirmed)	0	Nr/100ml	WS Regs 20	-	-	-	-	-	0	-	0	-	-	-	-	0	-	-	-

Source of data*				SI	SI	TT	TT	TT	TT	TT	TT	SI	SI	TT	TT	TT	TT	TT	SI
Name				PR1107	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	SA1110	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A	SA1101
Hydrogeological unit**				RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	MG	RTD	RTD	RTD	RTD	RTD	RTD	RTD
Distance from site	EQS Criteria			82m	156m	156m	156m	156m	156m	156m	156m	554m	559m	559m	559m	559m	559m	559m	620m
Chemical	Value	Units	Source	2009	2009	15/8/2011	4/11/2011	16/1/2012	22/3/2012	3/5/2012	14/8/2012	2009	2009	15/8/2011	16/1/2012	16/4/2012	18/5/2012	3/11/2011	2009
Ethofumesate	-	ug/l	None	-	-	-	-	-	<0.01	-	<0.01	-	-	-	-	<0.100	-	-	-
Ethylbenzene	-	ug/l	None	<1	<1	-	-	-	-	-	-	<1	<1	-	-	-	-	-	<1
Fenuron	-	ug/l	None	-	-	-	-	-	<0.01	-	<0.01	-	-	-	-	<0.01	-	-	-
Fluoranthene	0.2	ug/l	EEC MAC	0.04	<0.01	-	-	-	<0.01	-	<0.01	0.04	<0.01	-	-	1.2	-	-	<0.01
Fluorene	-	ug/l	None	0.06	<0.01	-	-	-	<0.01	-	<0.01	<0.01	0.43	-	-	1	-	-	<0.01
Fluoride	1.5	mg/l as F	DWS 2010	-	-	0.13	0.14	0.08	-	0.165	0.212	-	-	0.32	0.33	-	0.424	0.34	-
Glyphosate	-	ug/l	None	-	-	<0.01400	<0.01400	<0.01400	-	-	<0.01400	-	-	<0.01400	0.04000	-	0.04600	<0.01400	-
Hardness Total - As CaCO3	-	mg/l as CaCO3	None	-	-	-	-	-	426	-	310	-	-	-	-	540	-	-	-
Indeno-[1,2,3-Cd]-Pyrene	0.002	ug/l	WFD D 10	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	0.36	-	-	<0.01	-	-	<0.01
Iodide Ion	-	ug/l as I	None	-	-	-	-	-	<5	-	<5	-	-	-	-	7	-	-	-
Irgarol 1051	-	ug/l	None	-	-	-	-	-	0.00700	-	-	-	-	-	-	<0.00500	-	-	-
Iron Dissolved	200	ug/l as Fe	DWS 2010	-	-	-	-	-	0.028	-	<0.018	-	-	-	-	5.1	-	-	-
Iron Total	200	ug/l as Fe	DWS 2010	-	-	-	-	-	0.035	-	0.16	-	-	-	-	5	-	-	-
Isoproturon (Diip1,3Dithiolan-2-Ylidenemalonate)	0.1	ug/l	DWS 2010	-	-	<0.00300	<0.00300	<0.00300	-	<0.00800	<0.00800	-	-	<0.00300	<0.50000	-	<0.00800	<0.00300	-
Lambda Cyhalothrin	-	ug/l	None	-	-	-	-	-	6.2	-	-	-	-	-	-	3.9	-	-	-
Lead Total	10	ug/l	WS Regs 20	<4	<4	<5	<5	<5	-	< 5	<5	<4	<4	<5	<5	-	< 5	<5	<4
Lithium Dissolved	-	ug/l as Li	None	-	-	-	-	-	0.003	-	<0.0006	-	-	-	-	0.026	-	-	-
Lithium Total	-	ug/l as Li	None	-	-	-	-	-	0.0024	-	<0.0006	-	-	-	-	0.025	-	-	-
Magnesium Dissolved	50	mg/l as Mg	EEC MAC	-	-	-	-	-	13	-	8.3	-	-	-	-	17	-	-	-
Magnesium Total	50	mg/l as Mg	EEC MAC	6	9	9.5	7.6	25	-	< 0.33	8.2	24	15	16	16	-	17	17	25
Manganese Dissolved	50	ug/l as Mn	DWS 2010	-	-	-	-	-	0.043	-	<0.004	-	-	-	-	0.84	-	-	-
Manganese Total	50	ug/l as Mn	DWS 2010	-	-	-	-	-	0.044	-	0.058	-	-	-	-	0.82	-	-	-
MCPA {2-methyl-4-chlorophenoxyacetic acid }	0.1	ug/l	DWS 2010	-	-	<0.00900	<0.00900	<0.00900	-	<0.00900	<0.00900	-	-	<0.09000	<0.00900	-	-	<0.03600	-
Mecoprop { }	0.1	ug/l	DWS 2010	-	-	<0.01000	<0.01000	<0.01000	-	<0.01000	<0.01000	-	-	<0.10000	<0.01000	-	-	<0.04000	-
Mercury Total	1	ug/l Hg	WS Regs 20	<0.05	<0.05	0.005	<0.002	0.003	-	0.008	0.004	<0.05	<0.05	0.015	<0.002	-	< 0.002	0.006	<0.05
Metazachlor	-	ug/l	None	-	-	<0	<0	<0	-	< 0	<0.00800	-	-	<0	<0	-	< 0	<0	-
Methane	-	ug/l	None	-	-	-	-	-	<10.0	-	<10	-	-	-	-	<9	-	-	-
Molybdenum Total	0	ug/l	GW Regs 98	-	-	-	-	-	13	-	17	-	-	-	-	<5	-	-	-
MTBE {Methyl Tert-Butyl Ether}	-	ug/l	None	<1	<1	-	-	-	-	-	-	<1	<1	-	-	-	-	-	<1
Multi Residual Scan	-	ug/l	None	-	-	-	-	-	-	<0.10000	-	-	-	-	-	-	<0.10000	-	-
Naphthalene	1.2	ug/l	WFD D 10	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	<0.01	-	-	1.1	-	-	<0.01
Nickel Total	20	ug/l as Ni	DWS 2010	<10	<10	<4	<4	<4	-	< 4	<4	<10	<10	5	<4	-	31	<4	<10
Nitrate - N	11.3	mg/l as N	WS Regs 20	<0.1	<0.1	<0.043	11.1	12.9	-	9.82	7.74	-	<0.1	8.93	<0.043	-	< 0.068	<0.043	34
Nitrogen Total Oxidised	11.3	mg/l as N	WS Regs 20	-	-	-	-	-	15.5	-	7.91	-	-	-	-	16.8	-	-	-
Orthophosphate	-	mg/l as P	None	-	-	-	-	-	1.21	-	1.27	-	-	-	-	2.25	-	-	-
Oxamyl	-	ug/l	None	-	-	-	-	-	<0.00500	-	-	-	-	-	-	<0.00500	-	-	-
PAHs Total	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.160	-	<0.16	-	-	-	-	21.3	-	-	-
Permethrin (Cis + Trans)	0.01	ug/l	WFD D 10	-	-	-	<0.10000	<0.10000	-	-	<0.10000	-	-	-	<0.10000	-	-	<0.10000	-
Petrol range organics	-	ug/l	None	-	-	-	-	-	-	-	-	-	210	-	-	-	-	-	-
pH	10	pH units	DWS 2010	8.4	7.1	-	-	-	-	-	-	7.5	7.4	-	-	-	-	-	7.4
Phenanthrene	-	ug/l	None	0.17	<0.01	-	-	-	<0.01	-	<0.01	0.02	<0.01	-	-	0.03	-	-	<0.01
Phenol	0.5	ug/l	EEC MAC	0.19	<0.1	-	-	-	-	-	-	0.1	<3.3	-	-	-	-	-	<0.1
Phenol (Pentachlorophenol (PCP))	-	ug/l	None	-	-	<0.00900	<0.00900	<0.00900	-	<0.00900	-	-	-	<0.09000	<0.00900	-	-	<0.03600	-
Phenols Total For SWAD (7 Compounds)	-	ug/l	None	-	-	13.0	9.0	32.0	-	<8.0	<8.0	-	-	34.0	<80.0	-	<2,500,000	11.0	-

Source of data*				SI	SI	TT	TT	TT	TT	TT	TT	SI	SI	TT	TT	TT	TT	TT	SI
Name				PR1107	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	SA1110	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A	SA1101
Hydrogeological unit**				RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	MG	RTD	RTD	RTD	RTD	RTD	RTD	RTD
Distance from site	EQS Criteria			82m	156m	156m	156m	156m	156m	156m	156m	554m	559m	559m	559m	559m	559m	559m	620m
Chemical	Value	Units	Source	2009	2009	15/8/2011	4/11/2011	16/1/2012	22/3/2012	3/5/2012	14/8/2012	2009	2009	15/8/2011	16/1/2012	16/4/2012	18/5/2012	3/11/2011	2009
Polynuclear Aromatic Hydrocarbons (Total)	0.1	ug/l	DWS 2010	0.36	<0.2	-	-	-	-	-	-	<0.2	24	-	-	-	-	-	<0.2
Potassium Dissolved	-	mg/l as K	None	-	-	-	-	-	18	-	16	-	-	-	-	18	-	-	-
Potassium Total	-	mg/l as K	None	-	-	16	15	40	-	< 0.75	15	-	-	17	17	-	18	19	-
Preparation (Purge And Trap)	-	Text	None	-	-	-	-	-	-	-	Prepared	-	-	-	-	-	-	-	-
Propazine	0.1	ug/l	DWS 2010	-	-	<0.00400	<0.00400	<0.00400	-	<0.00500	<0.00500	-	-	<0.00400	<0.04000	-	<0.00500	<0.00400	-
Propetamphos	0.1	ug/l	DWS 2010	-	-	<0.00500	<0.00500	<0.00500	-	<0.00500	<0.00500	-	-	<0.00500	<0.00500	-	<0.00500	<0.00500	-
Pyrene	-	ug/l	None	0.06	<0.01	-	-	-	<0.01	-	<0.01	<0.01	2.3	-	-	1.3	-	-	<0.01
Selenium	10	ug/l as Se	DWS 2010	<3	<3	-	-	-	4.6	-	3	<3	<3	-	-	<0.4	-	-	<3
Silicate Reactive Dissolved - As SiO2	-	mg/l	None	-	-	-	-	-	21	-	22	-	-	-	-	21	-	-	-
Simazine	0.1	ug/l	DWS 2010	-	-	<0.00900	<0.00900	<0.00900	-	<0.00400	<0.00400	-	-	<0.00900	<0.04000	-	<0.00400	<0.00900	-
Sodium Total	200	mg/l as Na	DWS 2010	240	41	38	-	120	-	< 2.5	52	220	53	78	73	-	71	90	200
Strontium Dissolved	-	ug/l as Sr	None	-	-	-	-	-	0.55	-	-	-	-	-	-	0.8	-	-	-
Strontium Total	-	ug/l as Sr	None	-	-	-	-	-	0.56	-	0.37	-	-	-	-	0.8	-	-	-
Sulphate	250	mg/l as SO4	DWS 2010	230	390	100	76	111	-	117	107	-	51	70.9	75.5	-	946	65	120
Sulphide	-	ug/l	None	<10	<10	-	-	-	<29.0	-	<29.0	<10	<10	-	-	<29.0	-	-	<10
Terbutryn	0.1	ug/l	DWS 2010	-	-	<0.00300	<0.00300	<0.00300	-	<0.00500	<0.00500	-	-	<0.00300	<0.04000	-	<0.00500	<0.00300	-
Tetrachloroethylene	-	ug/l	None	-	-	<0.09	0.14	0.3	-	0.18	0.12	-	-	<0.09	<0.09	-	< 0.09	<0.09	-
Tetrachlorothioanisole	-	ug/l	None	-	-	-	-	-	<0.00500	-	-	-	-	-	-	<0.00500	-	-	-
Tin Total	0	ug/l as Sn	GW Regs 98	-	-	-	-	-	<5	-	7	-	-	-	-	<5	-	-	-
Titanium	0	ug/l as Ti	GW Regs 98	-	-	-	-	-	0.054	-	0.04	-	-	-	-	0.072	-	-	-
Toluene (Methylbenzene)	50	ug/l	WFD 2010	<1	<1	-	-	-	<0.55	-	<0.55	<1	<1	-	-	0.72	-	-	<1
Total Aliphatic TPH	-	ug/l	None	24	37	-	-	-	-	-	-	-	28	-	-	-	-	-	22
Total Aromatic TPH	-	ug/l	None	31	66	-	-	-	-	-	-	-	39	-	-	-	-	-	42
Total Chemical Oxygen Demand	-	mg/l	None	<10	<10	-	-	-	-	-	-	440	70	-	-	-	-	-	59
Total Petroleum Hydrocarbons (TPH)	-	ug/l	None	-	-	-	-	-	-	-	-	-	1700	-	-	-	-	-	-
Total Petroleum Hydrocarbons 10-20 (TPH)	-	ug/l	None	-	-	-	-	-	-	-	-	-	570	-	-	-	-	-	-
Total Petroleum Hydrocarbons 20-30 (TPH)	-	ug/l	None	-	-	-	-	-	-	-	-	-	950	-	-	-	-	-	-
Trichloroethene (Trichloroethylene)	10	ug/l	DWS 2010	-	-	<0.07	<0.07	<0.07	-	< 0.07	<0.07	-	-	<0.07	<0.07	-	< 0.07	<0.07	-
Trietazine	-	ug/l	None	-	-	<0.00600	<0.00600	<0.00600	-	<0.00800	<0.00800	-	-	<0.00600	0.06200	-	<0.00800	<0.00600	-
Trifluralin	0.1	ug/l	DWS 2010	-	-	<0.01000	<0.01000	<0.01000	-	<0.01000	-	-	-	<0.01000	<0.01000	-	<0.01000	<0.01000	-
Turbidity	1	FTU	WS Regs 20	-	-	0.24	0.2	0.26	-	0.28	0.15	-	-	22	33.6	-	31.9	20.6	-
Uranium	0	ug/l as U	GW Regs 98	-	-	-	-	-	0.7	-	0.4	-	-	-	-	0.3	-	-	-
Xylene (Meta & Para){1,3+1,4-Dimethylbenzene}	30	ug/l	WFD 2010	<1	<1	<0.09	0.21	<0.09	<0.180	0.43	<0.09	<1	12	0.27	<0.09	<0.180	0.46	0.1	<1
Xylene (ortho)	30	ug/l	SW Regs 98	-	-	-	-	-	<0.09	-	<0.09	-	-	-	-	<0.09	-	-	-
Zinc Total	50	ug/l as Zn	DWS 2010	17	28	8	<5	7	-	7	12	6	<1	<5	<5	-	< 5	<5	5

Notes:

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

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

*** Hydrogeological unit: MG – Made Ground, RTD – River Terrace Deposits*

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) (EA, 2009)[10] shows no groundwater body designation for either the upper or lower aquifers within the area in which the Dormay Street 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)[10].

K.8.6 The Thames Tideway Tunnel project would prevent deterioration of the current and predicted status of groundwater and would adhere to the key actions identified in the RBMP to achieve good status by 2021 or 2027, as follows (EA, 2009)[10]:

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 Dormay Street site assessment is given in Vol 8 Table K.8 below.

Vol 8 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 main tunnel alignment
EA	Designated source protection zones	December 2010	
EA	Groundwater level records for EA observation boreholes	September 2009, June 2011, December 2011	
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 Tideway Tunnel project	Land quality data	February 2011	

Source	Data	Date received	Notes
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 Tunnel project (February 2009).

[2] Environment Agency. *Environment Agency website*. Available at: http://www.environment-agency.gov.uk/homeandleisure/117020.aspx. Accessed 29/11/2012.

[3] 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. Accessed 29/11/2012.

[4] 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. Accessed 29/11/2012.

[5] *The Water Supply (Water Quality) Regulations, 2000*. Available at: http://www.legislation.gov.uk/uksi/2000/3184/contents/made. Accessed 29/11/2012.

[6] *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/. Accessed 29/11/2012.

[7] Environment Agency. REACH Annex *XVII Restrictions Polycyclic-aromatic Hydrocarbons (PAHs) Guidance Note Part 1* (October 2010). Available at: http://www.environment-agency.gov.uk/static/documents/Business/Part_1_PAH_Guidance_Note.pdf. Accessed 29/11/2012.

[8] Commission of the European Communities. *Directive of the European Parliament and of the Council on environmental quality standards in the field of water policy and amending Directive 2000/60/EC* (2009). Available at: http://ec.europa.eu/environment/water/water-dangersub/pdf/com_2006_397_en.pdf?lang=_e. Accessed 29/11/2012.

[9] Environment Agency. *Soil Guideline Value Reports* (2009). Available at: http://www.environment-agency.gov.uk/research/planning/64015.aspx. Accessed 29/11/2012.

[10] 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. Accessed 29/11/2012.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.08**

Volume 8: Dormay Street appendices

Appendix L: Water resources - surface water

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

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Appendix L: Water resources – surface water

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Appendix L: Water resources – surface water

L.1 Introduction

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

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

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Appendix M: Water resources - flood risk

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Appendix M: Water resources – flood risk

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Appendix M: Water resources – flood risk

M.1 Policy considerations

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

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

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

Local policy

Strategic Flood Risk Assessment

M.1.4 The Dormay Street site lies within the London Borough (LB) of Wandsworth. 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 and present the outcomes of the hydraulic modelling completed as part of the Level 2 study to investigate the residual risk of breaches in the Thames Tideway Defences (Thames Barrier and Tidal flood defence walls) at a number of locations along the River Thames.

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

M.1.6 The SFRA advocates the use of flood resilience and resistant measures.

M.1.7 According to the SFRA:

a. The site overlies London Clay.

b. It is within the Wandsworth Tidal Flood Warning Area, the River Wandle from Colliers Wood to Wandsworth Fluvial Flood Warning Area and the Environment Agency (EA) Flood Zone 3.

c. There have been '>5' 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.

e. In terms of emergency planning during the construction phase, the SFRA has identified rest and reception centres as Leisure Centre, Churches, Schools and Community Centres.

M.1.8 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.1.9 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.1.10 According to the SWMP:

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

b. A section of the site lies within an area of significant surface water flood hazard rating for the 1% AEP + 30% climate change event.

c. Surface water depths of up to1.5m occur for the 1% AEP + 30% climate change rainfall event.

Regional policy

Thames Estuary 2100

M.1.11 The site lies within the Wandsworth to Deptford 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.1.12 The TE2100 Plan identifies the local sources of flood risk at this location including:

a. tidal flooding from the River Thames

b. fluvial flooding from the River Wandle

c. heavy rainfall and urban drainage sources

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

M.1.13 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) and the lower reach of the River Wandle

b. combined sewer overflows (CSOs) for mitigation of urban drainage

c. flood forecasting and warning.

[i] Area susceptible to surface water flooding

M.1.14 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 the vision to increase flood risk awareness within the area.

M.1.15 There is an acknowledgement that tidal defences on the River Wandle will require raising for estuary wide options.

Thames Region Catchment Flood Management Plan

M.1.16 The Thames Region Catchment Flood Management Plan (CFMP) (EA, 2007)[5] covers fluvial and non-tidal sections of the River Thames, ie, the River Thames upstream of Teddington weir and tributaries to the River Thames.

M.1.17 The Thames Region CFMP advocates the reduction in flood risk through the design and layout of developments within the fluvial floodplain. This should be achieved through re-creating more natural river systems and giving space for flood water, aiming for a balance between attenuation and conveyance.

London Regional Flood Risk Appraisal

M.1.18 For the reach between Hammersmith Bridge and the Thames Barrier (City Reach (does not specify inclusion of River Wandle) the London Regional Flood Risk Appraisal (RFRA) (GLA, 2009)[6] 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 be designed in such a way as to take opportunities to reduce flood risk and include resilience.

M.1.19 There is particular concern surrounding confluences of tributaries into the River Thames and the interactions between tidal and fluvial flows in the future due to climate change. This should be taken into consideration during the re-development process.

M.1.20 The RFRA states that the current flood risk on the River Wandle should be sustained into the future. There is potential that some upstream areas of the River Wandle, south of Mitcham have the possibility of enabling catchment storage.

M.1.21 The RFRA indicates that SuDS should be included within developments to reduce surface water discharge.

M.2 Hydraulic Modelling Technical Note

Introduction

Scope

M.2.1 The EA Flood Map shows that the King George's Park site and Dormay Street site are located within Flood Zone 3a High Probability of Flooding associated with the River Wandle. In addition, the SFRA for LB of Wandsworth (Scott Wilson Ltd, 2008 and 2009)[7] identifies the part of the Dormay Street site located on the Causeway to be defined as Flood Zone 3b Functional Floodplain.

M.2.2 As a result, further modelling has been required to identify the flood risk to each of these sites and quantify the potential implications of the proposed works upon the wider flood cell in terms of floodplain storage.

M.2.3 This technical note has been prepared to summarise the methodology and conclusions of the hydraulic modelling that has been undertaken.

Software Selection

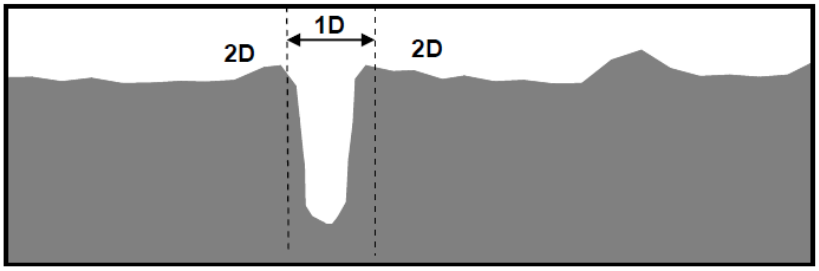
M.2.4 The model simulations have been run using ISIS Version 3.5 and TUFLOW Build 2010-10-AF-iSP.

M.2.5 ISIS (www.halcrow.com/isis) is UK standard river modelling software developed by Halcrow and used extensively by the EA and its consultants. The 1D hydrodynamic module in ISIS was used for this study.

M.2.6 TUFLOW (www.tuflow.com) is a modelling package for simulating depth averaged 2D free-surface flows, and is developed by BMT WBM, Australia. TUFLOW is in widespread use in the UK and elsewhere for 2D inundation modelling.

M.2.7 An ISIS-TUFLOW link has been developed as a joint research and development project between BMT WBM and Halcrow. This link allows the ISIS 'in bank' model to be directly linked to a TUFLOW 2D domain, which allows for better representation of urban areas focussing the computational time on the most complex flow paths. Vol 8 Plate M.1 shows an example of modelling a river channel in 1D and floodplain in 2D. Water is transferred between the 1D and 2D domains along the line of the flood defences (or bank top if no defences are present).

Vol 8 Plate M.1 Flood risk – modelling a river channel in 1D and floodplain in 2D



Data sources

M.2.8 The following information and data have been gathered to inform the construction and development of the hydraulic model:

a. River Wandle ISIS-TUFLOW Catchment Model files (EA).

b. 0.5m resolution LiDAR data (EA, Composite October 2010[8]).

c. Thames tidal defences joint probability extreme water level report (EA April 2008[9]);

d. Ordnance Survey 10K mapping;

e. Ordnance Survey Master Map (OSMM) data;

f. aerial photography;

g. site visits;

h. topographic survey for King George's Park and Dormay Street/The Causeway (Thames Water 2010[10]);

i. channel Survey for Bell Lane Creek (National Rivers Authority 1992[11]); and

j. proposed development drawings for the proposed temporary and permanent works at the King George's Park and Dormay Street/The Causeway sites (Thames Water 2011).

Consultation

M.2.9 Following the completion of the initial modelled outputs, meetings were held with representatives of the EA (30th November 2011; 17th January 2012) to discuss the findings of the modelling and inform further development of the hydraulic model.

M.2.10 Further meetings were held with the EA and LB Wandsworth throughout 2012 to discuss the modelling results and potential floodplain compensation storage options in the northern part of King George's Park.

M.2.11 The hydraulic modelling files were supplied to the EA for review and have been approved for use to inform the Level 3 FRA for the King George's Park and Dormay Street sites.

Model construction

Overview

M.2.12 The base of the hydraulic model prepared for the assessment of the Thames Tideway Tunnel sites is taken from the linked 1D-2D ISIS-TUFLOW hydraulic model covering the River Wandle catchment. The EA model represents the river channel using a series of cross sections and relevant structures and the floodplain is represented by a fixed grid with a resolution of 6m.

M.2.13 This section contains information on the changes that have been made to the model as part of this project. Detailed comments regarding the model construction and development are recorded in the model log.

M.2.14 The main elements in model construction are as follows:

a. The ISIS-TUFLOW River Wandle Catchment Model has been truncated at the Earlsfield railway embankment (Node 15.093D).

b. In order to better represent the area around The Causeway, the ISIS model has been extended to the north to include cross sections along the Bell Lane Creek informed by a channel survey (National Rivers Authority 1992).

c. The floodplain has been represented using a fix grid with a higher resolution of 3m which has been generated using up-to-date LiDAR data of 0.5m resolution (EA October 2010).

d. Up-to-date topographic survey information (Thames Water 2010) of the area around Dormay Street and The Causeway as well as King George's Park has been used to update the representation within the model for the existing scenario including accurate representation of the Thames Tidal Flood Defences along the edge of the Bell Lane Creek.

e. A series of proposed model scenarios have been constructed based upon the proposed designs of the Thames Tideway Tunnel sites at Dormay Street and King George's Park including assessment of proposed mitigation works and temporary works at the King George's Park site.

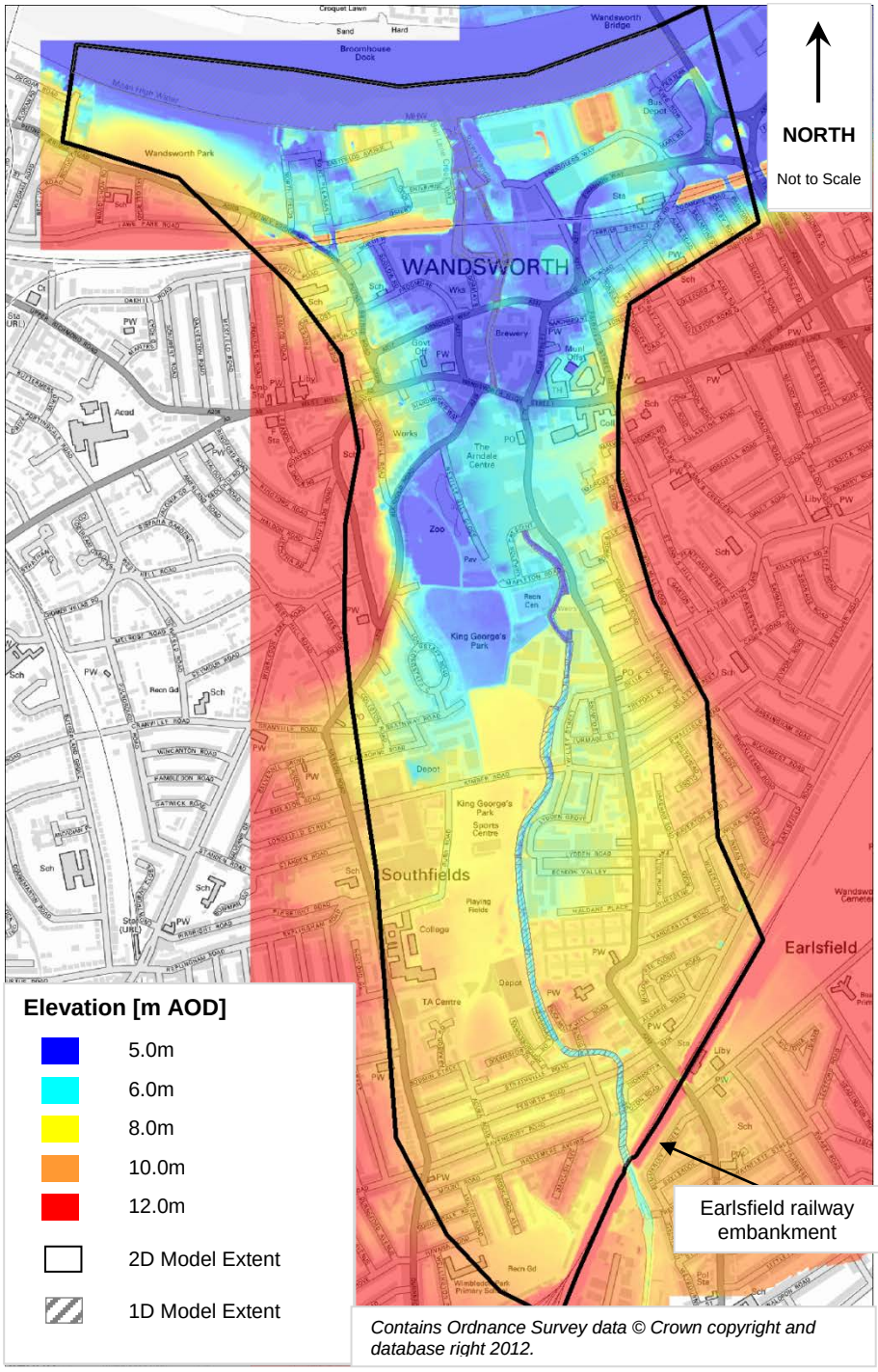
Model extent

Upstream extent

M.2.15 The existing EA River Wandle Catchment Model has been truncated at Node 15.093D to revise the upstream extent to Earlsfield railway embankment as shown in Vol 8 Plate M.2.

M.2.16 The initial TUFLOW model extents were set based on the previous flood mapping results and topography based on the DTM. These were later trimmed based on initial results from the ISIS-TUFLOW model so that the run time could be optimised.

Vol 8 Plate M.2 Flood risk – River Wandle model extent



Bell Lane Creek

M.2.17 The downstream extent of the ISIS model has been revised to include the Bell Lane Creek channel and accurate representation of the floodplain around The Causeway.

M.2.18 A channel survey (National Rivers Authority, 1992)[12] of the Bell Lane Creek provided by the EA was used to inform the representation of the Bell Lane Creek channel within the 1D domain. A narrow slot was inserted in the channel bed to prevent the channel from drying out at low tide, which had previously resulted in the model crashing.

M.2.19 As the water levels in Bell Lane Creek are dominated by tidal levels in the River Thames, the additional storage provided by the narrow slots in the bed will have a negligible impact on model results.

Grid size

M.2.20 It was considered that the 6m grid size of the existing EA River Wandle Catchment Model was of insufficient resolution to enable accurate analyses of floodplain storage at the two proposed sites. The existing model has therefore been modified to create a finer grid representation of the floodplain using a 3m grid size.

M.2.21 Following a series of initial runs, a 3m grid size was selected as it represented a good balance between the degree of accuracy (ie, ability to model overland flow paths along roads or around buildings) whilst maintaining reasonable model run ("simulation") times.

Topography

M.2.22 The EA River Wandle Catchment Model has been constructed using a range of different topographic data types. Channel survey data and existing model data has been used to develop the in-bank ISIS model and LiDAR and OSMM datasets have been used to build the out of bank TUFLOW model. A number of modifications and alterations have been made to the topography within the Catchment Model for the Thames Tideway Tunnel assessments. These are detailed below.

LiDAR

M.2.23 Light Detecting and Ranging Data (LiDAR) is used as the base information for the model topography. LiDAR data is an airborne survey technique that uses a laser to measure the distance between an aircraft and the ground surface.

M.2.24 As part of this project, LiDAR data was provided by the EA for the modelled area. The data was flown in February 2007 and has a resolution of 0.5m. The model's floodplain representation has been improved, and a high resolution 3m grid size has been specified which uses the 0.5m LiDAR data to determine the ground levels throughout the floodplain.

Survey data

M.2.25 Topographic survey data (Thames Water, 2010)[13] for the Dormay Street/Causeway and King George's Park sites has been used to supplement the LiDAR data and update the floodplain representation on the sites.

M.2.26 In addition, the Thames Tidal Defences along the west and south banks of the Bell Lane Creek have been included within the model representation; these flood defences were not included within the EA Catchment Model. Crest levels adjacent to the Dormay Street and Causeway sites have been determined from the topographic survey information.

Vol 8 Plate M.3 Flood risk – Thames tidal defences along the Bell Lane Creek

M.2.27 The photograph on the left shows the flood defences adjacent to Dormay Street. The photograph on the right shows the confluence of the Bell Lane Creek and the River Wandle channels.

Bank levels

M.2.28 For the majority of the River Wandle, the 2D boundary condition lines were drawn along the extents of the ISIS cross sections. Bank levels for TUFLOW were picked based on the top of bank heights for the ISIS cross sections.

M.2.29 Bank levels for the Bell Lane Creek were established from the channel survey and topographic site survey data provided. All bank levels have been included in the model as a series of z lines.

Roughness coefficients

M.2.30 The Manning's 'n' roughness coefficients throughout the model have been set according to the land-use based on OSMM data. Vol 8 Table M.1 provides details of the values used within the model.

Vol 8 Table M.1 Flood risk – manning's values by land classification

TUFLO W Material Code	Manning's 'n' Value	Land-use type
1	0.04	Grass
2	0.06	Dense trees
3	0.05	Fence shrubs
4	0.035	Gravel Road
5	0.025	Footpaths and paved areas and roads
6	0.05	Hard surface, standing areas, work yards
7	0.04	Open car parks
8	0.20	Multi-storey car parks

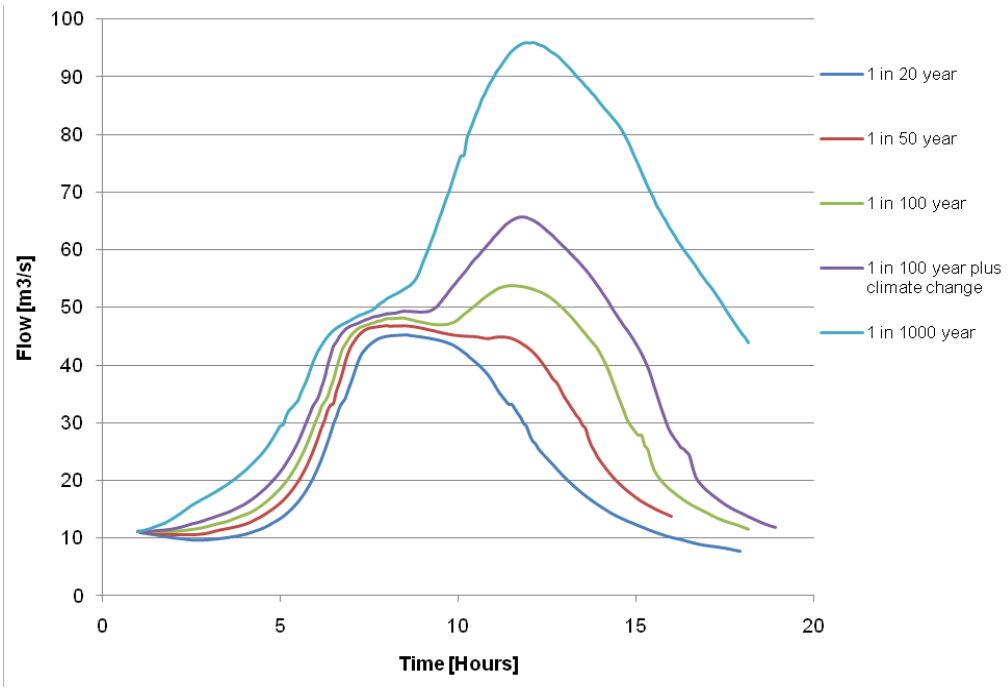
TUFLO W Material Code	Manning's 'n' Value	Land-use type
9	0.05	Fields and natural land (Default value)
10	0.1	Buildings
11	0.05	Railway
12	0.03	Water
13	0.03	Structures
14	0.03	Water
98	0.04	Default Value
99	0.25	Stability

Water Level Boundaries

Upstream boundary

M.2.31 The EA Catchment Model was truncated at the Earlsfield railway embankment (node 15.093D). In order to create the inflow boundaries for the truncated model, the flow at node 15.093D has been extracted from the Catchment Model results files for the five modelled annual exceedance probabilities (5%, 2%, 1% 1% plus 20% for climate change, and 0.1% AEP). These boundaries are shown in Vol 8 Plate M.4.

Vol 8 Plate M.4 Flood risk – upstream boundary conditions (node 15.093D)



Downstream tidal boundaries

M.2.32 The EA Catchment Model applied a Mean High Water Spring (MHWS) tidal water level profile as the downstream boundary. A tidal peak of 4mAOD was applied, that coincides with the fluvial peak level.

M.2.33 As part of the Thames Tideway modelling, three downstream tidal boundaries have been considered; the MHWS, 1 in 20 year (5% AEP) tidal profile and 1 in 1000 year (0.1% AEP) tidal profile.

M.2.34 In order to establish the boundaries for the 1 in 20 and 1 in 1000 year tidal events, the tidal curves from the Environment Agency Embayment Modelling and the water levels within the Environment Agency Thames Tidal Defences Joint Probability Extreme Water Levels 2008 Report (EA, 2008)[14] have been used.

M.2.35 The Joint Probability Extreme Water Level Report details the water levels throughout the Thames created from a 2D joint-probability computer hydraulic model. The study, which was completed in 2008,modelled water levels for 7 different annual exceedance probabilities (10%, 5%, 2%, 1%, 0.5%, 0.2% and 0.1%). Each of these probabilities has been modelled for present day (2005) and future years (2055 and 2017), taking into account Defra's climate change allowances as set out in the NPPF. These values have been extrapolated to determine a level for the year 2011.

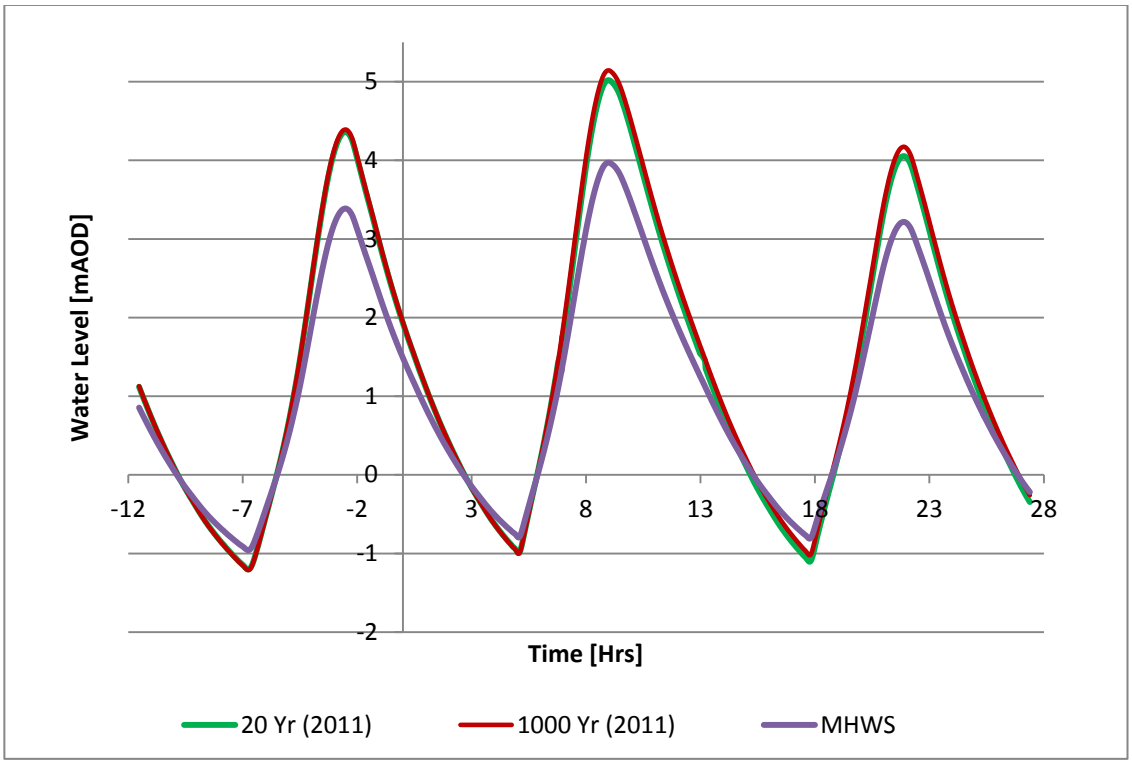
M.2.36 The confluence of the River Wandle and Bell Lane Creek with the River Thames is approximately half way between node 2.23 and node 2.25 from the Joint Probability Extreme Water Levels modelling, and therefore an average water level from these two nodes has been assumed, as shown in Vol 8 Table M.2.

Vol 8 Table M.2 Flood risk – Thames tidal levels (2011)

X	Y	Node	Annual Exeedance Probability (AEP) 2011						
			10%	5%	2%	1%	0.5%	0.2%	0.1%
524453	175620	2.23	4.994	5.034	5.074	5.104	5.124	5.144	5.154
525470	175310	Wandle	4.98	5.02	5.06	5.09	5.11	5.13	5.14
526164	175610	2.25	4.974	5.014	5.054	5.074	5.094	5.114	5.134

M.2.37 The tidal curves obtained from EA Embayment Modelling have been scaled to the peak water levels in the Thames shown in the table above and were then shifted to ensure that the tidal peak aligned with the fluvial peak in the River Wandle. The resulting tidal boundaries are shown in Vol 8 Plate M.5.

Vol 8 Plate M.5 Flood risk – downstream boundary condition



Design model runs

M.2.38 The design model simulations listed below were run on a fixed timestep of 0.75s and 1.5s for the 1D and 2D domains respectively. The runs were completed using ISIS version 3.5 and TUFLOW build 2010-10-AF-iSP.

a. 1 in 100 year (1% AEP) fluvial event with MHWS tidal boundary

b. 1 in 100 year (1% AEP) including 20% climate change fluvial event with MHWS tidal boundary

c. 1 in 1000 year (0.1% AEP) fluvial event with MHWS tidal boundary

d. 1 in 20 year (5% AEP) fluvial event with 1 in 20 year (5% AEP) tidal boundary

e. 1 in 20 year (5% AEP) fluvial event with 1 in 1000 year (0.1% AEP) tidal boundary

f. 1 in 100 year (1% AEP) including 20% climate change fluvial event with 1 in 20 year (5% AEP) tidal boundary

Model Development – Baseline Scenario

M.2.39 The model set-up files included within the EA Catchment Model have been used as the basis for representation of the baseline scenario.

M.2.40 As the ground levels within the Baseline Model were based on LiDAR data, some 'scouring out' of buildings had occurred (during the automatic LiDAR filtering process) resulting in very low ground levels within the building outline.

M.2.41 In order to better represent the existing building thresholds in the Dormay Street area, topographic survey has been reviewed and z-shapes were

inserted to apply a uniform level across the building thresholds of the existing buildings in that area.

Water level lines

M.2.42 Water level lines were added to the model set-up in order to ensure that the channels of the River Wandle and Bell Lane Creek watercourses are shown as flooding in the modelled outputs.

Results – Baseline scenario

M.2.43 The following figures are provided to show the comparison between the Catchment Model and the Baseline Model:

a. Vol 8 Figure M.2.1 Catchment model maximum flood depth 1% AEP fluvial event with MHWS tidal boundary (see separate volume of figures)

b. Vol 8 Figure M.2.2 Catchment model maximum flood depth 1% AEP plus climate change fluvial event with MHWS tidal boundary (see separate volume of figures)

c. Vol 8 Figure M.2.3 Baseline model maximum flood depth 1% AEP fluvial event with MHWS tidal boundary (see separate volume of figures)

d. Vol 8 Figure M.2.4 Baseline model maximum flood depth 1% AEP plus climate change fluvial event with MHWS tidal boundary (see separate volume of figures)

e. Vol 8 Figure M.2.5 Baseline model maximum flood depth 5% AEP fluvial event with 5% AEP tidal boundary (see separate volume of figures)

f. Vol 8 Figure M.2.6 Baseline model maximum flood depth 5% AEP fluvial event with 0.1% AEP tidal boundary (see separate volume of figures)

M.2.44 The results demonstrate that at the King George's Park site, the flood depths are very similar to those experienced in the EA Catchment Model. The flow capacity of the twin culvert beneath Southside Shopping Centre is not sufficient to convey the 1 in 100 year (1% AEP) fluvial flood event. This causes the channel upstream to back up and water to come out of bank adjacent to the recreation ground located to the south of Mapleton Road and to the east of King George's Park. The predominant flowpath is west into King George's Park where water ponds until it reaches a sufficient level to spill over into the northern part of the park and propagate northwards to the location of the proposed site. A peak flood level of 6.0mAOD is experienced on the King George's Park site during the 1 in 100 year (1% AEP) with climate change fluvial event and MHWS tidal boundary.

M.2.45 On reaching the northern part of King George's Park, floodwaters continue northwards along Buckhold Road, across Wandsworth High Street and Armoury Way and down Dormay Street and Frogmore Street. The railway embankment and tidal defences adjacent to the Bell Lane Creek present a

barrier to further propagation of the flowpath and therefore floodwaters accumulate to significant depths in the topographic depression.

M.2.46 It is noted that modelled flood depths adjacent to Hardwick's Way are shown to be particularly deep. A review of the topography in the model set up files shows that this is due to a minor error in the LiDAR data. This is likely to have occurred during the automatic LiDAR filtering process resulting in the ground levels in this area being much lower than the actual levels.

M.2.47 At the Dormay Street site, the results from the Baseline Model are different to those shown by the Catchment Model. This is due to the improved representation of the tidal flood defences along Bell Lane Creek which prevent overland flows from discharging straight into Bell Lane Creek. The tidal flood defences form a barrier and lead to increased ponding of floodwaters in this area. As a result, peak flood levels on the Dormay Street site are higher than those experienced in the Catchment Model. The peak flood level on the Dormay Street site during the 1 in 100 year (1% AEP) including an allowance for climate change fluvial event and MHWS tidal boundary is 5.77mAOD.

M.2.48 The modelling shows that floodwaters do spread northwards along the Causeway (road), however flow does not reach the area proposed for temporary works required to support the construction of the Dormay Street site. These modelled scenarios therefore confirm that The Causeway site is not located within the fluvial floodplain. As a result, it is not necessary to consider the impact of any proposed works on the floodplain storage.

M.2.49 To summarise;

a. the Causeway site is not located within Flood Zone 3b Functional Floodplain;

b. the Dormay Street site is not located within Flood Zone 3a associated with the River Wandle;

c. the Dormay Street site is located within Flood Zone 2 associated with the River Wandle as well as Flood Zone 3a including an allowance for climate change (ie, 1% AEP including climate change); and,

d. the King George's Park site is located in Flood Zone 3a associated with the River Wandle.

Model development – proposed scenario

M.2.50 As discussed above, the Dormay Street site is not located within Flood Zone 3a during the present day scenario. However when considering the 1 in 100 year (1% AEP) fluvial event *including an allowance for climate change*, the site does experience flooding. As a result, it is necessary to consider the impact of the proposed works on the ability of the floodplain to store floodwater during this scenario and a proposed model build has been developed to enable this

M.2.51 Detailed drawings of the proposed works at Dormay Street and The Causeway have been used to inform modifications to the model set up for the proposed scenario.

M.2.52 At the Dormay Street site, no changes to ground levels are proposed as part of the construction works. Instead, due to the proposed demolition of three large warehouse structures, the proposed works will actually result in a reduction of building footprint in this area of approximately 890m^2.

M.2.53 As a result, the proposed scenario has been represented within the model set up as changes to the roughness coefficients.

M.2.54 The changes to roughness coefficients that have been made between the baseline and proposed models are shown in Vol 8 Figure M.2.7 and Vol 8 Figure M.2.8 (see separate volume of figures).

Flood Hazard Rating

M.2.55 Flood hazard rating is a method of understand the risk of flooding based upon both the flood depth and flow velocity. The derivation of flood hazard categories is based on the formulae presented in the Defra publication 'Flood Risks to People FD2320' (Defra & Environment Agency, 200515).

M.2.56 The following figures show the maximum flood hazard rating for the baseline and proposed scenarios:

a. Vol 8 Figure M.2.10 Baseline model flood hazard rating 1% AEP plus climate change fluvial event with MHWS tidal boundary (see separate volume of figures)

b. Vol 8 Figure M.2.11 Proposed model flood hazard rating 1% AEP plus climate change fluvial event with MHWS tidal boundary (see separate volume of figures)

M.2.57 A comparison of these figures confirms that the proposed works do not impact on the hazard rating in the surrounding area. Vol 9 Figure M.2.9 (see separate volume of figures) shows the maximum flood depths for during the 1 in 100 year (1% AEP) including climate change fluvial event with MHWS tidal boundary for the proposed works, and comparison between this figure and Vol 9 Figure M.2.4 (see separate volume of figures) demonstrates no impact on flood levels in the surrounding area.

Sensitivity analysis

M.2.58 Additional model runs have been undertaken to determine the impact of varying roughness coefficients on the model results and to enable an appreciation of the impact of the proposed works in the context of the general sensitivity of the model. The sensitivity analysis has been undertaken on the 1 in 100 year (1% AEP) fluvial event including climate change and MHWS tidal boundary for both the baseline and proposed scenarios.

M.2.59 Global changes were made to the roughness values and applied either solely to the floodplain, or the floodplain and the channel. The following list summarises the scenarios that were undertaken as part of the sensitivity analysis:

a. Baseline model. Roughness values -20% applied to the floodplain.

b. Baseline model. Roughness values +20% applied to the floodplain.

c. Baseline model. Roughness values -20% applied to the floodplain and channel.

d. Baseline model. Roughness values +20% applied to the floodplain and channel.

e. Proposed model (without mitigation). Roughness values -20% applied to the floodplain.

f. Proposed model (without mitigation). Roughness values +20% applied to the floodplain.

g. Proposed model (without mitigation). Roughness values -20% applied to the floodplain and channel.

h. Proposed model (without mitigation). Roughness values +20% applied to the floodplain and channel.

M.2.60 A summary of the results from the sensitivity analysis is provided in Vol 8 Figure M.2.12 and Vol 8 Figure M.2.13 (see separate volume of figures).

Conclusions

M.2.61 Hydraulic modelling of the River Wandle has been undertaken to inform the Level 3 FRA for Dormay Street. This modelling confirms that the Dormay Street site is located within Flood Zone 2 associated with the River Wandle. Flood Zone 2 is land assessed as having between a 1 in 100 and 1 in 1000 annual probability of flooding from the fluvial River Wandle in any given year (0.1% AEP). For works located in Flood Zone 2, it is not necessary to consider the impact of the proposed works on floodplain storage.

M.2.62 The Dormay Street site is not located in Flood Zone 3a (1% AEP) during present day conditions. However, when considering the 1 in 100 year (1% AEP) fluvial event including an allowance for climate change, the Dormay Street site does experience flooding. As a result, it has become necessary to assess the impact of the proposed development on the ability of the floodplain to store floodwater during this scenario.

M.2.63 The proposed works do not result in any increase in ground levels. Changes have been represented with the model as changes to the roughness coefficients applied across the area as a result in the change of land surface materials. The results of the modelling show that the proposed works at Dormay Street do not result in any change in the flood levels in the area and therefore no further design measures are required for the Dormay Street site.

M.2.64 The Causeway site, located to the north of the Bell Lane Creek, is to be used only for temporary works. Revised modelling of the River Wandle undertaken as part of this study shows that the Causeway site is not located in Flood Zone 3b functional floodplain. As a result, no mitigation measures are proposed for this part of the site.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.08**

Volume 8: Dormay Street appendices

Appendix N: Development schedule

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

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Thames Tideway Tunnel

Environmental Statement

Volume 8 Dormay Street appendices

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 8 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 8 Table N.1 Development schedule for Dormay Street

Category types:

a. Under construction

b. Permitted but not yet implemented

c. Submitted but not yet determined

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2017 (peak construction traffic year)	2023 (Year 1 of operation)		
Southside Shopping Centre, Garratt Lane	110m south	2011/5534	Metro Shopping Fund LP	Demolition of Block B and erection of replacement building of up to four-storeys; erection of front extensions and formation of mezzanine floors to Block A to provide up to 3 levels of accommodation including existing basement; proposed floorspace to accommodate retail, financial and professional services, restaurants, pubs and bars and a gym (Classes A1, A2, A3, A4 and D2) together with improvements to existing facade and service yard E, landscaping, public art, signage, advertising and associated works.	B	100% complete & operational	100% complete & operational	100% complete & operational	Planning application held on the LBW online database, no information that indicates that the development would be built in phases.	Base case (all years)
Units 1 -20 Enterprise Way	Approx 155m north	2009/3017	Barratt Homes Ltd	Demolition of existing buildings. Erection of 8 buildings ranging in height from 2 to 21 storeys comprising 275 flats of which 89 would be affordable; 3,587sq.m. of commercial floor space to include shops, financial and professional services (Class A1).	A	100% complete & operational	100% complete & operational	100% complete & operational	Chapter 6 of ES - development programme, demolition and construction	Base case (all years)
Western Riverside Transfer Station	Approx 200m north	2009/1239	Cory Environmental Ltd	Replacement of existing Civic Amenity facility with a building with open sides to south and west elevations for use as a Civic Amenity facility including revised public access/queuing arrangements to the east of the proposed building. Revised staff car park.	A	100% complete & operational	100% complete & operational	100% complete & operational	Planning application information held on the LBW online database and site visit conducted December 2011.	Base case (all years)
Osiers Road	Approx 220m northwest	2011/5207	Boyer Planning	Demolition of existing buildings. Erection of buildings up to 8-storeys high plus basement to provide 158 flats (including 48 affordable units), 2,228sq.m. of commercial accommodation for retail, food and drink, business and community uses (Class A1, A2, A3, B1, D1) with associated parking, private amenity space and public realm with access through the site.	B	100% complete & operational	100% complete & operational	100% complete & operational	Planning application information held on the LBW online database, no information indicates that the development would be built in phases.	Base case (all years)
Wandsworth Riverside Quarter, Point Pleasant/Osiers Road	Approx 245m north	2009/3372	Frasers Riverside Quarter Ltd	Erection of six buildings ranging in height up to fifteen-storeys and two	A	Phase A (Buildings 5A, 5B, 5C and 5D) complete & operational.	Phase A (Buildings 5A, 5B, 5C and 5D) complete & operational. Phase B (Buildings	100% complete & operational	Planning application information held on the LBW online database and site visit conducted December 2011. Planning Statement states	**2016 & 2017:** Base case = Buildings 5A, 5B, 5C & 5D

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2017 (peak construction traffic year)	2023 (Year 1 of operation)		
				single-storey commercial pavilions to provide approximately 8,712sq.m. of commercial floorspace (including community and leisure uses) and 504 residential units (308 private/196 affordable). Provision of open space, new vehicular and pedestrian access points and associated parking.		Phase B (Buildings 6A & 6B) under construction.	6A & 6B) under construction.		the development will be constructed in two phases but does not indicate over what time period. As construction has commenced, it is assumed that Phase A (Buildings 5A, 5B, 5C & 5D) will be complete and occupied by 2016 and Phase B (Buildings 6A & 6B) by 2019/20.	Cumulative = Buildings 6A & 6B **2023:** Base case = all buildings No cumulative
Cockpen House, Buckhold Road	Approx 290m south	2008/0960	Minerva (Wandsworth) Ltd	Demolition of all existing buildings. Erection of 5 to16-storey buildings plus basement made up of a 5-storey building to the rear, stepping up to a 10-storey building along Buckhold Road with the 4-storey element and 16-storey tower facing King George's Park along the new pedestrian route to Hardwicks Square. Provision of 207 flats. 1010sq. m of commercial space including shops, community uses, offices, bars and restaurants. Underground parking for 78 vehicles and 206 cycles.	A	100% complete & operational	100% complete & operational	100% complete & operational	Environmental Statement Non Technical Study (Section 6 Development Programme and Construction) Site visit conducted December 2011	Base case (all years)
The Business Village, Broomhill Road	Approx 350m southwest	2007/2999	Workspace Glebe Ltd	Demolition of existing buildings. Erection of buildings between four and sixteen-storeys in height to provide 10,500 sq.m. of B1 floorspace (office, research and development, and light industry), 209 residential units, retail, cafe+/restaurant and crèche/nursery uses with 120 parking spaces within the basement and provision of new public routes/spaces.	A	100% complete & operational	100% complete & operational	100% complete & operational	ES not available online Site visit conducted December 2011 As it is currently under construction, it is assumed it will be complete and operational by Site Year 1 of construction.	Base case (all years)
Battersea Reach	Approx 600m northeast	2011/0324	St. George South London Limited	Erection of five buildings ranging in height between 6 and 15-storeys (Blocks M, N, P, Q & T) to south-west part of site, to include 374 flats and 2,636sq.m. of commercial floorspace comprising retail, restaurants/cafes/bars (Class A1, A2, A3 and B1 Use), with associated car parking, access and landscaping. (Revision to Outline planning permission dated 02.01.2008 ref: 2006/4533)	B	Under construction	Under construction	100% complete and operational	No information in planning application documentation on construction phasing. As the development is permitted it is expected that construction will begin by 2013 and take several years. Given the scale of the development it is therefore assumed that the development is still under construction in 2016/17 but complete and operational by 2018.	**2016 & 2017:** Cumulative **2023:** Base case
Townmead Road	Approx 750m northeast	2010/01792/FUL	Cemex UK Operations,	Redevelopment of site involving the demolition of existing concrete plant, conveyors, aggregate building, workshop and related structures and the	B	100% complete and operational	100% complete and operational	100% complete and operational	LBHF online planning applications database. The information submitted does not indicate that the development is proposed to	

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2017 (peak construction traffic year)	2023 (Year 1 of operation)		
				erection of a replacement concrete plant, aggregate storage facility, transfer building and conveyors and siting of batch cabin and office portacabin with associated cycle storage area.					be built out in phases and therefore assumption made that the development would be built out in full by Site Year 1 of construction.	Base case (all years)

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

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